

Prioritizing investments in public health: a multi-criteria decision analysis

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ABSTRACT

Background The evidence on public health interventions has traditionally focussed on a limited number of costs and benefits, adopted inconsistent methods and is not always relevant to the UK context. This paper develops a multi-criteria decision analysis (MCDA) approach to overcome these challenges.

Methods A document review and stakeholder consultation was used to identify interventions and the criteria against which they should be assessed. The interventions were measured against these criteria using literature reviews and decision models. Criteria weights were generated using a discrete choice experiment.

Results Fourteen interventions were included in the final ranking. Taxation was ranked as the highest priority. Mass-media campaigns and brief interventions ranked in the top half of interventions. School-based educational interventions, statins and interventions to address mental health problems ranked in the bottom half of interventions.

Conclusions This paper demonstrates that it is possible to incorporate criteria other than cost-effectiveness in the prioritization of public health investment using an MCDA approach. There are numerous approaches available that adopt the MCDA framework. Further research is required to determine the most appropriate approach in different settings.

Keywords economics, methods, public health

Introduction

Health-care commissioners are faced with the challenge of allocating resources in order to achieve their objectives.^{1,2} In the current economic climate, this is made more challenging by the pressures on health budgets. This is particularly challenging for the NHS in England where the Health and Social Care Bill³ will put the responsibility for commissioning in the hands of newly established clinical commissioning groups, and in the case of public health in the hands of Local Authorities (LAs) through newly established Health and Well-being Boards.⁴ The principles of the World Class Commissioning (WCC) Standards require that these commissioners ensure better health and well-being, better care for all, as well as better value for money.⁵ To this end they will need to use sound evidence to inform their decisions. Despite the large investments in the production, synthesis

and dissemination of evidence on the effectiveness and cost-effectiveness of health-care interventions by organizations like the National Institute for Health and Clinical Excellence (NICE) and the National Institute for Health Research (NIHR), the use of evidence by health-care decision-makers remains limited.^{6–8}

The challenges of evidence-informed decision-making are of equal, if not greater, importance in the field of public health, for which the evidence base is much less developed when compared with clinical health. A recent review

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identified about 150 economic evaluations in the field of public health,⁹ which compares with many thousands of economic evaluations in health more broadly.¹⁰

The objective of this paper is to demonstrate the feasibility of developing and applying a method for prioritizing preventative health interventions in the UK in order to help improve the accessibility of existing evidence. The method was developed through extensive engagement with those responsible for making public health investment decisions to ensure that it was fit for purpose: accessible and based on the evidence relevant to their needs.

One of the challenges facing the evaluation of public health interventions is that their objectives are not easily captured by the standard criteria employed by health economists, like the quality adjusted life year (QALY) gained.¹¹ In order to address this challenge, the method adopted a multi-criteria decision analysis (MCDA) approach to incorporate both health economic and non-health economic outcomes into the prioritization of public health interventions. In doing so, this paper addresses a question of increasing interest to health decision-making—how to formally incorporate a range of factors into Health Technology Assessment (HTA). Whilst HTA has tended to explicitly quantify only a limited number of benefits and costs, decision-makers responsible for using the evidence generated by HTA have also considered other sources of value. NICE, for instance, has acknowledged that its committees take into account a wider range of factors than cost-effectiveness when assessing health technologies.^{12,13} The Department of Health’s recent consultation on the use of a value-based approach to price branded medicines (VBP) also raises the question of how to capture a definition of value broader than that traditionally quantified in HTA.¹⁴ As a result there is interest in MCDA as a method for capturing this broader value in a more systematic manner.^{15,16}

The next section summarizes the approach employed to define and construct the MCDA framework. The generation of evidence on a range of criteria for the 17 public health interventions included in the analysis involved a range of complex data collection and analytical approaches. As a consequence, the methods section can only provide an overview of the approach adopted, but provides links to online sources where more details can be obtained.

