

Application of Discrete-Choice Experiment Methods in Tobacco Control: A Systematic Review

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Abstract

Background Economic evidence relating to tobacco control is generally derived from the cost effectiveness of smoking-cessation programs or the economic impact of tobacco-induced disease, based on revealed-preference data. However, empirical estimates from stated-preference data on tobacco users' preferences, smoking behaviour and smoking cessation aids using analytical techniques such as

discrete-choice experiments (DCEs) could be important for policy decision making in tobacco control.

Objectives Our objective was to review the practice and utility of DCE methodology across nicotine- and tobacco-related issues, particularly smoking and smoking-cessation behaviour, anti-smoking policies and preferences for smoking-cessation aids.

Methods We searched the PubMed, MEDLINE and ECONLIT databases for full-text original research articles on tobacco-related issues published between January 2000 and April 2016 that used a DCE method. We summarised the evidence and methodological characteristics of DCEs according to Lancsar and Louviere, 2008.

Results Our review of the 12 eligible studies showed that DCE methodology was used to elicit smoker preferences and to evaluate tobacco-control policies. The majority of the studies were published in the last 5 years. The areas of application were smoking cessation, smoking behaviour, electronic cigarette use, water-pipe smoking and tobacco packaging. Monetary attributes were the most influential attributes in all studies. The design of the DCEs varied.

Conclusion DCE studies of tobacco-related issues were methodologically consistent with guidelines proposed for conducting health-related DCEs.

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Key Points for Decision Makers

Discrete-choice experiments (DCEs) can be used to assess tobacco-control policies, smoking behaviour and smoker preferences for cessation aids.

DCE-based evidence from low- and middle-income countries could address the research gaps regarding smoking-cessation behaviour and tobacco-control policies in these countries.

Studies showed that monetary attributes were the most influential factor in the fight against tobacco use. Price attributes dominated tobacco policies and behaviour.

Future research on tobacco issues using the DCE framework should combine preferences on initiation with cessation of tobacco products, smoking-cessation therapy options and types of tobacco products to ensure DCEs fit into economic evaluations.

1 Background

The discrete-choice experiment (DCE) is an elicitation technique that provides stated-preference data for analysis. They are designed to elicit quantitative preferences for attributes of health products and programmes [1]. The technique is based on random utility theory, wherein individuals are asked to make a number of choices between health products and services. Each health product and service is defined by their attributes at different levels. Responses to the DCE questionnaire are then used to infer perceived utility: overall benefit and trade-offs between attributes [1–4].

The use of DCEs in the health sector is increasing. A review [5, 6] of health-related DCEs for the periods 1990–2000 and 2001–2008 reported that the study publication rate increased from a mean of 3 to 14 per year over this period. Wide adoption of DCEs by researchers in the UK, USA, Canada and Australia is evident in the literature. However, the increase in use of DCEs among researchers in low- and middle-income countries is slower [7]. Despite the dramatic increase in the use of DCEs in the health sector, only a few are applied to health-related behaviour. Recent examples of research using DCEs relating to health behaviour include studies on smoking [8], colorectal cancer screening [9] and immunisation behaviour [10].

Tobacco use and cigarette smoking contribute to a significant proportion of the world's mortality and morbidity [11]. An analysis of global tobacco consumption reported 6

million premature deaths from tobacco use and exposure each year, accounting for 6% of all female and 12% of all male deaths [11]. Smoking-cessation programs are a cost-effective way to mitigate the economic and health consequences of smoking [12]. The implementation and exploration of alternative methods to encourage smoking cessation and discourage initiation are a high priority. However, smoking initiation and cessation involve complex behaviours associated with nicotine dependence. Evidence suggests that individual, social and psychological characteristics are the main determinants of cessation. These determinants can be modified to increase the likelihood of success [13, 14]. Pharmacy-based and behavioural-based methods of smoking cessation are probably the most widely used cessation methods in public health practice. Recently, alternative intervention methods such as smartphone-based and online-based support services have also been implemented. It is important to note that factors from various perspectives overlap to when cessation succeeds or relapses over time, as previous smokers may adopt another form of tobacco. Moreover, rates of long-term smoking abstinence after being nicotine dependent are low [14]. Research from the past 30 years suggests that a combination of strategies within complex systems such as demand reduction, pharmacotherapies, behavioural therapies and population-level policies need to be employed to predict smoking-cessation behaviour and thus increase the rates of effective cessation [15, 16]. These alternatives would provide a basis for choice-based studies to reduce tobacco epidemics.

