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Original Article

# Designing Value-Based Dental Benefit Packages: A Multicriteria Decision Analysis in the Netherlands

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**Abstract**

**Background:** Oral diseases increasingly pose pressing challenges on the global political agenda. Given the vast absence of evidence-informed optimization of oral health resources, this study aimed to evaluate the application of multicriteria decision analysis (MCDA) for the design of value-based dental benefit packages in the Netherlands.

**Methods:** The MCDA approach of this study was aligned with three workshops, during which representatives from patient organizations, the dental profession, health insurers, policy-makers, and academic experts participated in an advisory panel to design benefit packages. Participants selected 17 conventional dental services for assessment through literature review and expert elicitation. Decision criteria included severity of treated oral diseases, the extent to which interventions produce positive effects on clinical and quality of life outcomes, the rate of complications resulting from interventions and the extent of high and unpredictable costs posing insurance risk. Performance on these criteria were combined via swing weights into cost-value ratios and informed deliberation of the advisory panel to determine priority rankings for interventions as well as allocate into minimal, moderately sized, and maximal packages. The overall priority setting process was evaluated with an online questionnaire.

**Results:** Following deliberation, the advisory panel ranked routine dental checkup, tooth extraction, oral hygiene instruction and direct restoration among highest priority interventions eligible for minimal coverage. Participants expanded this coverage with root canal treatment, scaling and polishing, partial denture, and occlusal splint in the moderately sized package. Periodontal therapy, tooth replacement, and indirect restoration were covered in the maximally expanded package. Participants expressed overall satisfaction with the process.

**Conclusion:** The findings of this study suggest MCDA to be a suitable approach to inform deliberative optimization of oral health resources and derive value-based benefit packages for oral healthcare. The highest priority ranking was identified for routine dental checkup and the lowest ranking for indirect restoration.

**Keywords:** Benefits Package, Multicriteria Decision Analysis, Oral Healthcare, Priority Setting, The Netherlands, Value-Based Care

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## Background

With over 3.5 billion people globally suffering from oral diseases, dental care increasingly draws the attention of the policy-making agenda.[1] The disease burden is exacerbated by substantial out of pocket expenditures, forming the third most expensive health sector in the European Union alone.[2,3] Most recent estimates show that the total economic impact of oral diseases surmounts to $387 billion in direct spending and $323 billion in productivity losses.[1] In response, the World Health Organization (WHO) has recently established a new resolution and action plan that highlights the need for universal dental coverage.[4]

Despite these global efforts, national oral health policy has been conflated by strong bargaining of the privatized profession and limited evidence of oral health interventions. Taken together, these challenges have formed a bottleneck in policy decision-making, paving the way for small scale fragmented policies instead of broader population interventions.[5] Evidence-informed policy-making supported by multicriteria decision analysis (MCDA) has been proposed as an approach to facilitate legitimate decision-making and optimize resource allocation. This method engages relevant stakeholders in the systematic evaluation of alternatives through explicit decision criteria to assess value. Key to this approach is an integrated deliberative process to enable informed consensus on resource allocation among decision-makers and relevant stakeholders.[6-8]

Previous studies have applied MCDA to inform broader deliberative prioritization frameworks for the National Health Service (NHS) dentistry in England. Holmes et al[9] used a program budgeting and marginal analysis (PBMA) framework to evaluate four hypothetical investment proposals. While facing significant implementation challenges, the study highlighted the importance of adaptability in the framework, which led to eventual acceptance of the methodology among commissioners. Similarly, Vernazza et al[10] applied a

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## Key Messages

### Implications for policy makers

- The rising global political traction for universal dental coverage has been confined by the vast absence of value-based optimization of oral health resources.
- This study fills this gap by demonstrating the suitability of deliberative resource allocation informed by multicriteria decision analysis (MCDA) to design value-based dental benefit packages in the Netherlands.
- The findings suggest an essential role for routine dental checkup, tooth extraction, oral hygiene instruction, and direct restoration in oral healthcare coverage, compared to low priorities identified for tooth replacement and indirect restoration.

### Implications for the public

More than 3.5 billion people suffer from oral diseases, resulting in an estimated economic impact of $710 billion globally.[1] Despite the growing disease and financial burden, efforts to optimize the allocation of oral healthcare resources have remained sparse. This study demonstrates a deliberative process that enables the design of value-based benefit packages. Through stepwise evidence-informed deliberation, key oral healthcare stakeholders were able to align on relevant dental services and criteria for a comparative assessment of interventions. Subsequent evidence collected and synthesized by the research team gave stakeholders an overview of the cost-value of interventions. This approach facilitates stakeholder engagement to determine key attributes of value and optimize the benefits derived by the population from healthcare resources. The resulting packages could contribute to the coverage of essential dental services in the Netherlands. Moreover, the processes demonstrated in this paper could serve as basis to align resource allocation with public needs in other settings.

