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REVIEW

ADDICTION SSA

Economic evaluations of tobacco control interventions in low- and middle-income countries: a systematic review

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Abstract

Background and Aims: Tobacco consumption and its associated adverse outcomes remain major public health issues, particularly in low- and middle-income countries. This systematic review aimed to identify and critically assess full economic evaluations for tobacco control interventions in low- and middle-income countries.

Methods: Electronic databases, including EMBASE, MEDLINE and PsycINFO and the grey literature, were searched using terms such as 'tobacco', 'economic evaluation' and 'smoking' from 1994 to 2020. Study quality was assessed using the Consensus Health Economic Criteria and the Philips checklist. Studies were included which were full economic evaluations of tobacco control interventions in low- and middle-income settings. Reviews, commentaries, conference proceedings and abstracts were excluded. Study selection and quality assessment were conducted by two reviewers independently. A narrative synthesis was conducted to synthesize the findings of the studies.

Results: This review identified 20 studies for inclusion. The studies evaluated a wide range of interventions, including tax increase, nicotine replacement therapy (nicotine patch/gum) and financial incentives. Overall, 12 interventions were reported to be cost-effective, especially tax increases for tobacco consumption and cessation counselling. There were considerable limitations regarding data sources (e.g. using cost data from other countries or assumptions due to the lack of local data) and the model structure; sensitivity analyses were inadequately described in many studies; and there were issues around the transferability of results to other settings. Additionally, the affordability of the interventions was only discussed in two studies.

Conclusions: There are few high-quality studies of the cost-effectiveness of tobacco use control interventions in low- and middle-income countries. The methodological limitations of the existing literatures could affect the generalizability of the findings.

KEYWORDS
Cost-effectiveness, economic evaluation, low- and middle-income countries, smoking cessation, tobacco control, tobacco economics

INTRODUCTION

Tobacco consumption is a major public health issue in low and middle-income countries (LMICs), and 80% of the current 1.3 billion smokers in the world live in LMICs [1]. The global smoking-attributable cost was estimated to be US$1436 billion in 2012, of which 40% was related to LMICs [2]. The number of tobacco-attributable deaths in LMICs was 3.4 million in 2002, and it was

predicted to reach 6.8 million per year by 2030 [3]. Although the global age-standardized prevalence of daily smoking decreased by approximately 30% between 1990 and 2015, only four LMICs (Brazil, China, Dominican Republic and Kenya) were among the 13 countries which showed a sustained success in controlling tobacco use [4].

The World Health Organization (WHO) has recommended the 'MPOWER' package which includes monitoring tobacco use and prevention policies, protecting people from tobacco smoke, offering help to quit tobacco use, warning about the dangers of tobacco, enforcing bans on tobacco advertising, promotion and sponsorship and raising taxes on tobacco [5]. Following this recommendation, 60% of LMICs had implemented the MPOWER indicators by 2014 [6]. However, it is difficult to fully implement tobacco control interventions in LMICs due to resource constraints and infrastructure shortages [7]. For example, only seven LMICs provided comprehensive cessation services by 2019, and there were still 24 countries providing no cessation support at all [8].

A review by Berg *et al.* [9] suggested that the successful implementation of any policy or regulation relating to tobacco use is dependent upon the availability of relevant research evidence. Therefore, economic evaluations which compare the cost and health outcomes (i.e. cost for achieving the desirable effect, benefit or utility) of tobacco control interventions could facilitate the identification of optimal interventions in LMICs. There are often challenges around the transferability of economic evaluation findings to other locations due to variabilities related to costs and outcomes. In this case, Sculpher *et al.* [10] suggested that although economic evaluations could be undertaken either alongside clinical trials or through decision analytical models, model-based economic evaluations can be easily adapted from one location to another as locally existing evidence can be incorporated and synthesized, thus generating results that reflect specific contexts. The generalizability of modelling techniques makes them particularly favourable to LMIC settings.

Although several tobacco control interventions have been found to be highly cost-effective in HICs, there is limited evidence for LMICs [11, 12]. The lack of a well-established research environment, limited health economics capacity and a lower level of acceptance of evidence-based policymaking were suggested to be the main limitations on the development of economic evaluations in LMICs [13–15]. To date, two systematic reviews and a scoping review have identified several observational or randomized controlled studies assessing the efficacy of smoking cessation interventions in LMICs [16–18] however, none of them focused upon economic evaluations that evaluated both the cost and effectiveness of those interventions.

The World Health Organization (WHO) reported that the age-standardized prevalence of tobacco smoking was 52.4% in 2015, and the age-standardized prevalence of smokeless tobacco use was 20.5% during 2007–17 among people aged more than 15 years among LMICs [19]. This systematic literature review aimed to identify and critically evaluate published full economic evaluations of interventions for combustible and smokeless tobacco use control in LMICs which focused upon health impacts. This included both population-level tobacco control policy/regulation initiatives, as well as cessation interventions and services. The objective of this study was to assess the methods adopted in the studies, reporting of findings and transferability in order to develop recommendations for policymakers and future evaluations.

METHODS

Search strategy

The focus of this review was upon full economic evaluations of tobacco control interventions which considered both costs and health outcomes, and compared more than one alternative [20]. Following a scoping search, a search strategy was developed which included key terms such as 'smoking cessation', 'tobacco control', 'Tobacco, Smokeless', 'low- and middle-income countries' and 'economic evaluation' (Supporting information, Appendix S1). Relevant databases were identified based on the findings of an experimental study which aimed to analyze the efficiency of identifying economic evaluations [21]. The experimental study examined different combinations of databases and showed that the combination of EMBASE, Health Technology Assessment database, MEDLINE and Scopus was capable of retrieving 96% of relevant economic evaluations. Therefore, the following electronic databases were searched: EMBASE, MEDLINE, Scopus, Health Technology Assessment database, PsycINFO and National Health Service Economic Evaluation Database (NHS EED).

Since the first international guideline of cost analysis in primary health care was released in 1994 by the WHO [22], the database search was limited to studies published after 1994. The database search was supplemented by hand-searching of references, citation chaining and searching grey literature, such as the Grey Literature Report and Health Systems Evidence, the World Bank and WHO databases.

Inclusion and exclusion criteria

Studies were selected according to the following criteria, which were developed based upon the PICOS framework [23].

Participants

The review included studies focusing upon the general population and clinical populations who sought or received support for cessation. Participants should be using at least one type of combustible or smokeless tobacco product including, but not limited to, combustible cigarettes, electronic cigarettes which are consumed through vaping devices and menthol cigarettes.

Interventions

Any type of clinical/non-clinical activity aiming at controlling combustible or smokeless tobacco use, including but not limited to brief

counselling, cessation campaigns, behavioural support, nicotine replacement therapies (e.g. nicotine patch/gum, nasal spray, inhalers, sublingual tablets, etc.) and tobacco control policies (i.e. governmental control measures such as tax rises on tobacco products, indoor smoking bans, advertisement restrictions, health warnings on cigarette packs, etc.).