Several key processes underlying tobacco-control interventions, such as initiation, cessation, relapse, policy process and cost, have been explored using mathematical and health behaviour models. Most of these models extrapolate prevalence, morbidity, mortality or economic consequences based on sensitive assumptions and uncertainties derived from past revealed-preference data. A recent review of 118 studies found that 18 different tobacco-control models had been tried; however, these are continuously changing with shifts in research focus—from explaining disease burden to economic consequences of tobacco use [17]. In contrast, DCEs can easily predict results of the tobacco-control interventions that are yet to be implemented and better reflect the influence of attributes over time. The use of DCE estimates such as cost, time, health risk and health outcomes could add precise parameter values to existing population mathematical models. Evidence from DCEs can provide high predictive value of behavioural responses that correspond to real-life situations [18]. For instance, an increase in tobacco price via taxation is an example of a population-level tobacco-control policy. Studies from Japan have shown that the pricing policy for smoking behaviour change could be the game changer in

anti-tobacco campaigns [8, 19]. Yet, only a few studies have used such research designs [20].

DCEs that are predominantly used as econometric tools to assess healthcare interventions do not have a long history of application to behavioural problems such as smoking and smoking cessation [1, 4–6, 21]. Moreover, the theoretical literature has not consistently defined a precise application of DCEs for research on smoking, cessation behaviour, population-level policies and related preferences [8, 19]. In addition, empirical studies that have evaluated the relative influence of multiple variables and dimensions are also limited. Overall, DCE-based empirical literature often lacks consistency in supporting standardised applications for tobacco control. Therefore, this study aimed to review and compare the application of DCE methods in existing tobacco-control studies.

2 Methods

2.1 Search Strategy

We conducted a literature search in the PubMed, MEDLINE and ECONLIT databases to identify original, peer-reviewed studies published between 1 January 2000 and 30 April 2016. We searched the free text, medical subject headings (MeSH) and index words related to tobacco and smoking cessation (Table 1), restricting the searches to papers published in the English language. We also manually searched the reference lists of each selected study. Duplicates were removed (by KR and NT) and titles, abstracts and methods were screened. The papers were selected based on the following eligibility criteria:

1. Subjects: The choice experiment was performed in adult smokers (aged ≥ 16 years) with the cognitive ability to perform choice tasks.

2. Study type: Economic evaluations, policy evaluations, preference measurements and predictive epidemiological studies with choice-based response formats.
3. Study design: Studies using the DCE framework in their experimental design. We included studies that clearly mentioned discrete-choice model-based analyses of preference data collected from tobacco users using choice-based response formats. We ensured that the experimental designs of the selected articles attempted to control for interactions between variables.

We excluded reviews, conference papers, commentaries, letters and studies that presented methodological issues or used conjoint analysis with rankings or ratings including best–worst scaling. The purpose of this exclusion was to achieve uniformity in the selected studies to facilitate a fairer comparison of the methods used to conduct the DCEs. The title, abstract and method sections of all potential articles meeting the inclusion criteria were independently studied by two authors (KR and NT). During the screening of selected articles, appropriate attention was given to synonyms of DCEs, such as stated-choice methods or choice-based conjoint analysis (Fig. 1).

2.2 Data Extraction

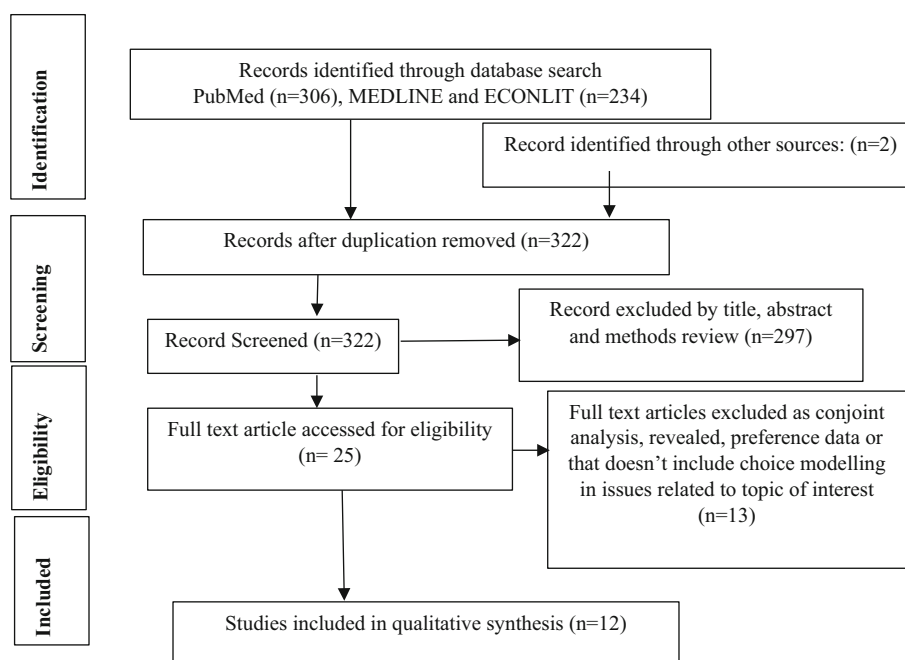
Data from and characteristics of the selected studies were assessed using the guidelines of Lancsar and Louviere [22] to check the DCE method quality. We used an adapted version of the report format used by Mandeville et al. [23], which was also developed from the former guidelines, to assess the validity of each study. Reporting items included information on study design, selection of attributes, method of creating the choice set, questionnaire and sampling design, estimation method, and application to tobacco-related issues. Two reviewers (KR and NT) independently extracted data, and any dissimilarities were resolved