PBMA framework to evaluate a broad range of public and dental services within NHS dentistry for investment and disinvestment. While MCDA has led to concrete investment recommendations in these contexts, the applicability of MCDA for priority setting of oral health services in other countries has yet to be tested.

Contrary to England, dental care is commissioned privately in many countries.[2] In the Netherlands, dental care is largely excluded from public coverage and provided by private practices. As a result, the coverage of dental benefits packages offered through supplementary insurance needs to comply to experience based underwriting, in contrast to publicly covered medical services.[11] Recent political debates in the Netherlands have highlighted the interest among most political parties in reintegrating oral healthcare into the public scheme.[12] Operationalization of such a reform remains ambiguous because parties vary in their desired coverage of dental services and no previous guidance on package design exists from the Dutch healthcare institute (*Zorginstituut Nederland*, ZIN), the formal Dutch health technology assessment (HTA) agency.[13]

As dental care continues to gain global political traction, this gap in the literature has become ever more relevant. Market-driven packages offered by supplementary dental insurers lack HTA-based optimization of dental resources.[11] In the absence of systematic prioritization of oral healthcare services, patients, insurers, and policy-makers could benefit from frameworks that minimize opportunity costs within packages, raising the value derived from current insurance packages as well as informing future policy decision-making. By integrating stakeholder engagement and evidence synthesis in the decision-making framework, MCDA offers unique potential to address existing bottlenecks in national oral health policy-making. Against this background, this study aimed to test and evaluate the application of MCDA for the design of value-based dental insurance.

## Methods

This study was carried out as part of the European Union funded DELIVER (Deliberative Improvement of Oral Care Quality) project.[14] A stepwise MCDA was facilitated with the focus of assessing dental services for their inclusion in value-based dental benefit packages in the context of private insurance coverage in the Netherlands. Drawing from evidence-informed deliberative processes, PBMA, and the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) guidelines on MCDAs for treatments, we adopted an iterative framework as depicted in Figure 1.[7,8,10,15,16] Stages in this framework can be categorized into (*i*) setting the scope of prioritization, (*ii*) assessing performance of interventions, and (*iii*) recommending resource allocation decisions for package design informed by the comparative assessment.

### Scoping

An advisory panel was recruited consisting of representatives from patient organizations, the dental profession, insurers, policy-makers, and academic experts. In total, 16 representatives participated in this panel, with at least three representatives from each stakeholder group. This purposive sample of key stakeholders was guided through all steps of the framework to form a recommendation on dental benefits package design. Participants were included if they belonged to one of the stakeholder groups and had relevant professional, policy, advocacy, or research expertise in oral health and benefit packages. Those lacking relevant experience in these areas were excluded from the study. The participants were invited to three 2-hour online workshop sessions that followed a focus group design, each of which adhering to one of the stages of the prioritization process. We denote these as Workshop A, B, and C, respectively.

During Workshop A, as part of the scoping stage, the interventions considered for evaluation, decision criteria and budgetary threshold were determined together with the advisory panel. The interventions selected for evaluation were based on the disease profile of the Netherlands. Currently, untreated caries, periodontitis, and tooth wear form the most common oral diseases in the Netherlands.[17] A list of