Comparators

The comparators in the studies could be other interventions, no intervention or usual care.

Outcomes

The study should report both the costs and outcomes of the intervention(s) used as part of an economic evaluation (e.g. cost-effectiveness, cost–benefit or cost–utility analysis). The cost categories could vary depending upon the perspective (e.g. societal, health-care system or individual) of the economic evaluation. For example, this could include direct costs (e.g. cost of diagnostics, therapy, healthcare, travelling, time loss and implementation of the interventions, etc.) and indirect costs, such as productivity loss. The outcomes of the interventions could be measured in terms of clinical effectiveness (e.g. abstinence rates, life years gained or quit rates), monetary benefit or utility gain [measured in terms of quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs)]. No other restrictions were placed on study outcomes, as one of the purposes of this review was to identify the outcomes reported in the studies.

Settings and study type

The study setting needed to be LMICs according to the World Bank's income criteria [24]. A list of LMICs included in this study is provided in Supporting information, Appendix S2. The study type was limited to full economic evaluations which compared both cost and health outcomes (i.e. cost–utility, cost-effectiveness, cost–benefit analysis) with or without a modelling component. Full texts of studies published in languages other than English were translated if they met the inclusion criteria at stage 1 of the screening process, based on the review of abstracts (published in English).

Exclusions

Studies that did not include original data analysis or were limited in scope, such as reviews, abstracts, conference proceedings, guidelines and editorials, were excluded.

Selection of studies

Study selection was undertaken by two reviewers independently. The two-stage categorization process outlined by Roberts *et al.* [25] was adopted for study identification (Table 1). At stage 1, studies were categorized based on title and abstract screening. Full texts were retrieved for the studies classified as groups A, B and C to carry out further examination at stage 2. Following the assessment of full texts, eligible studies were taken forward to quality assessment.

TABLE 1 Categorization criteria for study selection

Stage 1	A. The study involves a full economic evaluation of tobacco control interventions in low- and middle-income countries (LMICs) based on primary and/or secondary data (e.g. previously published studies or other sources)
	B. The study discusses economic aspects of tobacco control interventions in LMICs and contains relevant primary and/or secondary data
	C. The study discusses the effectiveness of tobacco control interventions in LMICs and contains relevant primary and/or secondary data
	D. The study discusses other aspects of tobacco control interventions in LMICs but is neither (A) nor (B) nor (C) (e.g. implementation, causal study or commentary)
	E. The study is not relevant to the economic evaluation of tobacco control interventions in LMICs
Stage 2	1. Full economic evaluation incorporating a decision analytical model (e.g. Markov model, decision tree and individual sampling models)
	2. Full economic evaluation incorporating other types of models but not a decision analytical model (e.g. demographic models such as the SimSmoke model)
	3. Full economic evaluation that does not include a model component (e.g. trial-based evaluation, etc.)
	4. Study that measured/valued outcomes of tobacco control interventions but did not consider cost or cost-effectiveness
	5. Study focusing upon costs or estimating resource use and/or economic burden of tobacco control interventions only
	6. Systematic review of economic evaluations for tobacco control interventions

Data extraction and quality assessment

Data extraction was performed by one reviewer and checked by another for consistency. A data extraction template was developed to extract useful data on study characteristics such as population, intervention, study design, costs and outcomes and key results. The quality of included studies was assessed using the Consensus Health Economic Criteria (CHEC) list [26] for trial-based studies and the Philips (2004) checklist [27] for model-based studies. Additionally, the consideration of affordability in relation to the interventions was added to both checklists as suggested by National Institute for Health and Care Excellence (NICE) International and the Bill and Melinda Gates Foundation (2014) [28] (Supporting information, Appendices S3 and S4). The quality assessment was undertaken by two independent reviewers and any conflict was resolved through discussion.

Analysis

The findings from the included studies were tabulated to facilitate analysis. A narrative synthesis was undertaken in line with Centre for Reviews and Dissemination (CRD) guidance [29]. This approach involves a descriptive summary of the included studies, together with an overall assessment of the robustness of the evidence. A narrative synthesis is recommended when a meta-analysis is difficult due to the methodological heterogeneity of the included studies [30]. It should be noted that the analysis was not pre-registered and that the results should be considered exploratory. This systematic review was not formally registered with Prospero. The protocol is not published, as the review was prepared as part of part of an educational programme. No funding was received for this study. Further information used for the review is available in the on-line appendices.

RESULTS

Search results

The process of searching and selecting studies is presented in the Preferred Reporting Items for Systematic reviews and Meta-Analyses PRISMA) flow diagram (Fig. 1). The systematic search of electronic databases yielded 1141 articles, and 25 additional studies were identified through hand-searching. After removing 225 duplicates, 941 articles were assessed for categorization at stage 1 based on title and abstract. Following this assessment, 844 articles were excluded and the remaining 97 articles that met the inclusion criteria based on title and abstract were included for full text assessment (stage 2). Of these 97 articles, 77 articles were excluded after full text assessment, mainly because they were partial economic evaluations that reported costs alone (n = 4), outcome alone (n = 22) or without an outcome of interest (n = 48). Three studies were excluded due to being unavailable as a full text (n = 3). Finally, 20 studies were included in this review, including 19 studies published in English and one in Spanish [31] (which was translated into English).

Study characteristics

The characteristics of the included studies (n = 20) are summarized in Table 2. The majority were from Southeast Asia, South Asia and East Asia (Thailand (n = 5) [32–36], Vietnam (n = 2) [37, 38], China (n = 1) [39], India (n = 1) [40] and Malaysia (n = 1) [41]. Seven were from Africa or America, which included Mexico, Argentina, El Salvador, Nicaragua and the Dominican Republic [31, 42–47]. One was from Iran [48]. Two were global studies which included both LMICs and HICs, but did not specify the names of the countries [49, 50].

