Methodological aspects of composite measures: A comparison of techniques for rescaling and aggregation

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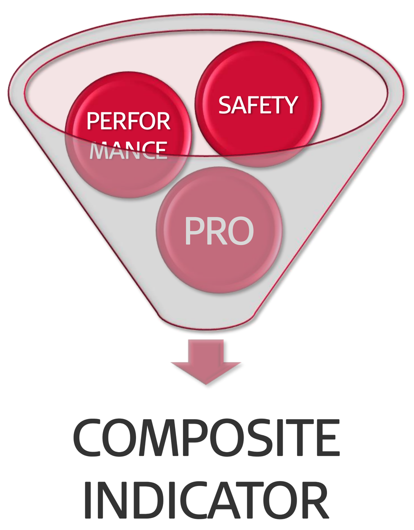
BACKGROUND



Sound comparative evidence is essential to demonstrate the value of health technologies but is often lacking. Generic measures of benefit such as quality-adjusted life years (QALYs) allow for an assessment of opportunity costs but fall short in adequately capturing all relevant dimensions of the benefit a specific technology brings. Composite indicators are powerful practical tools summarizing complex phenomena by aggregating different empirical measures into a single index.

OBJECTIVE

The quality of a composite indicator strongly depends on the methodology used in its construction. To this end, the goal of the presented study was to investigate methodical aspects of composite measures focusing on techniques for rescaling and aggregation for an indicator of hearing implant benefit.

METHODS

The presented study follows methodical guidelines by the European Commission's Joint Research Center for the construction of a composite indicator of hearing implant benefit.

RESULTS

1. Selecting variables

Based on a meta-analysis of published outcomes for different types of implants, three indicators were selected (Fig. 1).