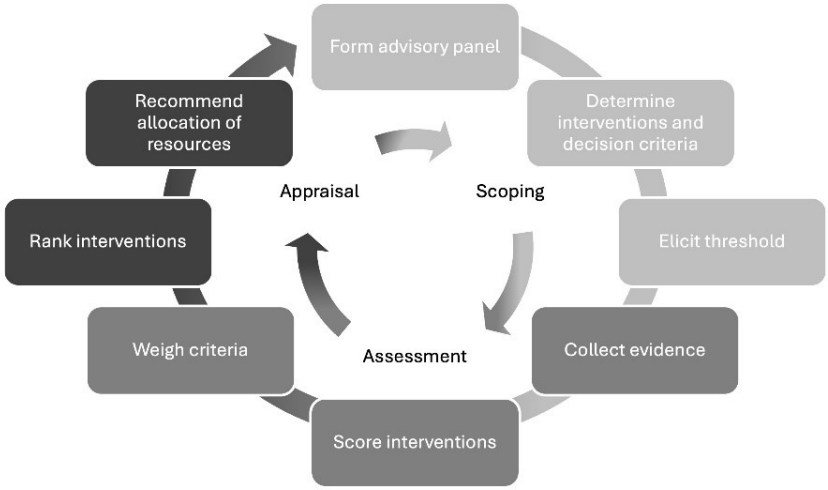



**Figure 1.** Priority Setting and Resource Allocation Framework.

17 conventional preventive, endodontic, periodontic, and prosthodontic interventions was generated addressing all relevant diseases, following the treatment code categories of the Dutch Healthcare Authority.[18] Moreover, decision criteria were based on the Dutch private insurance context and largely drawn from the four criteria used by ZIN for the appraisal of medical services in the basic benefits package.[19] These criteria were discussed with the advisory panel and adapted according to level of completeness, relevance, and mutual exclusivity as described by Marsh et al.[8] Common criteria such as budget impact and cost-effectiveness were excluded due to risks of inconsistent trade-offs highlighted by previous literature.[6] Complex considerations that could not be captured in the quantitative assessment were deliberatively valued during the appraisal stage.[6] An overview of the agreed upon decision criteria is shown in Table 1.

Comprehensively covering all services would incur substantial costs, translating into high insurance premiums. Therefore, the benefit packages are constrained by premium levels. Dental insurance premiums offered by insurers in the Netherlands served as a reference for the budgetary threshold of this case study. The advisory panel selected three threshold values based on the least and most expensive packages currently offered in the Netherlands, which were used to indicate minimal, moderately sized, and maximal packages. During the appraisal stage, the budgets of these packages were

**Table 1.** Decision Criteria

| Decision Criteria | Definition | Measurement Unit | Evidence Sources | Calculations |
|---|---|---|---|---|
| Disease burden | The severity of the oral condition being treated by the proposed intervention. | Quality of life score | Systematic reviews, clinical studies, cohort studies, and expert elicitation | EQ-5D scores were mapped using the OHIP of diseases. |
| Clinical efficacy | The ability of the proposed intervention to achieve the intended result in preventing, diagnosing, or producing a positive change in the disease, as demonstrated by clinical studies. | Direct restorations, indirect restorations, partial dentures, tooth replacement: annual failure rate; Oral hygiene instruction, scaling and polishing: percentage reduced early symptoms (eg, bleeding on probing); Periodontal therapy: clinical attachment loss; Root canal treatment: success rate; Routine dental checkups: diagnostic accuracy | Systematic reviews, clinical studies, cohort studies, and expert elicitation | Annual failure rates were calculated using reported survival or failure rate and follow-up time. Percentage reductions were calculated based on reported baseline and absolute reduction of outcomes. When not reported, diagnostic accuracy was calculated using specificity, sensitivity and prevalence of disease. |
| Impact on quality of life | The therapeutic effect of the proposed intervention on quality of life. | Percentage (oral health related) quality of life improvement | Systematic reviews, clinical studies, cohort studies, and expert elicitation | Percentage improvements were calculated relative to reported baseline quality of life. |
| Patient safety | The risk of adverse complications resulting from the proposed intervention. | Percentage adverse events (eg, toxicity, sensitivity, allergy, or injury) | Systematic reviews, clinical studies, cohort studies, and expert elicitation | Not applicable. |
| Insurability | The extent to which high and unpredictable costs of an intervention pose risks that justify covering it through insurance. | Percentage utilization and costs of treatment | Dental fees and claims data of insurers | Not applicable. |

Abbreviation: OHIP, Oral Health Impact Profile.

exhausted based on the priorities set by the advisory panel until thresholds were reached. The thresholds were set at an annual premium of €120, €300, and €1000, respectively.

### Assessment

To evaluate interventions, performance on disease burden, clinical efficacy, impact on quality of life and patient safety was determined through a systematic review and expert elicitation. Records were searched through the Cochrane Library, PubMed Medline, and Ovid Embase. Our search strategy was a combination of the relevant diseases (ie, gingivitis, periodontitis, caries, pulpitis, or tooth wear), one of the conventional interventions (ie, routine dental checkup, consultation, x-ray, bacteriological/enzymatic examination, integrated treatment plan, oral hygiene instruction, dental cleaning, anesthesia, dental filling, root canal treatment, partial denture, crown, periodontal treatment, tooth replacement (bridge/implant), extraction, occlusal splint or aftercare), and the decision criteria (ie, clinical efficacy, quality of life or patient safety). Disease burden was captured through a combination of disease and quality of life without specified treatment. The search strategy was restricted to systematic reviews, clinical studies and cohort studies about the adult population (See Supplementary file 1).

A stepwise approach was used for inclusion of records with the following heuristic: if any systematic reviews were found for a disease-treatment-outcome combination, no clinical or cohort studies would be included. Studies were included if they matched one of the searched combinations and reported relevant measurement units as shown in Table 1. Studies about cosmetic, orthodontic, or exclusively pediatric dentistry were excluded. Gaps in evidence were hand-searched using references from included records and Google Scholar. The review was performed by ZS and a randomized 10% sample was screened for inclusion by SA. Discrepancies between reviewers were discussed and resolved.