The interventions in the studies were grouped into two types, namely those focused at population-level and those at individual-level (Table 2). Seven studies focused upon population-level interventions, such as smoking bans, mass media campaigns and tax increases on cigarettes [38–40, 42, 43, 47, 50], while 11 studies focused upon interventions targeted at individuals such as counselling and pharmacotherapy [31–37, 41, 45, 46, 48]. The remaining two studies assessed both populational and individual level interventions [44, 49]. The tobacco product under evaluation referred to cigarettes in

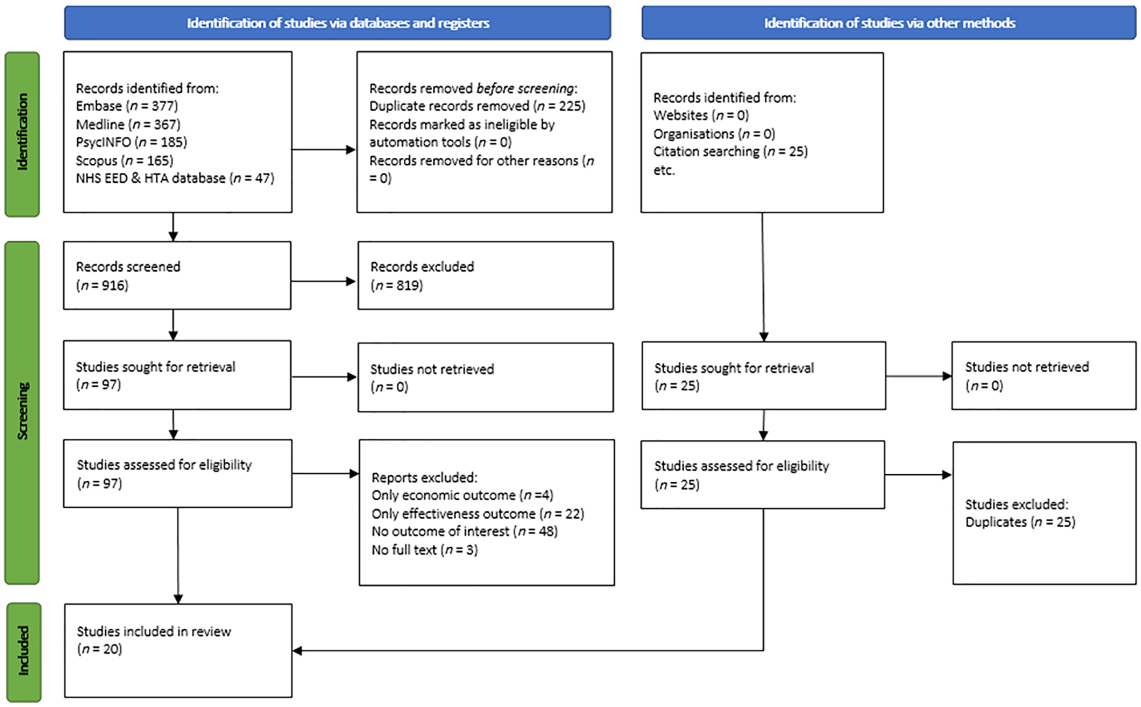

FIGURE 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow-chart showing the study selection process

TABLE 2 Characteristics of included studies

Author, year	Country	Perspective	Time horizon	Discount	Study design*	Population	Interventions	Baseline comparator
Connolly, 2018	Thailand	Government	Life-time	3%	Model- CBA	Adults aged < 60	Pharmacological smoking cessation interventions, specifically varenicline	Usual care
Thavorn, 2008	Thailand	Health Service	Life-time	3%	Model- CEA	Smokers aged ≥ 40	Community pharmacist-based smoking cessation (CPSC)	Usual care
White, 2013	Thailand	Health Service	3, 6, 14 months	No	Trial- CEA	215 smokers	Counselling + commitment contract, team incentives, and text reminders for cessation	Counselling alone
Meeyai, 2015	Thailand	Health Service	4 years	No	Trial- CEA	1161 smokers	Quitline	No intervention
Tosanguan, 2016	Thailand	Societal	Life-time	3%	Model- CUA	Smokers aged ≥ 40	Counselling, quitline, counselling + nicotine gum/patch, bupropion, nortriptyline or varenicline	Unassisted quitting
Higashi, 2011	Vietnam	Health Service	5 years	3%	Trial- CUA	Whole population	Tax increase, graphic warning on cigarette packs, media campaigns, smoking bans	Usual care
Higashi, 2012	Vietnam	Health Service	Life-time	3%	Trial- CUA	Smokers aged ≥ 15	Counselling, nicotine patch/gum, bupropion, varenicline	No intervention
Mould, 2009	Mexico	Health Service	Life-time	3%	Model- CEA	Smokers	Varenicline	NRT
Salomon, 2012	Mexico	Societal	100 years	3%	Model- CEA	General population	Tax, advertising bans, indoor air laws, NRT	No intervention
Donaldson, 2011	India	Societal	1 year	3%	Model- CEA	Whole population	Smoking bans	No intervention
Ibrahim, 2016	Malaysia	Health Service	≥ 6 months	No	Trial- CEA	All smokers	Counselling ± nicotine gum and/or patch	No intervention
Ortegon, 2012	Africa, Asia	Health Service	10 years	3%	Trial- CEA	Whole population	Tax, smoke free legislation, counselling, NRT	No intervention
Ranson, 2002	Global	Health Service	30 years	3%–10%	Model- CEA	Whole population	Price increase 10% (i.e. tax increase), NRT, regulations	No intervention
Rubinstein, 2010	Argentina	Health Service	10 years	3%	Trial- CEA	Smokers aged ≥ 35	Mass media campaign, bupropion	No intervention
Summan, 2020	Global	Not specified	50 years	3%	Model- CEA	General population	Tax increase	No intervention
Verguet, 2015	China	Individual	50 years	No	Trial- CEA	General population	50% retail price increase (i.e., tax increase)	Usual care
Lutz, 2012 [45]	Nicaragua	Health Service	2-, 5-, 10-, 20-year, life-time	5%	Model- CEA	Hypothetical cohort of adult smokers	Varenicline, bupropion	Unaided cessation
Shahrokhi, 2008	Iran	Not specified	1 year	No	Trial- CEA	Adult Smokers	Quit and Win campaigns	No intervention

(Continues)

TABLE 2 (Continued)

Author, year	Country	Perspective	Time horizon	Discount	Study design*	Population	Interventions	Baseline comparator
Ngalesoni, 2017	Tanzania	Government	Life-time	3%	Model- CEA	General population	Advertisement bans, graphic warning on cigarette packs, smoke free legislation, media campaigns, tax increase	No intervention
Lutz, 2012 [46]	Central America	Health Service	10 years	5%	Model- CEA	Smokers	Varenicline	NRT, Bupropion, No intervention

Trial-CEA = trial-based cost-effectiveness analysis; Model-CEA = model-based cost-effectiveness analysis; CUA = cost–utility analysis; CBA = cost–benefit analysis; NRT = nicotine replacement therapy.
*Based on the definition of the authors of each study.

16 studies [;32–41, 45–50] the other four studies did not specify the tobacco product, but they all referred to smoking rather than smokeless tobacco products [31, 42–44]. Although the comparator was no intervention in 13 studies, comparison of alternative interventions was found in many studies.