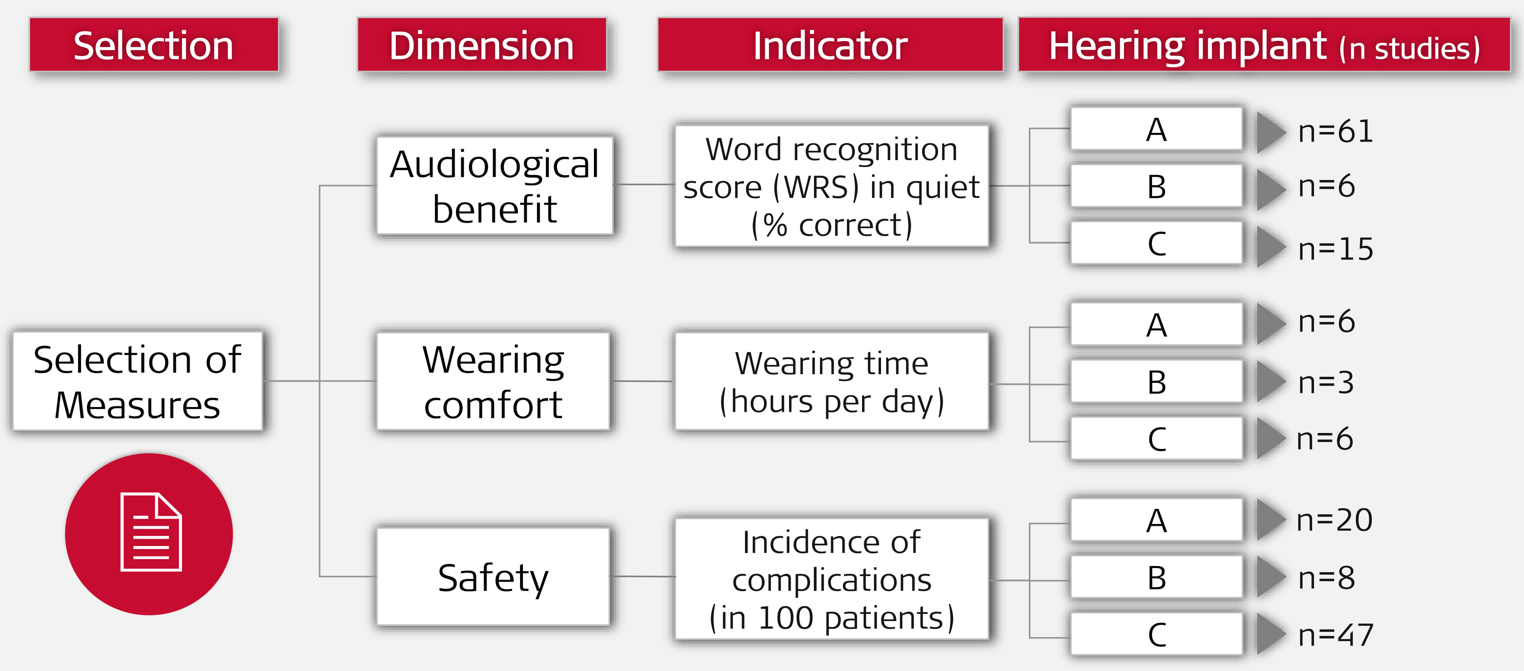


Fig. 1: Dimensions and indicators

2. Rescaling

Three different methods were used, each resulting in a normalized indicator distributed on the interval [0, 100].

2.1 Distance to reference: measures the relative position of a given indicator vi-à-vis a reference point, e.g. aided word recognition in quiet of 100 %, wearing time of 16 hours per day, incidence of complications of 0.

2.2 Min-Max transformation: normalizes indicators to have an identical range by subtracting the minimum value and dividing by the range of indicator values.

2.3 Z-Score standardization: converts indicators to a common scale with a mean of zero and standard deviation of one.

3. Aggregation

The dimensions are combined by additive and geometric aggregation with equal weights, resulting in six alternative models (Fig. 2).

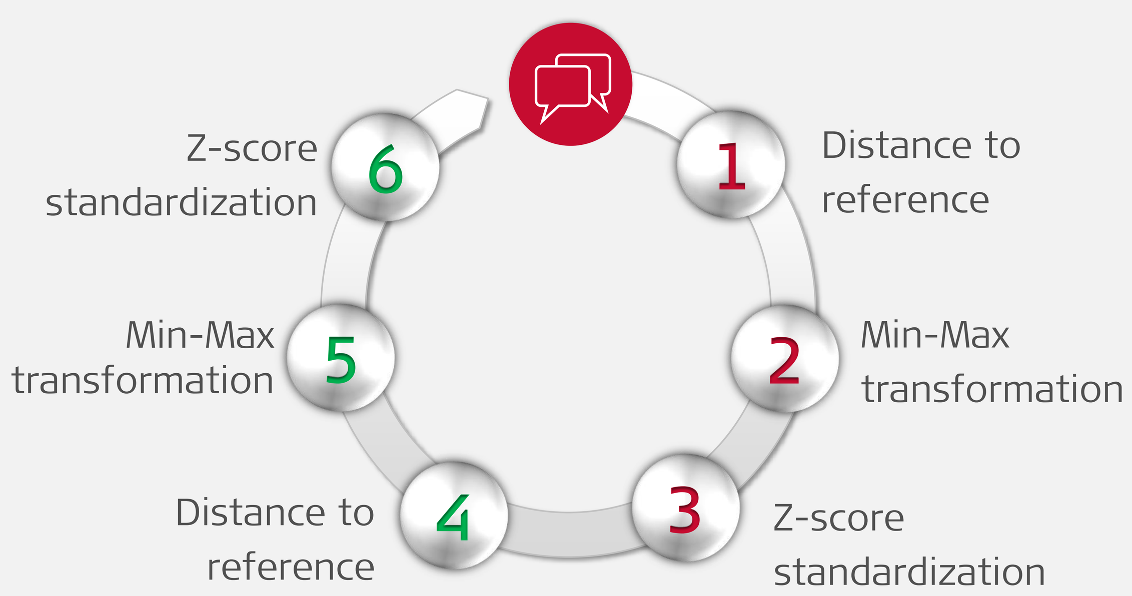


Fig. 2: Overview of models using multiplicative and additive aggregation.

4. Sensitivity of the results

The choice of the rescaling methodology has a considerable effect on the results. This is because z-score standardization and min-max-transformation widen the range of indicators lying within a small interval. This is particularly relevant for the audiological benefit dimension, which barely varies between different implant types (Tab. 1). Thus, both methods increase the effect of this dimension on the overall indicator compared to the "distance to reference" method.