As shown in Figure 2, 71 records were included for the assessment of interventions. Reported outcomes were extracted into a performance matrix (See Supplementary files 2 and 3). While some interventions had multiple records of evidence on performance, other interventions did not have any data reported in the literature. These evidence gaps were filled by means of expert elicitation. Collected evidence on criteria was first categorized into very low, low, moderate, high, and very high performance, using the lowest and highest possible outcomes as references for this scale. An initial performance level was assigned to each intervention on each criterion based on the midpoint of their reported outcomes in the literature. These performance levels would facilitate experts to attribute a performance estimate to missing interventions. A detailed overview of the scale and performance levels can be found in Supplementary file 3.

We organized two expert elicitation sessions. First, nine clinical experts representing all three dental schools in the Netherlands, external to the advisory panel, were invited to provide feedback on collected evidence and gaps in the performance matrix. These experts were purposively selected to ensure coverage of all relevant disease areas. Participants were included if they were affiliated with one of the dental schools and had an expertise in at least one of the treatment domains. Participants without affiliation or relevant experience were excluded. The feedback from these experts was then processed during a second session with three clinical experts from the advisory panel, who attributed final performance categories to all interventions. Following expert advice, the number of interventions was condensed from 17 to 11 services, consisting of routine dental checkup, oral hygiene instruction, scaling and polishing, direct restoration, indirect restoration, root canal treatment, tooth extraction, periodontal therapy, partial dentures, tooth replacement (bridge/implant), and occlusal splints. Since conventional diagnostics are required for treatment, they were separated from the evaluation and unconditionally included in the packages during the third stage.

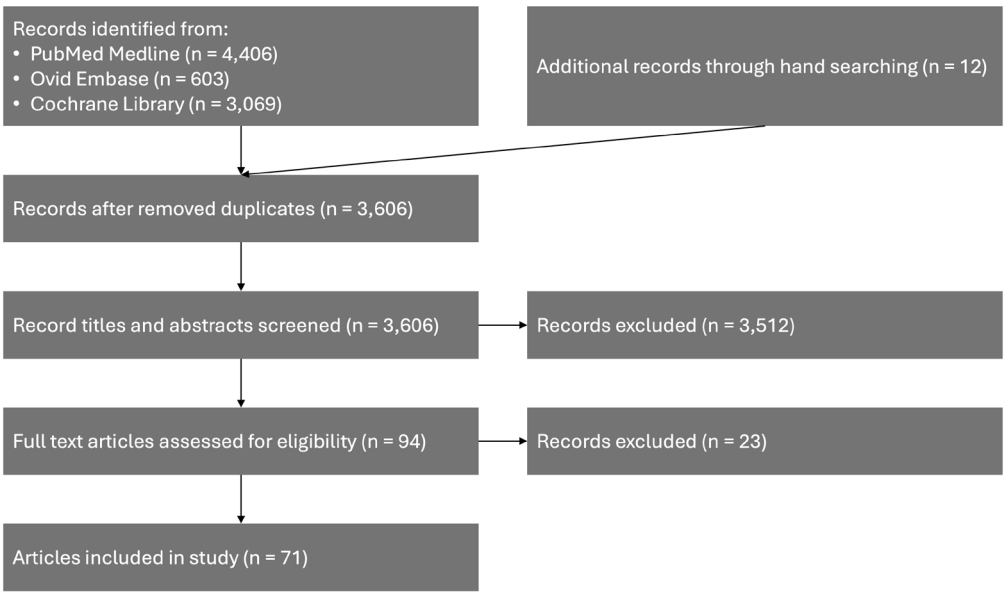



**Figure 2.** Flow Diagram of Evidence Synthesis.

Performance of treatments on the insurability criterion was determined using publicly available fees and aggregated utilization rates of interventions provided by the insurers.[20] A scale ranging from very high to very low performance was developed where low-cost treatments used by more than half the insured population were categorized as very low insurability, while unpredictable treatments with high fees were categorized as very high insurability. Thresholds between the performance levels were based on quartile values of costs and utilization rates.

Once performance of interventions had been assigned, criteria were weighted by the advisory panel to determine relative importance through swing weighting. Participants received a questionnaire in which they were shown hypothetical swings on each criterion from the worst possible performance on this criterion to its best performance. Participants were asked to rank the criteria based on the relative importance of improving from worst to best performance. Ranking one of the criteria first would indicate that the swing on this criterion from its worst to best performance is more important than the swings shown on other criteria.[7,21] Once all criteria had been ranked from most to least important, the highest ranked swing would be attributed 100 points. Participants were then asked to score the relative importance of swings on other criteria compared to the top ranked criterion. To illustrate, a score of 50 would indicate a swing that is half as important as the top ranked criterion.[21] These scores were normalized for each participant and aggregated across participants as follows:

$$w(y) = \frac{1}{n}\sum_{i=1}^{n} \frac{x_{i,y}}{\sum_{j=1} x_{i,j}}$$

where $w$ denotes the mean weight of criterion $y$ using scores $x$ filled in by participants.