Methods adopted by the included studies

Study design, perspective and time horizon

There were nine trial-based [33, 36–39, 41, 43, 44, 48] and 11 model-based studies [31, 32, 34, 35, 40–42, 45–47, 49, 50]. Cost-effectiveness analysis was the most common analytical approach, which was used in 16 studies [31, 33, 34, 36, 39–50]. Cost–utility analysis was adopted by three studies [35, 37, 38] and only one used a cost–benefit approach [32]. The most common perspective was the health service perspective, adopted by 12 studies [31, 33, 34, 36–38, 41, 43–46, 49]. Only three studies took a societal perspective [35, 40, 42], one used a service user perspective [39], two applied a governmental perspective [32, 47] and two studies did not specify their perspectives [48, 50]. The time horizon adopted by the studies varied, with eight studies using a life-time horizon [31, 32, 34, 35, 37, 42, 45, 47], 11 studies considering a time horizon of 6 months to 50 years [33, 38–41, 43, 44, 46, 48–50], and one considered only a 3-month period [36]. The majority (13 studies) used a discount rate of 3% to convert future costs to their present value.

Consideration of costs

Overall, 18 of the studies used data from secondary sources such as published literature and national databases (Table 3). Only two studies had clinical trial records as their source for costs [36, 48]. There were many issues concerning the availability of suitable local data, which meant that authors had to use data from other countries [35, 40, 43, 49], global data or make assumptions [32, 37–39, 47, 50]. Two studies acknowledged that they did not include all relevant resource use (e.g. smoking-related complications, examinations and medications) due to the lack of local data [45, 46].

The cost categories considered in the studies varied depending on the perspectives adopted (Table 3). All studies incorporated direct interventional costs, with five of them including only the cost of implementing the interventions [33, 36, 41, 47, 49]. Nine studies included the treatment costs of smoking-related diseases such as lung cancer, chronic obstructive pulmonary disease and stroke [31, 32, 34, 40–45]. Salomon *et al.* [42] took a societal perspective and involved a comprehensive category of costs, including patient costs (e.g. hospital stays, health centre visits and other costs) and intervention implementation costs (e.g. administration, communication activities and law enforcement). Tosanguan *et al.* [35], Higashi *et al.* [37] and Donaldson *et al.* [40] also considered costs borne by individuals or families such as transportation, household costs and productivity loss alongside

TABLE 3 Cost and outcome data reported in the studies

Lead author, year	Perspective	Costs (beside intervention costs)	Sources of costs	Main outcomes
Shahrokhi, 2008	Not specified	Smoking cost	Trial records	Long-term quitter*
Thavorn, 2008	Health-care	Treatment of lung cancer, COPD, myocardial infarction, CHF, angina, stroke	Government databases; literature	Life-year gained
Donaldson, 2011	Societal	Direct medical costs for smoking-related disease, household costs	WHO-CHOICE project; government databases, national survey data	Life-year gained
Higashi, 2011	Health-care	Cost saving by preventing smoking-related diseases	WHO's Cost It programme; government database.	DALYs averted
Higashi, 2012	Health-care	Smokers; time lost, travelling costs	literature; government database.	DALYs averted
White, 2013	Health-care	(only intervention costs)	Trial records	Abstinence rates
Meeyai, 2015	Health-care	(only intervention costs)	Estimates from the HTA programme	Life-year gained
Ibrahim, 2016	Health-care	(only intervention costs)	Hospital database	Number of quitters
Tosanguan, 2016	Societal	Transport, productivity loss	Government database; literature	QALYs
Ortegon, 2012	Health-care	Treatment of CHD, cancer, stroke	Global/regional pricing databases	DALYs averted
Ranson, 2002	Health-care	(only intervention costs)	Literature	DALYs averted
Rubinstein, 2010	Health-care	Treatment of CHD and stroke	Literature and national database/survey	DALYs averted
Salomon, 2012	Societal	Patient costs (hospital bed days, hospital visits, health centre visits, ancillary care, laboratory and diagnostic tests, drugs and other costs to participate in the intervention), training costs	Administrative registries, population estimates, household surveys and drug cost databases	DALYs averted
Summan, 2020	Not specified	Smoking cost	Literature	Life-year gained
Verguet, 2015	Consumer	Smoking cost, cost-saving by preventing smoking-related diseases	Literature	Life-year gained
Lutz, 2012 [45]	Health-care	Hospital stay and emergency visits	Government/non-governmental database; market price	Additional quitter
Connolly, 2018	Government	Life-time health-care	government database; literature	Life-time savings
Ngalesoni, 2017	Government	(only intervention costs)	Government database; costing study; market price	DALYs averted
Mould, 2009	Health-care	Treatment of COPD, lung cancer, stroke, CHD	literature	Life-year gained
Lutz, 2012 [46]	Health-care	Treatment of COPD, lung cancer, stroke, CHD	Literature	QALYs

DALY = disability-adjusted life years; QALY = quality-adjusted life years; CHD = coronary heart disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; HTA = health technology assessment.

*Not smoking for 1 year.

health-care costs. Cost savings associated with preventing smoking-related diseases were taken into account by only two studies [38, 39]. Changes in the cost of tobacco products were considered in only three studies [39, 48, 50].

Health outcomes

Half the studies used intermediate end-points (e.g. abstinence rates or number of quitters) rather than quality-adjusted life years (QALYs) gained or disability-adjusted life-years (DALYs) averted as their main outcomes (Table 3). Specifically, six studies used life-year gained (LYG) to assess the efficacy of the interventions [31, 33, 34, 39, 40, 50], four used successful quitters as the main outcome [36, 41, 45, 48], seven studies measured DALYs averted [37, 38, 42–44, 47, 49], two studies used QALYs [35, 46] and one measured life-time savings as the main outcome [32].

Economic evaluation results and reporting

The key economic evaluation results of the interventions from each study are summarized in Table 4, grouped by population or individual-level interventions. The interventions have also been grouped into four broad categories (regulations, multimedia, motivational support and pharmacological therapy) and their cost-effectiveness assessment results are summarized in Table 5. Overall, 12 interventions were reported to be cost-effective, except for the nicotine patch/gum, bupropion and varenicline in Vietnam [37] and bupropion in Argentina [44].

Tax increases on cigarettes at various levels were examined in seven studies [38, 39, 42, 43, 47, 49, 50] and these increases were consistently reported to be more cost-effective than any other intervention or combination of interventions among several LMICs such as China, Mexico and Vietnam. Tax increases were found to save billions of dollars and produce thousands of life-years gained, or at least bring positive outcomes at a relatively low cost (i.e. $0.9–448/DALY averted [38, 39, 42, 43, 47, 49, 50]). Smoke-free laws in public spaces or work-places also proved to be highly cost-effective in Tanzania, India and Vietnam, with the cost per DALY averted being less than $267 [38, 40, 47]. In addition, media campaigns (e.g. graphic pack warnings, advertising bans, etc.) were found to be cost-effective, with the cost per DALY averted being less than $140 in Tanzania, Vietnam and Mexico [38, 42, 47] and $3186 in Argentina [44].

Motivational support interventions were found to be cost-effective in Iran, Thailand, Vietnam and Malaysia. These interventions mainly involved behavioural or professional advice from pharmacists and were found to achieve a positive outcome at a very low cost (e.g. $0.43 per person who remained abstinent for more than 1 year in Iran [48]). Quitline (counselling through telephone) was the most cost-effective motivational supportive intervention (the cost could be as low as $32 per life year gained [33, 35]). Face-to-face counselling, either alone or in combination with other interventions, was generally found to be comparably less cost-effective but also favourable [34–37, 41].