Implant	WRS in quiet
A	82.2 %
B	83.8 %
C	88.1 %

rescaling

Implant	Distance to reference	Min-Max transformation	Z-score standardization
A	84	11	32
B	84	0	25
C	88	100	87

Tab. 1: Effect of rescaling on audiological dimension

Comparing two models with normalization to a reference (Model 1 and Model 4) demonstrates that the results are sensitive to the method used for aggregation. In Model 1, implant C receives a higher overall score than implant B, while in Model 4, implant C scores lowest (Fig. 3).

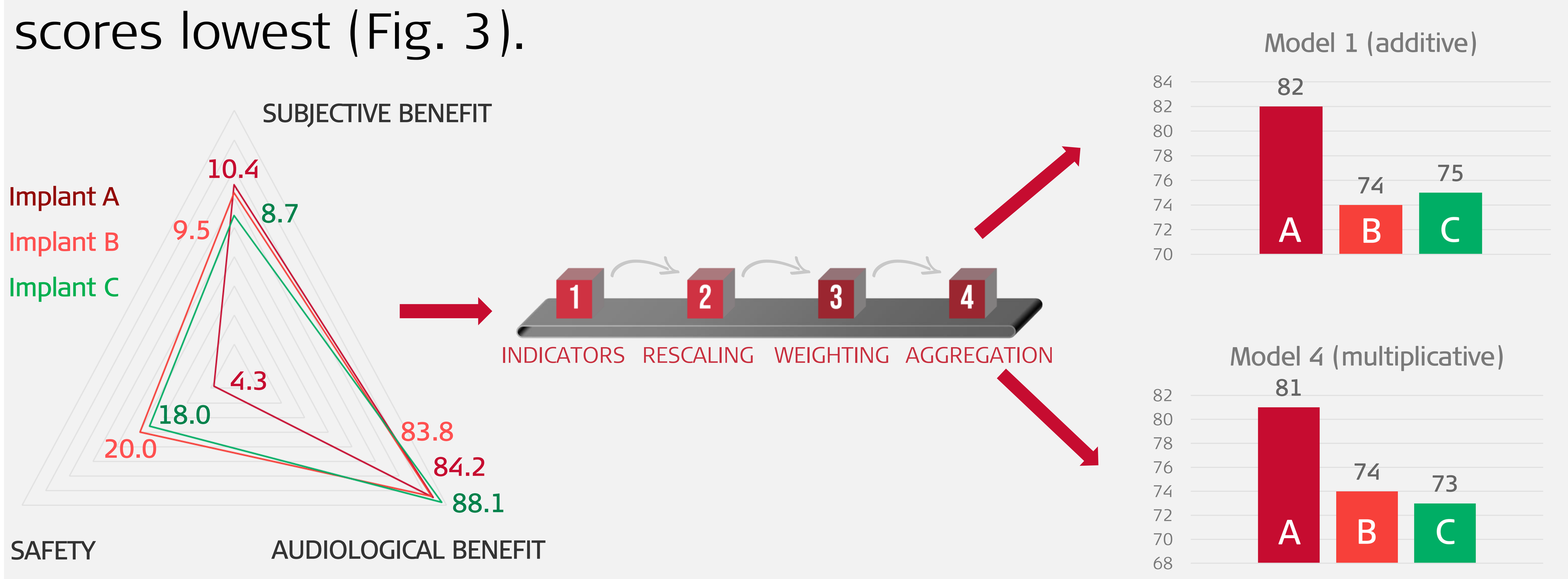


Fig. 3: Effect of aggregation methodology

The reason is a low indicator score of implant C for one dimension (safety). Unlike additive aggregation, geometric combination does not allow for a full compensation of a low score by the two other dimensions, where implant C scores high.

CONCLUSION

Composite indicators may be used to measure multiple dimensions of hearing implant benefit and enable a comparative analysis. The proposed composite indicator demonstrates to be sensitive to the techniques used for rescaling and aggregation. A careful assessment of the pros and cons and the impact of the different construction methods is essential.