The advisory panel was invited to Workshop B where the performance of interventions and the relative importance weight of criteria were discussed. During this session, participants had the opportunity to internalize collected evidence and highlight potentially missing aspects before proceeding to the appraisal stage. Once a consensus was reached, performance of interventions on criteria were translated into a score between 0 to 100 using a linear partial value function, as determined by the advisory panel. In this scale, 0 points corresponded to very low performance, 25 to low, 50 to moderate, 75 to high, and 100 to very high performance. Moreover, disease-treatment combinations were aggregated into a single score for each treatment on each criterion, using a weighted average based on disease prevalence.

### Appraisal

During the final stage, performance scores and weights were combined into weighted value scores for each intervention through an additive value function. A cost-value ratio was computed by dividing the aggregated value score of an intervention by its respective expected cost impact on the premium. These expected costs of treatments were calculated using the proportion of the population that uses an intervention, indicating risk, multiplied by fee of the intervention. Cost-value ratios provided grounds for the preliminary ranking of interventions. Given that reported outcomes on decision criteria varied between studies, we also computed cost-value ratios using the upper and lower bound performance reported in the literature. These best- and worst-case scenarios facilitated the assessment of consistency in the ranking of interventions as a sensitivity analysis.

The advisory panel was invited to appraise the interventions during Workshop C. Participants were given access to the synthesized evidence from the assessment, including initial ranking. They were then invited to deliberate over the comparative value and costs of interventions, as well as highlight potential arguments that require further consideration for the priority setting based on their experience and expertise. Following a plenary discussion, the advisory panel was asked to individually rank interventions based on the presented evidence and raised arguments through Mentimeter, which calculated an overall ranking based on the Borda Count method.[22] The aggregated ranking was used to allocate interventions across a minimal, comprehensive and maximal package until the budgetary constraint of each was reached.

### Process Evaluation

After Workshop C, an online survey was distributed among participants of the advisory panel to collect their experiences with the prioritization process. This survey was adapted from the questionnaire developed by Baltussen et al.[23] Participants were asked five-point Likert-scale questions about their satisfaction with the stakeholder engagement, assessment, appraisal, and the overall priority setting process (See Supplementary file 4). Participants could also provide their views on how the process could be improved in the open questions after each section. Responses were analyzed using descriptive statistics and thematic analysis.

## Results

### Evidence Synthesis

Table 2 shows the performance matrix that resulted from the review and expert elicitation. These scores were derived from the performance levels in Supplementary file 3 using a linear partial value function. Relative importance weights calculated based on the 12 responses received can also be found in Table 2. On average, clinical efficacy was seen as the most important criterion, followed by similar weights across disease burden, patient safety and impact on quality of life. Insurability was considered the least important criterion by the advisory panel.

Performance scores were combined with prevalence weights as well as relative importance weights to calculate an overall value score for each intervention. Overall value ranged between 27 and 74. Notably, tooth replacement had the highest overall value score, while scaling and polishing had the lowest.

### Recommended Package Design

Cost-value ratios were computed for each treatment, as shown in Table 3. Services in this table are ordered according to cost-