Table 1 Search strategy

Search focus	Keywords
Study design (Scope 1)	Discrete Choice Experiment OR Choice Model*OR Stated preference methods OR Preference OR Patient preference{MeSH} OR Choice behaviour {MeSH}
Tobacco-related issues (Scope 2)	Tobacco OR Nicotine OR Cigarettes OR Electronic cigarettes OR Water-pipe tobacco OR Tobacco Use OR Tobacco chewing OR Vaping OR Smoking behaviour OR Smoking OR Anti-tobacco policy OR Tobacco control OR Smoking regulation OR Health warnings OR Pricing policies OR Packaging OR plain packaging OR Branding
Treatment or outcomes (Scope 3)	Smoking cessation {MeSH} OR Tobacco Use cessation product {MeSH} OR smoking prevention OR smoking cessation therapy OR nicotine replacement therapy OR behavioural therapy OR pharmacotherapy
	Final search [(Scope 1) AND (Scope 2) AND (Scope 3)]

MeSH medical subject heading

* Indicates a wild card

Fig. 1 Flow diagram of study selection

through discussion. A kappa inter-rater agreement of 85% was achieved using SPSS version 16 [24].

3 Results

3.1 Details of Selected Discrete-Choice Experiment (DCE) Studies

Only one [25] of the 12 studies selected was conducted in a developing country (Lebanon). This study elicited preferences for a university-based smoking-cessation program. The other 11 studies were conducted in developed countries: Japan, USA, UK, Canada, Switzerland and Sweden. The majority of studies (8/12) were published in the last 5 years. We found a variety of areas of application within tobacco research: half of the studies focused on smoking cessation, two on smoking behaviour [8, 19], two on electronic cigarette use [26, 27], one on waterpipe smoking [28] and another on cigarette packaging issues [29]. Six studies were published in journals that focus on smoking addiction, and four were published in health economics journals. A single study each was published in a general public health and health technology assessment journal (Table 2).

3.2 Methodological Characteristics

We examined the selected studies for the methodology used based on DCE stages: selection of attributes, experimental design and construction of the choice set, DCE questionnaire design, estimation method and applicability.

Table 2 Characteristics of included discrete-choice experiment studies

Characteristic	Studies (<i>n</i>)
Country of origin	
Japan	3
Canada	3
USA	2
UK	1
Lebanon	1
Switzerland	1
Sweden	1
Year of publication	
2001–2005	1
2006–2010	3
2011–2016	8
Area of application	
Smoking cessation	6
Smoking behaviour	2
Electronic cigarettes	2
Water-pipe tobacco	1
Tobacco packaging	1
Source of publication	
Addiction/tobacco/nicotine-related journals	6
Health economics journal	4
Other public health/epidemiology journal	1
Health technology assessment journal	1

Validity assessment is presented in Table 3 and methodological characteristics are presented in Table 4, and a summary of findings is presented in Table 5.

Table 3 Validity assessment of the included studies^a

Section	Criteria	Hammar and Carlsson [33]	Goto et al. [8]	Paterson et al. [30]	Goto et al. [34]	Goto et al. [19]	Marti [31]	Czoli et al. [26]	Salloum et al. [28]	Salloum et al. [25]	Morgan et al. [32]	Kotnowski et al. [29]	Pesko et al. [27]
Choice design	Choice of attributes and levels grounded in qualitative work with target population	Green	Blue	Green	Green	Green	Green	Green	Blue	Green	Green	Green	Blue
	No conceptual overlap between attributes	Green	Green	Green	Green	Green	Red	Green	Blue	Blue	Green	Blue	Blue
	Single dimensional attributes	Green	Green	Green	Red	Red	Red	Blue	Blue	Red	Green	Blue	Red
	Inclusion of an opt-out or status quo option or justification of forced choice	Green	Red	Blue	Red	Red	Green	Green	Green	Green	Green	Green	Red
Experimental design	Experimental design optimal or statistically efficient	Green	Blue	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Conduct	Piloting conducted amongst target population	Green	Blue	Blue	Green	Green	Green	Blue	Blue	Blue	Green	Green	Blue
	Target population(s) appropriate for research objective	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Sampling frame representative of target population	Blue	Green	Red	Green	Green	Red	Blue	Blue	Blue	Green	Green	Blue
	Response rate sufficient to minimize response bias	Blue	Green	Blue	Green	Green	Blue	Blue	Blue	Blue	Green	Blue	Blue
Analysis	Any pooled analysis from different subgroups appropriate	Green	Green	Blue	Green	Green	Green	Green	Blue	Blue	Green	Green	Green
	Econometric model appropriate for choice task design	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Econometric model accounts for serial correlation of choices	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Relative attribute effects compared using a common metric	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green

Red= criteria not met, (no evidence that could justify the criteria in the text) Blue= not enough information to judge the criteria (authors have limited information to make the judgement) and Green= criteria met. (the text sufficiently confirm the criteria)
^a Criteria adapted from Lancsar E, Louviere J. Conducting discrete choice experiments to inform healthcare decision making: a user's guide *PharmacoEconomics*. 2008;26(8):661-77.