Lastly, Varenicline was reported to be a cost-effective pharmacological therapy throughout Nicaragua, Thailand, Mexico and El Salvador [31, 32, 45, 46], whereas it was found to be not cost-effective in Vietnam as it would cost $21 823 per DALY averted, which was much higher than the applied threshold (GDP per capita × 3 = $10 794 per DALY averted) [37]. Another medicine, bupropion, was found to be not cost-effective in both Argentina and Vietnam ($59 443/DALY averted and $17 409/DALY averted, respectively) [37, 44]. In addition, nicotine patch/gum was assessed as not cost-effective in Vietnam (nicotine gum: $33 608/DALY averted; nicotine patch: $86 358/DALY averted) [37], but it was generally cost-effective in LMICs ($280–870/DALY averted.) [49].

Sensitivity analysis

While 15 studies conducted deterministic and/or probabilistic sensitivity analyses to examine the uncertainties associated with their analyses, four studies did not perform any sensitivity analysis [32, 33, 36, 48] and Ibrahim *et al.* [41] reported the conclusion of their sensitivity analysis but did not specify their methods. The studies found that the overall results were not generally changed by the sensitivity analyses, but important uncertainties around the results were highlighted.

Quality of included studies

The quality of the nine trial-based studies is summarized in Supporting information, Appendix S3. Most of them performed well in specifying population, competing alternatives and study design, except for the choice of an appropriate perspective. Only four studies met all the criteria regarding the costs and outcomes [33, 36, 39, 41]. Six studies conducted an incremental analysis of costs and outcomes of alternatives [36–39, 43, 44], whereas not all of them considered discounting for future costs and outcomes, as well as sensitivity analyses for variables [37, 38, 43, 44]. The generalizability of the results to new settings was explored in only three studies [39, 44, 48]. Only Verguet *et al.* [39] discussed the ethical and distributional issues of the tobacco control interventions.

The quality of the 11 model-based studies is summarized in Supporting information, Appendix S4. Ngalesoni *et al.* [32], Connolly *et al.* [42] and Salomon *et al.* [47] met most of the criteria regarding reporting of model structure (e.g. time horizon, disease states, evidence for model structure) and data (source of data, cost, utility weights and discounting method. Very few of the studies conducted a comprehensive sensitivity analysis. For example, only one study addressed the four principal types of uncertainty [47] and none of the studies considered structural uncertainties. In addition, only the two studies by Lutz and colleagues explored the affordability of the interventions through a discussion of willingness to pay and the probability of them being cost-effective in the regions of interest [45, 46].

TABLE 4 Key results and sensitivity analysis results in each study (population and individual-level interventions)

Lead author, year	Intervention (s)	Currency, year	Incremental cost per LY, DALY, QALY /incremental cost per quitter	Sensitivity analysis	Results of sensitivity analysis
A. Population-level interventions					
Ortegon, 2012	Tax increase ± smoke-free legislation ± counselling ± advertising bans ± graphic warning	Int.$, 2005	Cost per DALY averted in Africa/Asia:* 1. Tax increase of 20%: $448/ $87 2. 1 + indoor smoke-free legislation + advertising ban: $1384/$182 3. 2 + pack warning: $1645/$198 3 + counselling: $28 082/$4229	Deterministic and probabilistic	Significant uncertainty around DALYs averted
Ranson, 2002	Price increase, regulations (e.g. advertisement bans, health promotion, smoke-free law)	US$, 1997	Price increase of 10%: $3–70 per DALY averted Regulations: $36–710 per DALY averted	Deterministic	They remained cost- effective in many settings under lower and upper estimates
Rubinstein, 2010	Mass media campaign	Int.$, 2007	Mass media campaign: Int$ 3186.71 per DALY averted (95% CI = 3024.42–3337.92)	Deterministic	Changing the disease risks and the intervention effectiveness did not change the results significantly
Salomon, 2012	Excise taxes, Advertising bans, Indoor air laws	Int.$ 2005	Tax increase: Int$140 per DALY averted* Advertising bans: Int $2800 per DALY averted*	Deterministic	NRT become potentially cost-effective if age weights are removed
Summan, 2020	Tax increase (by 20% and 50%)	US$, 2018	20% tax increase: 1836–2711 life years gained per 100 000 population (95% UI = 1105–3796) Change in expenditure: $9–427 billion (95% UI = 3–658) 50% tax increase: 4591–6778 life years gained per 100 000 population (95% UI = 2762–9490) Change in expenditure: $7–481 billion (95% UI = −172 to 1127)	Probabilistic	Not fully reported
Verguet, 2015	Specific excise tax on cigarettes (50% retail price increase)	US$, 2011	$231 million years of life would be gained (95% UI = 194–268) Additional revenues raised: $703 billion (95% UI = 616–781) Decreased household tobacco expense: $21 billion (95% UI = −83 to 52) in the lowest income quintile Expense on tobacco-related disease saved: $24.0 billion (95% UI = 17.3–26.3) Provide financial risk protection worth $1·8 billion (95% UI = 1.2–2.3)	Probabilistic	Different assumptions have different impacts on income groups
Ngalesoni, 2017	Advertisement bans, package warnings, smoke-free law, mass media campaigns, tax increase	US$, 2013	The most cost-effective intervention was tax increase: ICER of US$5 per DALY averted. The least cost-effective	Probabilistic	All interventions are uncertain both in costs and effects, tax increase is

(Continues)

TABLE 4 (Continued)