**Table 2.** Performance Matrix of Interventions

| | Disease Burden | Clinical Efficacy | Impact on Quality of Life | Patient Safety | Insurability | Overall Value Score |
|---|---|---|---|---|---|---|
| Relative importance weights | 0.20 | 0.27 | 0.19 | 0.20 | 0.14 | |
| Tooth replacement (periodontitis) | 25 | 100 | 75 | 75 | 100 | 74 |
| Tooth replacement (pulpitis) | 50 | 100 | 75 | 75 | 100 | |
| Tooth replacement (tooth wear) | 0 | 100 | 75 | 75 | 100 | |
| Root canal treatment (pulpitis) | 50 | 75 | 75 | 50 | 50 | 62 |
| Indirect restoration/crown (caries) | 0 | 100 | 25 | 75 | 75 | 58 |
| Indirect restoration/crown (tooth wear) | 0 | 100 | 25 | 100 | 75 | |
| Tooth extraction (periodontitis) | 25 | 100 | 0 | 100 | 50 | 58 |
| Tooth extraction (pulpitis) | 50 | 100 | 0 | 100 | 50 | |
| Tooth extraction (tooth wear) | 0 | 100 | 0 | 100 | 50 | |
| Periodontal therapy (periodontitis) | 25 | 75 | 25 | 50 | 75 | 50 |
| Direct restoration/filling (caries) | 0 | 75 | 25 | 100 | 25 | 48 |
| Direct restoration/filling (tooth wear) | 0 | 75 | 25 | 100 | 25 | |
| Partial denture (periodontitis) | 25 | 0 | 50 | 100 | 100 | 47 |
| Partial denture (pulpitis) | 50 | 0 | 50 | 100 | 100 | |
| Partial denture (tooth wear) | 0 | 0 | 50 | 100 | 100 | |
| Routine dental checkup (caries) | 0 | 75 | 0 | 100 | 0 | 40 |
| Routine dental checkup (gingivitis) | 0 | 75 | 0 | 100 | 0 | |
| Routine dental checkup (periodontitis) | 25 | 50 | 0 | 100 | 0 | |
| Routine dental checkup (tooth wear) | 0 | 50 | 0 | 100 | 0 | |
| Oral hygiene instruction (caries) | 0 | 50 | 0 | 100 | 0 | 34 |
| Oral hygiene instruction (gingivitis) | 0 | 50 | 0 | 100 | 0 | |
| Oral hygiene instruction (periodontitis) | 25 | 50 | 0 | 100 | 0 | |
| Oral hygiene instruction (tooth wear) | 0 | 25 | 0 | 100 | 0 | |
| Occlusal splint (tooth wear) | 0 | 0 | 0 | 100 | 100 | 33 |
| Scaling and polishing (gingivitis) | 0 | 25 | 0 | 100 | 0 | 27 |
| Scaling and polishing (periodontitis) | 25 | 25 | 0 | 100 | 0 | |

value ratios. The lower and upper bound cost-value ratios based on best- and worst-case scenarios are also presented in this table. We find a Pearson's r value of 0.99 in the correlation with both upper and lower bound cost-value. Similarly, we find a Spearman's ρ of 0.98 and 0.99 in the correlation of rankings, corroborating the robustness of estimated cost-value based on available evidence.

Following deliberation informed by this evidence, participants of the advisory panel individually ranked the treatments. The participants highlighted several arguments based on their expertise that required further consideration in the priority setting. The linear partial value function used in this MCDA assumes equal intervals of performance on the overall value scale. While participants had initially agreed that the simplified linear function sufficiently aligned with their perception of value, they noted that this may have led to an overestimation of gaps in performance in some criteria, particularly in patient safety. Moreover, uncertainty varied across treatments, as some had greater intervals between lower and upper bound cost-value ratios. Participants considered these relevant aspects of the model in comparing treatments.

The advisory panel also highlighted prevention as a key attribute. Interventions focused on tooth retention were considered to have greater priority. Ensuring that these interventions were available to all was an important equity consideration. Coverage of interventions can impact utilization of services due to price elasticity. While increased uptake of prevention may decrease future need of restorative care, this coverage may also incentivize overtreatment. Such potential changes in utilization were also deemed important to consider if a treatment was excluded from coverage. Altogether, these additional arguments were reflected in the deliberative priority ranking by the participants, as shown in Table 3.

The advisory panel was then asked to distribute treatments into minimal, comprehensive, and maximal insurance packages until respective budgets were exhausted. Diagnostics, including x-rays, consultations, and laboratory tests, were unconditionally included in all packages as they were mutually unexclusive to treatment. At the minimum, the advisory panel recommended coverage for the routine dental checkup, tooth extraction, oral hygiene instruction, and direct restoration. When expanding the budget of the package from €120 to €300, participants added root canal

**Table 3.** Cost-Value and Ranking of Treatments

| Treatment | Cost-Value Ratio | Lower Bound | Upper Bound | Deliberative Ranking | Recommended Package Allocation |
|---|---|---|---|---|---|
| Tooth extraction | €0.00-0.25 | €0.00-0.25 | €0.00-0.25 | 2 | Minimal |
| Oral hygiene instruction | €0.25-0.50 | €0.00-0.25 | €0.50-0.75 | 3 | Minimal |
| Routine dental checkup | €0.50-0.75 | €0.50-0.75 | €0.50-0.75 | 1 | Minimal |
| Partial denture | €0.50-0.75 | €0.50-0.75 | €0.50-0.75 | 8 | Comprehensive |
| Occlusal splint | €0.50-0.75 | €0.50-0.75 | €0.50-0.75 | 9 | Comprehensive |
| Root canal treatment | €0.75-1.00 | €0.50-0.75 | €1.25-1.50 | 6 | Comprehensive |
| Direct restoration | €1.25-1.50 | €1.00-1.25 | €1.25-1.50 | 4 | Minimal |
| Scaling and polishing | €1.25-1.50 | €1.00-1.25 | €2.00-2.25 | 7 | Comprehensive |
| Tooth replacement | €1.50-1.75 | €1.50-1.75 | €1.50-1.75 | 10 | Maximal |
| Indirect restoration | €2.00-2.25 | €2.00-2.25 | €2.00-2.25 | 11 | Maximal |
| Periodontal therapy | €8.25-8.50 | €5.50-5.75 | €13.75-14.00 | 5 | Maximal |