3.2.1 Selection and Level of Attributes

The reporting of how attributes and their respective levels were selected was consistent in most studies. Half of the studies ($n = 6$) selected attributes based on a literature review. Four other studies [8, 26, 30, 31] reported a literature review followed by qualitative studies such as consulting experts or focus groups. Similarly, one study [29] used a literature review and observation of market practice, and another study used comparative meta-analysis followed by a qualitative study [32]. The method of defining attribute levels was relatively inconsistent. Studies using literature reviews to define attributes tended to use qualitative techniques such as interviews [29], expert consultation [19, 26, 30], focus group rankings and pilot tests [25, 33]. Two studies [8, 34] confirmed attribute levels using a pre-test technique only, and another study [27] did not report their method clearly. Half of the studies included five or more attributes, four studies [27, 29, 33, 34] used three or fewer attributes and only two studies [25, 30] included four attributes to define utility or preference (Fig. 2). All studies included a monetary attribute in the

form of an incentive, price or cost of the service. Four studies [25, 30, 32, 34] included a time attribute representing the time taken to obtain any service or the duration of travel to get there. Five articles included short- or long-term health risks [8, 19, 25, 28, 31] (Fig. 3).

3.2.2 Experimental Design and Construction of Choice Set

Ten studies followed fractional factorial design, and two studies [26, 27] applied balanced and incomplete block designs. For ten of the studies, the design plan was only to estimate the main effect and its interactions with covariates, whereas two recently published studies presented the main effect along with subgroup analysis [32] and interaction effects with all variables [27]. Half of the studies used the Statistical Analysis System (SAS; Cary, NC, USA) and three studies [8, 19, 34] used NLOGIT econometric software to design the orthogonal arrays. The method used to create choices varied among the studies. The majority (7/12) used orthogonal planning methods, and others used the D-efficient design [27], D-efficient with covariance matrix [32] or orthogonal balanced design [26].

Table 4 Discrete-choice experiment methodology in tobacco-control research

References	Design	Design plan	Design source	Method of creating choice set	Number of choice sets	Questionnaire	Estimation method
Marti [31]	Fractional factorial	Main effects only and interactions	Website	Orthogonal array	10	Interviewer administered	All models comparison
Goto et al. [8]	Factorial	Main effects only with interaction	N-Logit Version 3	Orthogonal planning method	8	Unclear	Mix logit model and simulation
Pesko et al. [27]	Balanced	Interaction with all variables	Unclear	D-efficient design D-efficiency	12	Unclear	Linear probability model with sensitivity analysis
Goto et al. [19]	Fractional factorial	Main effect only with interactions	N-Logit version 4.0 and Stata 11	Orthogonal planning method	8	Unclear	Random parameter logit model
Paterson et al. [30]	Fractional factorial	Unclear	Expert panel	Orthogonal design	4	Internet	Random parameter logit
Czoli et al. [26]	Balance incomplete block	Main effect only with interactions	SAS v. 9.4	Orthogonal design	20	Online/ internet	Multinomial logit regression
Salloum et al. [28]	Fractional factorial	Main effects with interaction	SAS v. 9.4	Unclear	9	Internet-based (tablet)	Multinomial logit regression, nested logit model
Salloum et al. [25]	Fractional factorial	Main effect and alternative	SAS v. 9.3	Unclear	8	Interviewer	Conditional logit models
Goto et al. [34]	Fractional factorial	Time risk preference: survival analysis	NLOGIT 3.0	Orthogonal planning method	8	Interviewer administered	Mixed logit model with simulation
Morgan et al. [32]	Fractional factorial	Main effect and subgroup analysis	SAS v. 9.1.2	D efficient design (co-variance matrix)	24	Web-based online	Conditional logit regression model
Kotnowski et al. [29]	Fractional factorial	Main analysis and interaction	SAS v. 9.3 (D-efficiency 98%)	Orthogonal and balanced choice set	10	Web-based online	Multinomial logic model
Hammar and Carlsson [33]	Fractional factorial	Main analysis	SAS	D-optimal design	4	Unclear	Standard random effects binary Probit model

3.2.3 DCE Sampling Design and Questionnaire Administration

Four of the studies used pretesting and pre-used questionnaires to make them user friendly [19, 31–33]. Three studies [8, 19, 33] used probability sampling, but the majority incorporated some form of non-probability sampling. Studies using non-probability sampling tended to pool subjects from heterogeneous subgroups and extrapolate the findings to certain groups of smokers. Eight studies administered questionnaires via the internet using web-based technology or email, and the remaining four [19, 25, 31, 34] administered interviews. Non-response rates varied from 40% [33] to 80% [34]. The

number of choice sets per respondent ranged from four to 24. Only one study reported using forced choice methods [32].