Lead author, year	Intervention (s)	Currency, year	Incremental cost per LY, DALY, QALY /incremental cost per quitter	Sensitivity analysis	Results of sensitivity analysis
			intervention is the work-place smoking ban: ICER of US$267 per DALY averted* (Tanzania's GDP per capita for 2013 was $910)		relatively more uncertain regarding effectiveness than costs
Donaldson, 2011	Smoking bans	US$, 2008	(1) Complete ban is highly cost-effective compared to current rule (2) Incremental cost was $9.13 per LYG (range = 2.24–112) and $229 per acute myocardial infarction averted (range = 37–387)	Deterministic	Without medical treatment costs averted, the CE ratio ranges from $2 to $112 per LYG and $37 to $386 per acute myocardial infarction averted
Higashi, 2011	1. Tax increase 2. Graphic pack warnings 3. Mass media campaigns 4. Smoking bans	VND, 2006	Incremental costs per DALY averted: Tax increase from 55 to 65%: 8600 VND (95% UI = 3400–20 100) Tax increase from 55% to 75%: 4200 VND (95% UI = 1700–9900) Tax increase from 55 to 85%: 2900 VND (95% UI = 1100–6700) Graphic warning on cigarette packs: 500 VND (95% UI = 300–1200)Media campaign: 78 300 VND (95% UI = 43 700–176 300) Smoking ban in public places: 67 900 VND (95% UI = 28 200–332 000) Smoking ban in work-places: 336 800 VND (95% UI = 169 300-822 900)	Probabilistic	Sensitivity analysis did not alter the findings and all interventions were far below the threshold level of being very cost effective
B. Individual-level interventions					
Shahrokhi, 2008	Quit and Win campaigns	US$, (year unknown)	Cost per long-term quitter (not smoking for 1 year): $1.89 for year 1998, $0.65 for 2000, $0.43 for year 2002 and $1.98 for 2004*	Not conducted	No
Thavorn, 2008	Community pharmacist-based smoking cessation (CPSC)	Thai baht, 2005	17 503.53 baht (US$ 500) saved and 0.18 LYG per men* 21 499.75 baht (US$ 614) saved and 0.24 LYG per women*	Deterministic and probabilistic	The probability of CPSC being cost effective is 99.6% if the WTP or ceiling ratio is 315 000 baht per LYG
Higashi, 2012	1. Physician advice 2. Nicotine patch/gum 3. Bupropion 4. Varenicline	Int.$, 2006	Physician advice was the only 'very cost-effective' intervention, with $543 per DALY averted (95% UI = 375–869) Nicotine gum:	(1) Probabilistic (2) Changing intervention effects by 50%.	The pharmaceuticals must be 70–90% cheaper to become cost-effective. Only the advice + bupropion becomes cost-effective if the effect increased by > 25%

(Continues)

TABLE 4 (Continued)

Lead author, year	Intervention (s)	Currency, year	Incremental cost per LY, DALY, QALY /incremental cost per quitter	Sensitivity analysis	Results of sensitivity analysis
			$33 608/DALY averted (95% UI = 24 776–46 068) Nicotine patch: $86 358/DALY averted (95% UI = 65 194-116 093) Bupropion: $17 409/DALY averted (95% UI = 13 084–23 761) Varenicline: $21 823/DALY averted (95% UI = 15 346–31 957)		
White, 2013	1. Counselling + team commitment contract 2. Counselling + nicotine gum 3. Counselling + varenicline	Int.$, 2006	Team commitment: $281 per quitter (95% CI = 187–562) [less than for nicotine gum- $2073 per quitter (95% CI = 1357–4388) or varenicline: $1780 per quitter (95% CI = 1414–2401)]	Not conducted	No
Meeyai, 2015	Quitline	US$, (year unknown)	$32 per LYG	Not conducted	No
Ranson, 2002	NRT	US$, 1997	$280–870 per DALY averted	Deterministic	It remained cost- effective in many settings under lower and upper estimates
Rubinstein, 2010	Bupropion	Int.$, 2007	$59 443 per DALY averted (95% CI = 57 819.14–60 906.25)	Deterministic	Changing the disease risks and the intervention effectiveness did not change the results significantly
Ibrahim, 2016	Counselling ± nicotine gum and/or patch	MYR (year unknown)	Cost per 1% of success rate:* (1) Counselling alone: 360.00 (2) Counselling + gum and patch: 841.19 (3) Counselling + gum: 1066.99 (4) Counselling + patch was ineffective	Not specified	Counselling alone was the most cost-effective, others can achieve the same cost/effectiveness ratio as the first choice in case its success rate increased to 70.09%
Tosanguan, 2016	Quitline, counselling ± nicotine gum/patch, bupropion, nortriptyline or varenicline	US$, 2009	Quitline only was the most cost-effective intervention of all interventions. Incremental cost of $212.5 per QALY gained*	Probabilistic	At a ceiling ratio of 120 000 baht, the cost-effectiveness probability of all interventions ranged from 0.97–0.99
Lutz, 2012 [45]	Varenicline	US$, 2010	Varenicline was cost-saving than bupropion in all time horizons. At year 2, the net cost per additional quitter for varenicline was $408* and $808,* respectively, compared with NRT and unaided cessation, and it can be cost -saving from year 5 to life-time	Probabilistic	Model results are consistent across numerous trials

(Continues)

TABLE 4 (Continued)

Lead author, year	Intervention (s)	Currency, year	Incremental cost per LY, DALY, QALY /incremental cost per quitter	Sensitivity analysis	Results of sensitivity analysis
Connolly, 2018	Varenicline	Thai Baht, (year unknown)	ROI: 1 THB invested in smoking cessation = THB1.35 saving	Not conducted	No
Mould, 2009	Varenicline	US$, 2008	Varenicline was dominant over NRT	Probabilistic	Significant uncertainty around LYG. PSA found it to be 70% cost-effective
Lutz, 2012 [46]	Varenicline	US$, 2010	Varenicline was dominant over NRT/bupropion	Probabilistic	The probability of it being cost-effective is 99%

DALY = disability-adjusted life years; NRT = nicotine replacement therapy; LYG = life year gained; CE = cost-effectiveness; Int.$ = international dollar; MYR = Malaysian Ringgit; VND = Vietnamese dong; ROI = return of investment; WTP = willingness to pay; UI = uncertainty interval; CI = confidence interval.
[a]Range was not reported.

DISCUSSION

To our knowledge, this is the first systematic review of full economic evaluations of tobacco use control interventions in LMICs. The significant health-care and economic burdens associated with tobacco use in LMICs and the limitations of the current evidence base highlighted in this review have important implications for both researchers and decision-makers.

Principal findings

This review identified 20 economic evaluations concerned with LMICs. Although WHO states that there are seven LMICs (India, Mexico, Brazil, El Salvador, Jamaica, Senegal and Turkey) providing comprehensive cessation support [8], this review found only four studies from these countries (India, Mexico and El Salvador) [31, 40, 42, 46]. The included studies generally had several limitations and the overall quality of the studies was judged to be poor to moderate according to the quality check lists employed.

Most studies adopted a health-care system perspective (*n* = 12). Economic evaluations can be conducted from individual, health-care or societal perspectives depending on the nature of the decision problem [51]. Generally, a societal perspective gives a much broader viewpoint which includes the health/non-health and current/future costs and outcomes associated with all stakeholders [51]. Tobacco use and control is a complex issue that involves the whole of society; therefore, it is recommended that a broad perspective should be considered in tobacco control research [52]. The aim of an economic evaluation is to generate valid and informative evidence to inform policymaking, and failure to consider all relevant costs and outcomes might result in suboptimal decisions [53].

Secondly, most studies did not identify the sources of cost data, and some studies derived cost and outcome data from the published literature from HICs without adaptation. The unavailability of local data has been a major limitation over the past decades for research in LMIC settings. Researchers often have to make assumptions and adopt data from HICs to carry out such studies in LMICs. The quality assessments of the included studies revealed general limitations in terms of the methods adopted, particularly in relation to costs, sensitivity analysis and consideration of distributional issues. These limitations are likely to have an impact upon the findings and conclusions, and therefore should be considered in the interpretation of their results.