*Note*: Costs of interventions are not shown, and cost-value ratios have been expressed as €0.25 intervals to protect sensitive data. The order of treatment from top to bottom of the table is based on cost-value ratio. Budgetary thresholds were €120 for the minimal package, €300 for the comprehensive package and €1000 for the maximal package. During deliberation with the advisory panel, interventions were placed into packages according to deliberative ranking until the budget was exhausted.

treatment, scaling and polishing, partial dentures and occlusal splints. Periodontal therapy, tooth replacement and indirect restoration were recommended for coverage when the budget restriction was €1000. While periodontal therapy had a relatively high priority ranking, participants considered the opportunity costs of covering periodontal therapy under comprehensive coverage instead of root canal treatment, scaling and polishing, partial dentures, and occlusal splints too large. The final recommendation of resource allocation largely aligns with a distribution based solely on cost-value ratios, with the only difference being that direct restorations would have been replaced by partial dentures and occlusal splints under minimal coverage.

### Participant Satisfaction

Overall satisfaction with the process was evaluated based on 11 responses collected from the advisory panel. Mean results of the 5-point Likert-scale questions per sub-topic are presented in Table 4. Responses to individual questions can be found in Supplementary file 4. On average, the advisory panel was positive about the process. Participants were generally more satisfied with the stakeholder involvement and decision criteria, while highlighting areas of improvement in the evidence and appraisal aspects of the process.

**Table 4.** Results of Process Evaluation

| Process Category | Mean Satisfaction | Standard Deviation |
|---|---|---|
| Stakeholder involvement | 3.92 | 0.79 |
| Decision criteria | 3.93 | 0.78 |
| Evidence | 3.58 | 0.70 |
| Appraisal | 3.51 | 0.88 |
| General process | 3.59 | 0.84 |
| Total | 3.74 | 0.81 |

*Note:* A 5-point Likert scale was used in the survey, ranging from strong disagreement (1) to strong agreement (5) with being satisfied about aspects of the process.

Responses to the open questions emphasized the importance of close guidance during the implementation of a new priority setting framework given established processes and institutions. The workshop sessions in this study could have benefitted from physical instead of online meetings. While this may have gone at the expense of the number of available participants, the respondents argued that additional sessions could have been facilitated with smaller groups to raise flexibility. Heterogeneity of stakeholder views and inclusivity were also highlighted as key considerations for the organized workshops.

In addition to the arguments raised during the deliberation, participants argued that the use of decision criteria could have benefitted from an alignment with real-world context and implications. The exercise could have matched existing health system context by providing an upfront presentation of budget impact, hypothetical packages, and resulting cost sharing. Presenting evidence in this manner, with further details of the synthesis, could make the difference between new recommendations and the status quo more explicit, and help participants internalize as well as communicate policy implications. Policy context was therefore a recurrent theme across all aspects of the process and should be given more attention by extending the stages of the framework, according to participants. More details of the themes derived from participant responses are described in Supplementary file 4.

## Discussion

The findings of this study suggest that MCDA offers good potential for supporting the optimization of dental benefit packages design. Using evidence-informed deliberation, key oral healthcare stakeholders were able to prioritize conventional dental treatments. Comparative analyses between treatments were guided, in order of relative importance, by clinical efficacy, disease burden, patient safety, impact on quality of life, and insurability. Additional attributes considered were prevention, equity, and (un)desired price

elasticity. Valuation of these criteria led to the design of three value-based packages, where routine dental checkup, tooth extraction, oral hygiene instruction, and direct restoration were identified as essential services to be covered in all packages at the minimum. Overall, participants expressed satisfaction with their experience using this framework.

To our knowledge, this case study presents the first application of MCDA in the context of privately funded oral healthcare. Our findings demonstrate a methodology for MCDA guided by structured deliberation to the broader health policy literature. Given that priority setting in healthcare is driven by an intricate combination of values, we show how these values can be systematically considered alongside evidence.[6] The organized workshops described with stakeholder representatives, carefully moderated by experts, provide health policy an operational approach to deliberation in parallel to evidence synthesis. These insights are particularly important in contexts where formal processes for explicit and value-driven appraisal have lacked. In the absence of HTA-based optimization of resource allocation, the framework provides novel insights into the methodology and outcomes of benefits package design. Furthermore, this study demonstrates how cost thresholds can be leveraged as a reference to design multiple tiers of packages. Ranking services based on cost-value and exhausting package tiers until respective cost constraints are reached allows for the consideration of opportunity costs.[6] This results in packages that can range from coverage for essential services to broader coverage when constraints are relaxed.