3.2.4 Method of Estimation

The objective-oriented method of estimation was used across studies. One study presented all model comparisons [31], three [26, 28, 29] used multinomial logit models and only two studies used mixed logit models [8, 34]. The oldest study [33] used a standard random-effect binary probit model, whereas the studies conducted after 2010 [25, 26, 28, 29, 32] used mixed, multinomial or a combination of other model designs.

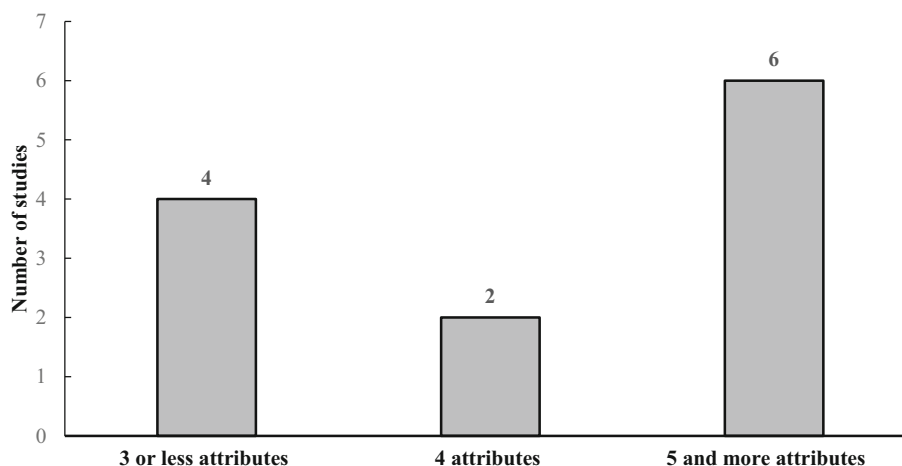
Table 5 Study limitations, main findings and policy decisions offered

References	Attributes and choice scenarios	Outcome measurements	Main findings	Strengths/limitations	Policy decision offered
Marti [31]	Price efficacy, side effects, weight gains and availability (location of cessation service)	WTP for improving cessation service	Smokers are willing to pay for higher efficacy, less-frequent side effects and prevention of weight gain	Non-random non-representative sample, no measure of preference heterogeneity, discussed hypothetical bias	High demand for improved cessation service
Goto et al. [8]	Price, penalty, mortality, rest, passive risk of cancer	Influence in behaviour	Price has greater effect on smoker with low nicotine dependence	Use of stratified random sampling, no consideration of interaction within attributes and heterogeneity, measure goodness of fit	Nicotine dependence and individual factors emphasized in smoking-cessation counselling
Pesko et al. [27]	Brand, price, flavour, warning label	Measure heterogeneity in policy response	Price responsiveness was higher among adult smokers who vape. Strong warning labels reduced smoking by about 5%	Internal and theoretical validity maintained, studied only current smokers, non-random sampling	Tax increase and strong warning label encouraged switch to electronic nicotine delivery system
Goto et al. [19]	Price per pack, fine, mortality risk, short-term risk, health risk to others	Attitude change due to anti-smoking policies	Price consistently influenced smokers of all dependence levels to attempt to quit; risk information and a smoking ban were effective only for low-dependence smokers	Test of internal validity assumed based on design	Anti-tobacco pricing policies changes smoker's attitude
Paterson et al. [30]	Frequency of dose, availability of cessation service, duration of use, success rate, total cost	Heterogeneity in preference for smoking cessation service, WTP	Systematic preference heterogeneity and random heterogeneity for therapy types by dose, light smokers were willing to pay more for 40% of success rate	Pretesting of choices, non-random sampling	Increasing success rate should be the primary focus of smoking-cessation programs
Czoli et al. [26]	Flavour, nicotine content, health warning, price	Preference for electronic cigarettes	Both flavour (36%) and health warnings (35%) significantly predicted perceptions of product harm; heterogeneity in consumers' trade-offs with respect to e-cigarette product characteristics	Cross-validation of the study findings across other design, convenience sampling	Health warnings and flavour need to be targeted for e-cigarette regulation
Salloum et al. [28]	Flavour, nicotine content, price of waterpipe tobacco	Impact on consumer choice of attributes and between-subject assignment of health warnings	More females preferred flavoured product than males, health warning prompt subject to opt out, fruit-flavoured products were chosen most	Convenience sampling and no systematic effort to control sampling factors	Water pipe-specific regulation should limit the availability of flavoured water pipe tobacco and require accurate labelling of constituents
Salloum et al. [25]	Treatment type, risk of side effect, cessation support service, distance travelled, cost	Attribute of most importance for cessation, WTP	Respondents were willing to give up \$US70 to avoid an additional 10% risk of minor side effects and \$US12 to avoid an addition km of travel to the nearest pharmacy	Convenience sampling	Young students are willing to trade-off to be smoke free