In addition, guidelines from NICE International and the Bill and Melinda Gates Foundation (2014) suggest that issues relating to affordability should be taken into account in economic evaluations in LMIC settings. The reason is that there is uncertain and asynchronous timing of investment and pay-off, together with the existence of other limitations than budget constraints. However, only two studies discussed the affordability of the tobacco control interventions [45, 46]. The guideline also highlighted that budget impact analysis of the implementation of interventions is of particular importance to LMICs,

TABLE 5 Cost-effective assessment results for population and individual-level interventions

Category	Study	Country	Intervention	Comparator	(Incremental) cost per outcome	Threshold of cost-effectiveness	Cost-effective?	Currency, year
A. Population-level interventions								
Regulations	Ranson, 2002	Global	Tax increase of 10% in LMIC	No intervention	$3–70/DALY averted	Not reported	Yes	US$, 1997
	Ranson, 2002	Global	Regulations (e.g. advertisement bans, health promotion, smoke-free law)	No intervention	$36–710 per DALY averted	Not reported	Yes	US$, 1997
	Summan, 2020	Global	Tax increase of 20% and 50% in LMIC	No intervention	20% tax increase: 1836–2711 life years gained per 100 000 population (95% UI = 1105–3796) Change in expenditure $9–427 billion (95% UI = 3–658) 50% tax increase: 4591–6778 life years gained per 100 000 population (95% UI = 2762–9490) Change in expenditure: $7–481 billion (95% UI = −172 to 1127)	Not reported	Yes	US$, 2018
	Ortegon, 2020	Africa, Asia	Tax increase of 20%*	No intervention	$448/DALY averted[1] $87/DALY averted[2] (range not reported)	$2000/DALY averted	Yes	Int.$, 2005
	Salomon, 2012	Mexico	Tax increase at different levels	No intervention	$140/DALY averted (range not reported)	$10 770/DALY averted	Yes	Int.$, 2005
	Verguet, 2015	China	Tax increase of 50%	Usual care	$231 million years of life would be gained (95% UI = 194–268) Additional revenues raised: $703 billion (95% UI = 616–781) Decreased household tobacco expense: $21 billion (95% UI = −83 to 52) in the lowest income quintile Expense on tobacco-related disease saved: $24.0 billion (95% UI = 17.3–26.3) Provide financial risk protection worth $1·8 billion 95% UI = 1.2–2.3)	Not reported	Yes	US$, 2011
	Ngalesoni, 2017	Tanzania	Tax increase of 15 and 25%	No intervention	$5/DALY averted (range not reported)	$910/DALY averted	Yes	US$, 2013

(Continues)

TABLE 5 (Continued)

Category	Study	Country	Intervention	Comparator	(Incremental) cost per outcome	Threshold of cost-effectiveness	Cost-effective?	Currency, year
	Ngalesoni, 2017	Tanzania	Smoke-free law	No intervention	In public: $103/DALY averted In work-place: $267/DALY averted (range not reported)	$910/DALY averted	Yes	US$, 2013
	Donaldson, 2011	India	Smoke-free law	No intervention	$9.13 per life year gained (range = 2.24–112) $229 per acute myocardial infarction averted (range = 37–387)	US$880 per life year gained	Yes	US$, 2008
	Higashi, 2011	Vietnam	Tax increase of 10, 20 and 30%	Usual care	Incremental costs per DALY averted[†]: tax increase from 55 to 65%: 8600 VND (95% UI = 3400–20 100) Tax increase from 55 to 75%: 4200 VND (95% UI = 1700–9900) Tax increase from 55 to 85%: 2900 VND (95% UI = 1100–6700)	VND 34 629 900/DALY averted	Yes	VND, 2006[#]
	Higashi, 2011	Vietnam	Smoke-free law	Usual care	In public: VND 67 900/DALY averted (95% UI = 28 200–332 000)[†] In work-place: VND 336–800/DALY averted (95% UI = 169 300–822 900)[†]	VND 34 629 900/DALY averted	Yes	VND, 2006[#]
Multimedia	Ngalesoni, 2017	Tanzania	Graphic pack warnings	No intervention	$40/DALY averted (range not reported)	$910/DALY averted	Yes	US$, 2013
	Ngalesoni, 2017	Tanzania	Media campaigns	No intervention	$38/DALY averted (range not reported)	$910/DALY averted	Yes	US$, 2013
	Ngalesoni, 2017	Tanzania	Advertising bans	No intervention	$97/DALY averted (range not reported)	$910/DALY averted	Yes	US$, 2013
	Rubinstein, 2010	Argentina	Media campaigns	No intervention	$3186.71/DALY averted (95% CI = 3024.42–3337.92).	$39 765/DALY averted	Yes	Int.$, 2007
	Higashi, 2011	Vietnam	Graphic pack warnings	Usual care	VND 500/DALY averted (95% UI = 300–1200)[†]	VND 34 629 900/DALY averted	Yes	VND, 2006[#]

(Continues)

TABLE 5 (Continued)

Category	Study	Country	Intervention	Comparator	(Incremental) cost per outcome	Threshold of cost-effectiveness	Cost-effective?	Currency, year
	Higashi, 2011	Vietnam	Media campaigns	Usual care	VND 78300/DALY averted (95% UI = 43700–176 300)[†]	VND 34 629 900/DALY averted	Yes	VND, 2006[#]
	Salomon, 2012	Mexico	Advertising bans	No intervention	$2800/DALY averted (range not reported)	$10 770/DALY averted	Yes	Int.$, 2005
B. Individual-level interventions								
Motivational support	Shahrokhi, 2008	Iran	Quit and Win contest	No intervention	Cost per long-term quitter (not smoking for 1 year): $1.89 in 1998, $0.65 in 2000, $0.43 in 2002 and $1.98 in 2004 (range not reported)	Not reported	Yes	US$, UN
	Thavorn, 2008	Thailand	Pharmacist supported cessation[‡]	Usual care	17 503.53 baht saved and 0.18 LYG per men; 21 499.75 baht saved and 0.24 LYG per women (range not reported)	315 000 baht/LYG	Yes	Thai baht, 2005[#]
	White, 2013	Thailand	Counselling + incentives[**]	Counselling alone	$281 per quitter	$8600 per quitter	Yes	Int.$, 2006
	White, 2013	Thailand	Counselling + nicotine gum	Counselling alone	$1780 per quitter	$8600 per quitter	Yes	Int.$, 2006
	White, 2013	Thailand	Counselling + varenicline	Counselling alone	$2073 per quitter	$8600 per quitter	Yes	Int.$, 2006
	Higashi, 2012	Vietnam	Physician advice	No intervention	$543/DALY averted (95% UI = 375–869)	$10 784/DALY averted	Yes	Int.$, 2006
	Ibrahim, 2016	Malaysia	Counselling[§]	No intervention	MYR 360 per 1% of success rate (range not reported)	Not reported	Yes	MYR[#] UN
	Tosanguan, 2016	Thailand	Counselling[§]	Unaided cessation	$637.5/QALY (range not reported)	$4000/QALY	Yes	US$, 2009
	Tosanguan, 2016	Thailand	Quitline	Unaided cessation	$212.5/QALY (range not reported)	$4000/QALY	Yes	US$, 2009
	Meeyai, 2015	Thailand	Quitline	No intervention	$32 per LYG (range not reported)	Not reported	Yes	US$, UN
Pharmacological therapy	Ranson, 2002	Global	NRT[***] in LMIC	No intervention	$280–870/DALY averted	Not reported	Yes	US$, 1997
	Higashi, 2012	Vietnam	Nicotine patch/gum	No intervention	Gum: $33 608/DALY averted (95% UI = 24776–46 068) Patch: $86 358/DALY averted (95% UI = 65194–116 093)	$10 784/DALY averted	No	Int.$, 2006