While several studies have used MCDA in the overall healthcare literature, only a subset made deliberation an integral part of their design. This has been noted as a key challenge of the quantitative MCDA approach as well as an argument for limited adoption by HTA agencies.[6] In contrast, our study facilitated deliberation throughout each stage to allow structured consideration of arguments that could not be captured by the value function. Previous studies have applied similar frameworks for oral healthcare in NHS England.[9,10] Despite reported challenges, both studies describe successful use of PBMA to recommend resource allocation in publicly funded dentistry. Similar to our findings, context was shown to be an important concern for the operationalization of recommendations.

Importantly, the value set for the appraisal of dental services largely aligned with the criteria used for overall healthcare. Participants agreed on decision criteria that were drawn from ZIN's guidelines for the appraisal of medical services in the basic benefits package.[19] Moreover, the additional attributes considered during deliberation are not unique to oral healthcare.[7] This overlap suggests that coverage decision and package design for oral healthcare can be integrated into priority setting processes for overall medical services. However, due to the largely privatized context of oral healthcare, the value set may deviate in weights attributed to criteria. Considerations such as equity may weigh more heavily in oral healthcare due to large out of pocket expenditures currently experienced by patients. Additionally, oral diseases are largely preventable, making prevention an important consideration.[4] These differences require additional attention in the oral healthcare context for adequate allocation of resources.

The outcomes of a deliberative prioritization as described in this study depend largely on the input of involved stakeholders. One of the limitations of this study is the sample size of the participants. While representatives were purposively selected to ensure involvement of key stakeholders, increasing the number of participants from each stakeholder group could account for heterogeneity among stakeholders and raise legitimacy of the process. Patient representatives were included throughout all workshop sessions to provide key perspectives for this stakeholder group. However, these representatives may not have been able to capture the diversity of individual patient experiences as we did not elicit preferences from a large sample of patients. Some of the participants of the panel could not attend all workshop sessions, and most were unavailable for physical sessions, which is why online sessions were conducted instead. Collecting stakeholder views through multiple organized sessions during each stage with subsamples of the advisory panel, may enable further participant engagement.

Evidence collected by the study team informed deliberation during workshop sessions. This evidence was synthesized by combining weights and scores into overall value of treatments. Potential limitations of this study therefore also reside in the underlying assumptions for the value functions. A linear partial value function was used to translate performance into a standardized scale. While the advisory panel determined this, participants later expressed concerns of disproportionally large gaps in scores, for example, in the performance of patient safety. Moreover, we used an additive value function to combine weights and scores, assuming independent preferences for criteria. Both approaches reduced cognitive load at the expense of precision. Nevertheless, the allocation of treatments across packages based on cost-value largely aligned with the deliberative allocation, indicating that the value functions adequately captured stakeholder preferences.

The limitations of the quantitative valuation of stakeholder preferences highlight the importance of deliberative processes. Stakeholders were able to interpret presented evidence, identify the gaps and weigh (additional) arguments to make transparent decisions for the final recommendation. Further research is needed to explore methods to facilitate optimized participant involvement and ensure context is more comprehensively captured in the process.

## Conclusions

The findings of this study highlight the potential of MCDA for the optimization of dental benefit packages. In the context of oral healthcare in the Netherlands, routine dental checkup, tooth extraction, oral hygiene instruction and direct restoration were identified for inclusion in basic coverage; root canal treatment, scaling and polishing, partial dentures and occlusal splints in an expanded package; and periodontal therapy, tooth replacement and indirect restoration in a maximum package. The presented processes for the operationalization of MCDA may serve as a basis for adaptation and adoption in other settings.

## Disclosure of artificial intelligence (AI) use

Not applicable.

## Ethical issues

Participants were not subject to the Dutch Medical Research Involving Human Subjects Act and the study was exempted from ethics review by the Medical Ethical Clearance Commission (METC) as well as the ethics commission of the Radboud University Medical Center (Reference: 2023-16899).

## Conflicts of interest

Authors declare that they have no conflicts of interest.

## Authors' contributions

Conceptualization: Ziade Sarroukh, Patrick Jeurissen, Rob Baltussen, and Stefan Listl.
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Writing–original draft: Ziade Sarroukh.
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## Supplementary files

Supplementary file 1. Search Strategy.
Supplementary file 2. Extraction.
Supplementary file 3. Evidence Synthesis.
Supplementary file 4. Process Evaluation.

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