Table 5 continued

References	Attributes and choice scenarios	Outcome measurements	Main findings	Strengths/limitations	Policy decision offered
Goto et al. [34]	Reward, time delayed	Time discount rate, risk aversion, duration of smoking cessation	Time and risk parameters significantly predicted the success attempts of those who had already quit for up to 1 month at baseline	Follow-up design to measure time risk, over-estimation, purposive selection	Time and risk preference determine long-term quit
Morgan et al. [32]	First meeting with expert adviser, frequency of meeting, support method, incentive, quitting pal	Likelihood of quitting, subgroup analysis	Incentives of >£20–80 per month are required to increase the likelihood of quitting. Daily initial telephone or text support and a quitting pal increased their likelihood of quitting	Qualitative study and pre-test before deciding the attributes	Incentives increases quit likelihood among pregnant women
Kotnowski et al. [29]	Pack structure, brand, branding, warning label size, price	Impact on consumer choice	Price (23%) and branding (18%) were weighted as important in trial intent decisions, warning label size (23%) and brand (17%) were weighted important when judging product harm	Non-representative sample, limited attributes, underestimation	Standardized cigarette packaging decreases demand and misleading perceptions about product harm among females
Hammar and Carlsson [33]	Price, subsidy and regulation	Effectiveness of different smoking policies on smokers' expectations to quit smoking	On average, respondents expected to quit smoking in 53% of the choice situations	Discussion on potential errors, overestimation	Restricted availability, increased cigarette prices, cessation subsidies and regulations at restaurants, increase probability of smoking cessation

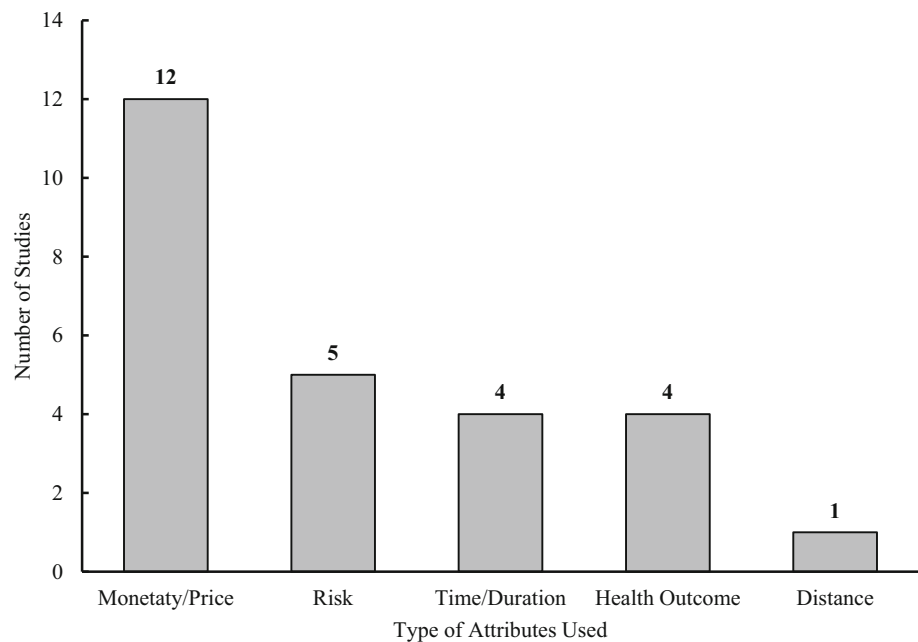
WTP willingness to pay

Fig. 2 Number of attributes used in studies

3.2.5 Validity

Validity and reliability reporting were inconsistent. However, studies reported adjusting and discussing potential errors [33] or follow-up strategies [34], discussed hypothetical bias [31], goodness-of-fit measurements [8], and

pretesting of choice and cross-validation with other designs [26, 30] to maintain validity and reliability. Three studies [8, 33, 34] discussed the risks of over-estimation when comparing findings from revealed behavioural studies. Only one study [32] triangulated the findings of a DCE with revealed-preference data. Overall, the validity

Fig. 3 Types of attributes used in studies

assessment revealed that the validity criteria in the studies were not met or could not be judged for choice design and conduct of DCEs (Table 3).

3.3 Application to Tobacco and Smoking

Half of the DCE studies evaluated preferences for various aspects of cessation services. Three studies [25, 30, 31] reported marginal willingness-to-pay (WTP) estimates. In general, studies reported that smokers were willing to trade for personalised cessation support, to increase the success rate of smoking-cessation aids and to reduce side effects from smoking-cessation medication. Three studies [27, 30, 31] investigated the existence of preference heterogeneity. Only one study [29] comprehensively illustrated the influence of tobacco packaging, marketing and branding, including the size of warning labels; however, two studies included health warnings, and both concluded they had a substantial influence on users. Two studies [26, 27] applied the DCE technique to elicit preferences for electronic cigarettes.