Method

MCDA approaches vary according to the source and nature of information used to inform decision-making, but they include four common steps: identifying interventions; identifying evaluation criteria; measuring the interventions against the criteria; and combining the criteria scores using a

weighting to produce an overall assessment of each intervention. This section provides an overview of the MCDA approach adopted. Further detail is available at: <http://help.matrixknowledge.com/page/Methodology.aspx>

Interventions evaluated

Sixteen preventative health interventions were identified across the following national priorities¹⁷: obesity, alcohol, smoking, sexually transmitted disease and mental health. The interventions were suggested by senior decision-makers (in a workshop of Directors of Commissioning, Public Health and Social Services, and in consultation with a range of national figures such as national screening committees, Department of Health), and those that had been recommended by NICE. Exceptions to these rules were made in a number of cases. In particular, a number of mental health interventions would not have made it into the short-list, but were included, as these were considered of interest to both the health and social care fields. The final list of interventions is summarized in Table 1. Statins were added to the list, as they were considered a preventative health intervention that was commonly considered to be value for money, and thus represented an interesting benchmark.

Evaluation criteria

Whilst the objective of the MCDA was to undertake a quantitative assessment of interventions, it was still important that the criteria used to assess the interventions were those of interest to decision-makers. Criteria were identified

Table 1. Preventative health interventions included in the MCDA

<i>Policy area</i>	<i>Intervention</i>
Alcohol	Brief interventions delivered in GP surgeries. Increase tax by 5%. National mass-media campaigns. School-based group education
Mental health	Assessment and support of caregivers. Screening to prevent depression in retirees
Obesity	Brief GP interventions to promote physical activity. Cognitive Behavioural Therapy. National mass-media campaigns. School-based education
Smoking	Brief interventions delivered in GP practices. Increase tax by 5%. National mass-media campaigns. Nicotine replacement therapy
STI	School-based education to increase condom use. Screening and treatment to reduce Chlamydia

through two sources: a review of previous MCDAs of preventative health interventions^{18–23}; and engagement with public health decision-makers in a workshop. An online survey was then used to elicit the decision-maker's ratings of the importance of these evaluation criteria. Emails were sent to over 700 senior figures in health and social care requesting their participation. Those approached were: Chief Executives, Directors of Public Health and Directors in charge of commissioning from every Primary Care Trust (PCT); the Chief Executives and Directors of Public Health from every Strategic Health Authority; and the Directors of Social Services (Adult, Child and Joint) from every LA. A total of 83 surveys were completed. The majority of respondents were from the health-care sector (77%) with a small number from social care (19%) or joint health and social care (4%). A large proportion of respondents were Directors or Executive Directors (43%) with responses from some Chief Executives (13%).

The results of the review, workshop and survey were combined to identify the following criteria for inclusion in the analysis:

- Incremental cost-effectiveness: cost per QALY gained, including the long-term impact on health-care costs avoided and quality of life gains.
- The proportion of the population eligible for the intervention.
- The distribution of benefits: the ratio of the proportion of the most disadvantaged 20% of the population eligible for the intervention to the proportion of the population as a whole eligible for the intervention.
- Affordability: the budget required to fund the intervention if all eligible people received the intervention.
- Certainty: confidence in the evaluation of the intervention, based on an assessment of the quality of the method and data used in the evaluation.

This final list excluded two criteria identified as important: the feasibility and acceptability of interventions. These criteria were excluded as they could not be measured quantitatively within the scope of the project.

Measuring interventions against criteria

A review of existing studies was undertaken to identify data on the effectiveness and cost of relevant interventions. Decision models were then constructed to extrapolate the short-term effects identified in the review into lifetime health gains, and to value these gains in terms of incremental public sector costs avoided and improvements in participants' health-related quality of life. These long-term benefits were discounted at 3.5% in accordance with H.M. Treasury

guidance. Separate models were constructed for each of the interventions included in the analysis.

Data to estimate the proportion of the population benefiting from the intervention and the distribution of benefits were identified from the following sources: Office of National Statistics (ONS); departmental and associated organizations; charities for the health states or behaviours.

The final criterion was certainty—confidence in the evaluation of the intervention, based on an assessment of the quality of the method and data used in the evaluation. Each of the criteria estimates were graded for the quality of the data and methods employed to arrive at the estimate. Quality grading scales were developed using existing scales in the fields of research design,²⁴ economic evaluation²⁵ and statistics.²⁶

Generating a ranking

A discrete choice experiment (DCE) was employed to elicit weights for the criteria from public health decision-makers, and thus combine the criteria into an overall priority score. DCEs involve presenting respondents with a series of hypothetical scenarios (choice sets) that are described using the criteria of interest. Faced with a number of such interventions, respondents are then asked to choose their preferred intervention. Given respondents' choice of interventions, statistical analysis can be employed to estimate the relative influence of each criterion on the choice made.