(Continues)

TABLE 5 (Continued)

Category	Study	Country	Intervention	Comparator	(Incremental) cost per outcome	Threshold of cost-effectiveness	Cost-effective?	Currency, year
	Rubinstein, 2010	Argentina	Bupropion	No intervention	$59 443.02/DALY averted (95% CI = 57 819.14–60 906.25)	$39 765/DALY averted	No	Int.$, 2007
	Higashi, 2012	Vietnam	Bupropion	No intervention	$17 409/DALY averted (95% UI = 13 084–23 761)	$10 784/DALY averted	No	Int.$, 2006
	Higashi, 2012	Vietnam	Varenicline	No intervention	$21 823/DALY averted (95% UI = 15 346–31 957)	$10 784/DALY averted	No	Int.$, 2006
	Lutz, 2012 [45]	Nicaragua	Varenicline	NRT***	$408 per additional quitter (range not reported)	$8700 per additional quitter	Yes	US$, 2010
	Lutz, 2012 [45]	Nicaragua	Varenicline	Unaided cessation	$808 per additional quitter (range not reported)	$8700 per additional quitter	Yes	US$, 2010
	Connolly, 2018	Thailand	Varenicline	Usual care	ROI: 1 THB invested = 1.35 THB saving	ROI > 1	Yes	Thai Baht, UN
	Mould, 2009	Mexico	Varenicline	Nicotine patch	Cost saving of $800 million, 149 273 LYG and avoid > 2854 deaths in the life-time period	$50 000/LYG	Yes	US$, 2008
	Lutz, 2012 [46]	Nicaragua	Varenicline	Bupropion, NRT, Unaided cessation	−$2522/QALY gained, −$2449/QALY gained, −$2415/QALY gained (range not reported)	$8700/QALY gained	Yes	US$, 2010
	Lutz, 2012 [46]	El Salvador	Varenicline	Bupropion, NRT, Unaided cessation	−$256/QALY gained, −$244/QALY gained, −$241/QALY gained (range not reported)	Not reported	Yes	US$, 2010
	Lutz, 2012 [46]	Dominican Republic	Varenicline	Bupropion, NRT, Unaided cessation	−$2886/QALY gained, −$2815/QALY gained, −$2791/QALY gained (range not reported)	$25 800 per additional quitter	Yes	US$, 2010

Int.$ = international dollar; VND = Vietnamese dong = MYR Malaysian Ringgit= DALY = disability-adjusted life year; LMIC = low- and middle-income region; CI = confidence interval; UI = uncertainty interval; LYG = life year gained; NRT = nicotine replacement therapy; ROI = return of investment; UN = unknown.

1, In WHO African sub-region AfrE; 2, in WHO Asian sub-region SearD.

#1000 Thai baht = US $32, US $1 = MYR 3.20, $US 1 = VND 3208.37.

†The value becomes negative when cost offset is considered, meaning that the intervention is cost-saving.

‡Tracking of smoking status; supportive cessation advice; assessment of quitting interest and nicotine dependence level; cessation therapy and follow-up visits.

*There are other interventions in combination with tax increase, but they are not as cost effective as tax increase alone.

**Commitment contract, team incentives, and text message reminders.

***NRT includes nicotine patch/gum, nasal spray, inhalers, sublingual tablets and lozenges, etc.

§There are other interventions in combination with counselling, but they are not as cost-effective as counselling alone.

covering both costs and capacity influences, as these would be the main considerations in the decision-making process [28].

Limitations of this review

This review is subject to certain limitations. It only included full economic evaluations pertaining to tobacco use control interventions, excluding partial economic evaluations (e.g. cost studies or efficacy studies). Another consideration is that the database search was limited to studies published after 1994. In addition, the literature search was only conducted in mainstream databases with abstracts published in English, country-specific databases were not searched in relevant languages (e.g. CNKI in China).

Recommendations for future research

This study identified the following as important considerations for future economic evaluations of tobacco control interventions in LMICs. It is important to improve adherence to standard reporting guidelines for economic evaluation studies, such as the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [54]. This is essential to provide transparency around methods and provide sufficient detail about the study process and results. The greater use of appropriate model-based full economic evaluation techniques in LMICs seems warranted [10]. A model-based study which is designed to optimize transferability would make it convenient to adapt the model to other contexts and reduce the financial and capacity burden associated with conducting such research in new settings. In line with published guidance by the Bill and Melinda Gates Foundation [28], affordability of the interventions and equity issues need to be considered when conducting economic evaluations in LMIC settings [28]. Budget impact and equity considerations are important to facilitate optimal decision-making for resource allocation. In LMICs where comprehensive tobacco control policies including cessation support are applied, [8] local data could be used to inform economic evaluations for tobacco use control interventions.

CONCLUSION

There are relatively few economic evaluations of tobacco use control interventions in low- and middle-income countries, and there is generally a lack of high-quality studies using relevant data sources, with comprehensive reporting of methodology, and clear adherence to the guidance for conducting economic evaluations. The existing evidence suggests that taxation increases on tobacco products is the most cost-effective intervention in many low- and middle- income countries, followed by telephone counselling alone, and then other interventions (e.g. multimedia advocations, nicotine replacement therapy, smoking ban and drug therapy varenicline). However, more robust evidence is required, particularly in relation to the use of local data, comprehensive sensitivity analyses and the consideration of affordability.

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DECLARATION OF INTERESTS

None.

AUTHOR CONTRIBUTIONS

Xiaobin Jiang: Conceptualization; formal analysis; investigation; methodology; project administration. **Louise Jackson:** Conceptualization; formal analysis; investigation; methodology; project administration; supervision. **Muslim Syed:** Conceptualization; formal analysis; methodology; project administration; supervision. **Tuba Avsar:** Conceptualization; formal analysis; investigation; methodology; validation. **Zainab Abdali:** Formal analysis; investigation; methodology.

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SUPPORTING INFORMATION

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