3.4 Tobacco-Cessation Preferences Evaluated

The two studies [26, 28] that evaluated client choices for tobacco products predicted that price, availability, tobacco packet design and health warnings (in terms of risk) were the most influential attributes. In people who intended to quit smoking, the efficacy of alternatives and treatment success rates were the most influential factors, as the study showed an increase in WTP when there were decreased chances of side effects [30] and relapse [25]. For a

vulnerable group such as pregnant women, incentives significantly altered the preference for, and success of, quitting. One study [30] investigated provider-related preferences, such as the drug-distribution setting (prescription or over the counter) and fear of weight gain and concluded that those factors did not influence cessation. However, two recent studies [25, 32] revealed a strong preference for quitting associated with peer pressure, incentives and counselling frequency.

3.5 Policy Decisions

One-third of the studies reported on the effects of price trade-offs in encouraging smoking cessation in terms of WTP for improved cessation services [25, 30, 31] and investigated the influence of incentives on vulnerable populations such as pregnant women [32]. All studies reported the significant influence of monetary attributes by contextual perspective. Four studies found pricing policies to be effective, as they shifted the preferences of smokers who intended to stop smoking [8, 19], and a proposed tax increase decreased consumption [27, 34]. Two studies [30, 31] reported that increasing the availability of cessation services or drugs predicted a higher demand for cessation services and increased success rates in clinical settings. One study [29] on branding and tobacco packaging reported that standardised cigarette packaging was the most influential policy, whereas studies investigating other policy decisions such as regulating flavour in electronic cigarettes [26, 27] and use of proper warning labels [26, 27, 29] found them to be less influential (Table 5).

4 Discussion

Tobacco use continues to be an important public health challenge worldwide, and econometric analysis of smoking behaviour and cessation therapies is a health research priority. This paper reviewed the application of DCEs to investigate smoking-cessation interventions and tobacco control policies. We found that researchers have adopted the DCE methodology to quantify behaviour, elicit future preferences and policy options and measure policy impacts. To the best of our knowledge, this is one of the first reviews to explore how DCE techniques have been designed and used globally in this area. In addition, price attributes were dominant in all studies, the reporting of design plans was inconsistent, and studies explicitly used non-random sampling techniques.

Along with DCE studies, subject-specific reviews on the utility of DCEs in the health literature is also increasing. The existing reviews investigated the use of DCEs in pharmacy practice [35], human resources for health [23] and healthcare decision making [36]. We found a limited number of tobacco-control studies adopting DCEs, perhaps because they often require skills in advanced statistical and design techniques [37]. A majority of smoking-related DCEs were published by researchers from developed countries. Indeed, DCEs have been regularly used in health economics studies in high-income countries [6]. Only a limited number of studies have used DCEs in resource-limited settings, and the results they produce may differ from those conducted in developed countries [7]. The trend for an increase in the number of DCE-based studies on tobacco-related issues over time is similar to the trend in the use of DCEs in healthcare research [6]. Furthermore, choice modelling requires multidisciplinary skills in research design, economic theory, experimental design and, most importantly, rigorous statistical analysis, which all consume large amounts of resources and expertise [37].

In addition, as well as finding monetary attribute effects in all studies, we also found other attributes such as risk, time and health outcomes. Only a few attribute levels, such as duration of service provision and the process of getting smoking-cessation medication, were set from the perspective of health service providers at smoking-cessation clinics. More research on preference assessment from the viewpoint of the smoking-cessation service provider is needed to combine their preferences with those of tobacco users. In general, smoking-related DCEs focused particularly on price and risk attributes from the tobacco user's perspective, which contrasts with other health-related DCEs that particularly emphasize health outcomes and the health service's perspective [6]. Most included studies used

monetary attributes as the most dominant attribute for making policy decisions based on smoker behaviour or response. Nevertheless, caution is necessary as the dominant preference effect is valid for smokers with strong preferences [3].

The validity of DCEs and their implications is still under investigation in health economics. Different types of attributes and the design of the DCE itself pose a threat to validity. In fact, evidence from environmental economics recommends the routine integration of tests of validity and reliability into a DCE framework [38]. The studies included in our review reported using a preparatory study such as expert consultation or focus group discussion when establishing attributes, in addition to the literature review. A preparatory study helps identify the appropriate attribute levels and ease in interpreting choices, thus maintaining internal validity [39, 40]. We found most studies used opportunistic or non-probability sampling. Overall, generalisability was weak; however, the objective of DCE studies is to measure weighted preferences [4]. Fractional factorial designs were the most common, adopted in nine studies; however, the design plans only included interactions with covariates such as age, sex and educational background. Furthermore, combining stated-preference and observed-preference data or comparing a DCE result with methods such as contingent valuation can only maintain external validity in choice experiments [9, 38, 41]. None of our studies reported any tests of external validity. Prior assumption of external validity was used in most studies, as suggested by some methodological studies [18, 40, 42]. The practice of assuming external validity is concurrent with a review of DCEs use in pharmacy practice [35]. A limited number of choices and attributes can provide much-needed external validity [1, 4, 43]. Furthermore, studies on complex and multifaceted health behaviours, such as smoking and smoking cessation, should use hierarchical information integration to test their theory and validity; these are considered less favourable and practical to implement but become evident with well-designed DCEs [44].