All respondents were given 16 choice sets designed using a programme to generate a fractional factorial design.²⁷ Where the respondent did not complete all choice sets, partial responses were included in the analysis. A conditional logit model was used to analyse responses. The results of the model were used to estimate the utility generated by each intervention, as per Equation 1.

$$U_a = e^{[(\beta CE.CE_a) + (\beta DB.DB_a) + (\beta PB.PB_a)]} \quad (1)$$

where U_a is the utility produced by intervention a , βCE is the coefficient on the cost-effectiveness criterion, βDB is the coefficient on the distribution of benefit criterion, βPB is the coefficient on the proportion benefiting criterion, CE_a is the cost per QALY gained from intervention a , DB_a is the distribution of benefits of intervention a and PB_a is the proportion benefiting from intervention a .

The relative probability of intervention a being chosen compared with the other interventions is given by Equation (2).

$$P_a = \frac{U_a}{\sum_{i=0}^n U_i} \quad (2)$$

where P_a is the probability that intervention a is chosen compared with other interventions being evaluated, U_a is the utility

produced by intervention a and $\sum_{i=0}^n U_i$ is the utility produced by all the interventions being evaluated.

Results

Table 2 summarizes the result of the MDCA. The results represent the implementation of the interventions for the whole of England. Equivalent results at PCT-level are available at <http://help.matrixknowledge.com/interventions/>.

Three interventions were not included in the final ranking. One of these interventions, Cognitive Behavioural Therapy to combat obesity, was found to be ineffective¹. Two alcohol interventions were excluded as there were insufficient data with which to estimate their lifetime cost-effectiveness. Both these interventions targeted young people's alcohol use. The lifetime benefits of this intervention could not be estimated due to the lack of epidemiological data on the relationship between young people's alcohol use and alcohol use later in life.²⁸

Table 2 demonstrates that taxation is the highest priority intervention for decision-makers, with 5% increases in the tax on alcohol and cigarettes topping the priority list. Furthermore, both these interventions rank high in terms of their affordability. National mass-media campaigns for smoking cessation and reducing obesity were ranked third and fifth, respectively. Brief interventions for smoking cessation, reducing obesity and reducing alcohol consumption were ranked fourth, sixth and seventh, respectively.

School-based education interventions and mental health interventions were in the bottom half of the ranking. School-based education to reduce obesity and increase condom use was ranked 10th and 11th, respectively. Interventions to address mental health problems (assessment and support for carers and screening of retirees) were ranked 13th and 14th, respectively.

Statins, an intervention that is generally acknowledged as being a high priority, was only ranked 12th.

Discussion

Main findings of this study

This study reported an MCDA designed to rank public health interventions according to the preferences of decision-makers

in the UK. There are two key sets of findings that can be drawn from the study. First, it is possible to use an MCDA framework to generate evidence to inform public health investment decisions. The example of MCDA presented in this paper demonstrates how it can be used to generate a ranking of interventions by combining the performance of interventions against a range of objectives. Furthermore, it does this through the powerful combination of decision-makers' priorities and rigorous analytical methods.

Secondly, the results of the application of the framework indicate decision-makers' preferences for the interventions assessed. Fourteen interventions were included in the final ranking. Taxation was ranked as the highest priority. Mass-media campaigns and brief interventions ranked in the top half of interventions. School-based educational interventions, statins and interventions to address mental health problems ranked in the bottom half of interventions. The ranking of interventions was driven primarily by their cost-effectiveness defined as incremental cost of quality adjusted life year gained, which was given greater weight by respondents to the DCE.

What is already known on this topic

Evidence is available on the effectiveness and cost-effectiveness of many of the interventions included in this study. This evidence is, however, limited for a number of reasons. First, evidence on cost-effectiveness is not available for all the interventions considered in this study. Secondly, where such evidence is available, it is not generated in a consistent manner, limiting the ability of users of the evidence to compare the interventions.⁷

Previous studies have attempted to overcome these limitations. For instance, Maciosek *et al.*^{18,19} have produced a ranking of preventative health interventions in the US based on their cost-effectiveness and the clinical burden of disease associated with the underlying health problem. These efforts have, however, been assessed as having only limited application to decision-making in the UK due to: the limits to generalizing US data on prevalence and cost to the UK context; no explicit consideration being given to equity impacts; and the need to consult UK stakeholders on the objectives that an MCDA framework should inform.¹¹

What this study adds

This study attempts to overcome the limitations identified in previous MCDAs in public health. As a consequence, this study makes a number of contributions to the public health evidence base. First, public health decision-makers in the UK were engaged to determine the criteria that should be

¹NICE guidance on CBT to combat obesity include a modelling exercise to estimate the cost per QALY gained through the intervention. However, this work was based on effects measured at the 1-year follow-up. The study from which these data are drawn also includes a 5-year follow-up that demonstrates that the intervention is not effective compared with a diet only counterfactual.

Table 2. Ranking of preventative health interventions

<i>Intervention</i>	<i>Problem targeted</i>	<i>Priority ranking</i>	<i>Priority score (% decision-makers rank the intervention as top priority)</i>	<i>Reach (% of total population affected)</i>	<i>Inequality score (% disadvantaged affected/ % all affected)</i>	<i>Cos-teffectiveness (Cost per QALY gained)</i>	<i>Affordability (***) <£100 m; ** £100 m- £1 bn * >£1 bn)</i>	<i>Certainty (***) High quality evidence; ** Good quality evidence *Low quality evidence)</i>
Increase tax by 5%	Alcohol	1	11.2	18.4%	1.78	-£5267	***	**
Increase tax by 5%	Smoking	2	9.8	22.3%	1.55	-£3320	***	***
National mass-media campaigns	Smoking	3	9.6	22.3%	1.55	-£3032	***	***
Brief interventions delivered in GP practices	Smoking	4	9.1	19.2%	1.55	-£2169	***	***
National mass-media campaigns	Obesity	5	9.0	0.1%	1.00	-£3290	***	**
Brief interventions delivered in GP surgeries	Alcohol	6	8.6	15.9%	1.78	-£750	**	**
Brief GP interventions to promote physical activity	Obesity	7	8.6	33.7%	1.00	-£2151	**	***
Nicotine replacement therapy	Smoking	8	8.4	12.8%	1.47	-£933	**	***
Screening and treatment to reduce Chlamydia	STI	9	7.3	11.3%	1.00	£370	***	**
School-based education	Obesity	10	7.2	3.6%	1.00	£599	***	**
School-based education to increase condom use	STI	11	6.0	0.5%	1.57	£4965	**	*
Statins for primary prevention	Statins	12	4.2	6.2%	1.08	£9858	*	**
Assessment and support of caregivers	Mental health	13	0.9	3.3%	1.00	£35 264	*	**
Screening to prevent depression in retirees	Mental health	14	0.1	1.5%	1.08	£70 120	***	***

used to evaluate public health interventions. Secondly, economic models were constructed to fill the gaps in the existing evidence base and to ensure that interventions can be assessed based on consistent data relevant to the UK context. Thirdly, a DCE is employed to elicit decision-makers' priorities when faced with multiple and often competing objectives.

Limitations of this study

The methodological questions raised by the task of prioritizing interventions are complex and challenging. It is, consequently, worth considering how the method summarized in this report might be improved going forward. First, MCDA approaches vary considerably in their balance between the use of stakeholder opinion and the use of research to generate quantitative inputs to the analysis. The approach presented in this paper adopted a relatively quantitative approach to MCDA. Further work is required to determine the appropriate MCDA approach in different settings. For instance, would a more qualitative, deliberative approach be required to support LAs and health and well-being boards make locally specific decisions. The appropriate approach will be determined by the objectives and capacity of those undertaking MCDA in these settings.

Secondly, the analysis was limited to 17 interventions. Given that data availability was a requirement for an intervention to be included in the analysis, it tended to be established interventions that are included. Innovative interventions that have yet to be evaluated will tend to be excluded. Further work is required to increase the number of interventions included in the prioritization.

Thirdly, the desire to produce a quantitative ranking of the interventions meant that criteria for which there is no existing, validated measurement instrument were excluded from the analysis. In particular, the acceptability and feasibility of the interventions were highlighted as important by stakeholders engaged during the criteria development stage of the project, but were not included in the prioritization. It is proposed that decision-makers should supplement the results of the analysis with additional criteria pertinent to their local circumstances.

Fourthly, the analysis uses decision-maker preferences to define and weight criteria. This raises the question: whose values should be used to define and weight criteria? It is often argued that it is the preferences of the public that should be employed to allocate resources.^{2,11} Further discussion of whose value should inform decisions is required to determine the appropriate methodology for weighting criteria.

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Conflicts of interest

None declared.

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