Orthogonal designs have been the most frequently used in health economics, followed by D-Optimal designs [45]. In our review, these designs were frequently reported as a method of constructing the choice set. The efficient design of DCEs is influenced by the choice-making behaviour of the study participants, and smokers and tobacco users are no exception [46]. Although the use of statistically efficient designs and statistical software is increasing [6], only one study [31] used websites to construct a choice set. Similarly, we found that the results of weighted preferences and welfare estimates varied along with the DCE framework. The recent studies used more advanced econometric

analyses for valuation [10, 47]. One study assessed time and risk preferences and their relation to smoking cessation using a DCE technique and concluded that smokers with a high time discount rate were more likely to relapse. We consider this finding to be a novel application of DCEs as it extends the scope of predictors of smoking cessation. This finding also supports quasi-hyperbolic discounting, a tendency to choose current benefits over future gains in prediction [48]. One potential explanation for risk attributes explaining long-term relapse could be the behavioural nature of self-selection, which is applicable to smoking cessation but not to smoking initiation [49].

The major strengths of this study include the rigorous database search, the validity assessment of the selected studies and the outlining of policy decision options. This is a subject-specific review of the application of DCEs within the field of tobacco use. Furthermore, the study presented the progressive application of DCEs for informed economic decision making for tobacco control.

The review also has some limitations. Our exclusion of grey literature may have neglected some relevant work within this field. However, our efforts in reference tracing from the selected articles and methodological research meant our search strategy was comprehensive and systematic. The review focussed more on a critique of methods than the results of the studies. It is not possible to answer how the results of welfare estimates can be used by policy makers. Future methodological studies and studies on generalising the findings of DCEs are recommended. Standardising the reporting and ‘method’ of approaching the question, justification and design of the study could be the first step to generating quantitative evidence from the evaluation of all tobacco-control efforts.

4.1 Implications for Practice and Research

The analysis of stated-preference data on health promotion or health behaviour change interventions from DCEs can adequately predict actual health behaviour [18]. Therefore, the application of DCEs to explain smoking or cessation behaviour has the potential to establish new interventions for tobacco control. DCEs were found that elicited preferences for electronic cigarettes and the marketing or branding of cigarettes. Electronic cigarettes and cigarette brand design are tobacco-control issues that have only recently emerged and for which limited research has been conducted [50]. The DCE framework can appropriately fit into such emerging behaviours and interventions that regularly inform policy makers and researchers. One possible benefit of using DCE techniques is that it can bring about triangulation in research findings. It promotes the

estimation of the degree of effects that induce changes in smoking behaviour and the environment, as outlined by tobacco-control policies, for example, determining the effects of incentives to avert smoking in pregnancy, measuring possible changes in smokers’ attitudes and behaviours after the introduction of tobacco prohibition in public places and tobacco tax increases. Furthermore, DCEs can also help inform the design of trials to test interventions in real-life settings [32]. The elicitation of smoker preferences as well as economic evaluations for new tobacco products such as e-cigarettes, and their appropriate cessation methods, can inform decision makers who implement changes to serve smokers who are willing to quit.

5 Conclusions

The DCE methodology adopted in nicotine- and tobacco-related studies were consistent with the guidelines for conducting health-related DCEs. However, we observed heterogeneity in the distribution of attributes, which included price, risk, time, distance and health outcomes. Price attributes had dominant effects on tobacco policies and behaviour. Perspectives from both tobacco users and tobacco-cessation service providers could be incorporated into DCE attributes. Prominent methodological issues identified included using fewer attributes, conducting a literature review followed by qualitative techniques to confirm the choice set and good explanation of DCE theory. Moreover, designs and design plans were reported inconsistently and is a key area for improvement. We suggest standardising the reporting and ‘method’ of approaching the question, justification and design of the study. Future studies could combine preference evaluations for tobacco products, smoker’s behavioural options and cessation intervention or service providers to incorporate DCE results in an economic evaluation framework that can ease tobacco-control decision making.

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Author contributions KR designed the review, searched for studies, extracted data, analyzed findings, and drafted the manuscript. DK validated the data extraction and wrote some sections of the manuscript and revised and proofread the manuscript. ST helped to write the review, interpreted the results, and performed a technical edit of the manuscript. NT contributed to the design of the study, to article screening and the final edit of the manuscript.

Compliance with Ethical Standards

Data availability statement All data generated or analysed during this study are included in this published article (its supplementary information files).

Conflicts of interest KR, DK, ST and NT have no conflicts of interest.

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