DEPARTMENT OF SPORTS SCIENCE AND CLINICAL BIOMECHANICS

Interpretation

Vodcast 2

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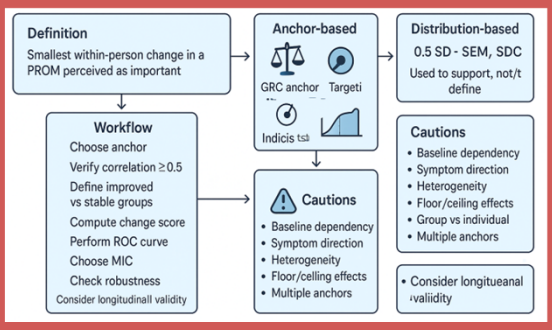
Overview

- Classical MIC methods
  - Anchor-based MIC distribution method
- Contemporary MIC models
  - Improved adjusted predictive modelling (IAPM)
  - Longitudinal confirmatory factory analysis (LCFA)



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Anchor-based MIC distribution method

Graphical method to determine the best MIC interval

- Uses a global anchor:
  - Must correlate with the health status instrument (> 0.3)
    - Transition question method – retrospective
    - Punum Ladder method - prospective

Depends on author or textbook. Many recommend > 0.5

Can be made for an 'important improvement' and 'important deterioration'

5-step process

de Vet et al., Quality of Life Research (2007)

Step 1-2

1. Choose a global anchor (transition question)
2. Define an 'important change'

Transition question method

"How are you now compared to when you started?"

- ❑ Much better
- ❑ Better

} Important improvement

- ❑ A little better
- ❑ No change
- ❑ A little worse

} Unchanged

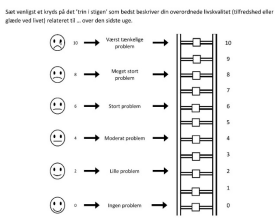
- ❑ Worse
- ❑ Much worse

} Important deterioration

Hebrew: face

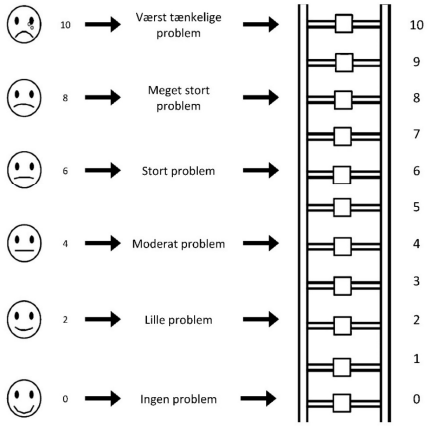
Punum Ladder method

"Change in QoL in the measured domain"



The Punum Ladder

Sæt venligst et kryds på det 'trin i stigen' som bedst beskriver din overordnede livskvalitet (tilfredshed eller glæde ved livet) relateret til ... over den sidste uge.



Used longitudinally

Difference between t_1 and t_2 (i.e., t_2-t_1):

-4, -3 = Important improvement

+3, +4 = Important deterioration

-2, -1, 0, +1, +2 = Unchanged

Fletcher et al. A prospective global measure, the Punum Ladder, provides more valid assessments of quality of life than a retrospective transition measure. J Clin Epidemiol. 2010;63(10):1123-31.

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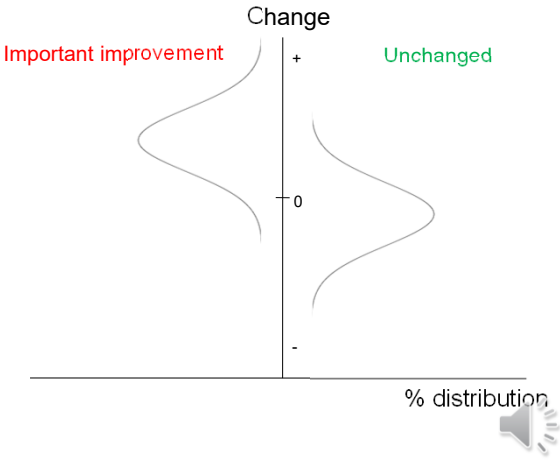
Step 3

3. Draw the curves



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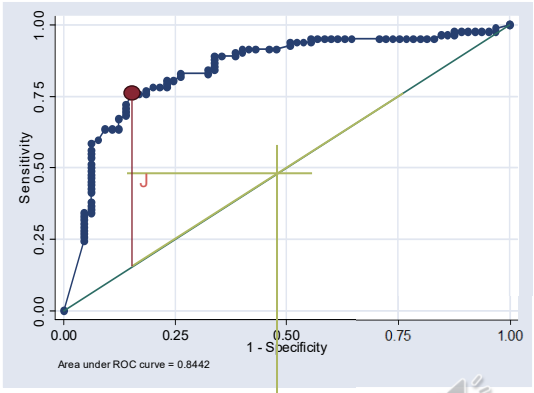
Step 4

4. Calc. MIC from ROC analysis

Point in the top left corner (Youden index (J)):

- Highest true positive rate
- Lowest false positive rate

Minimal Important Change



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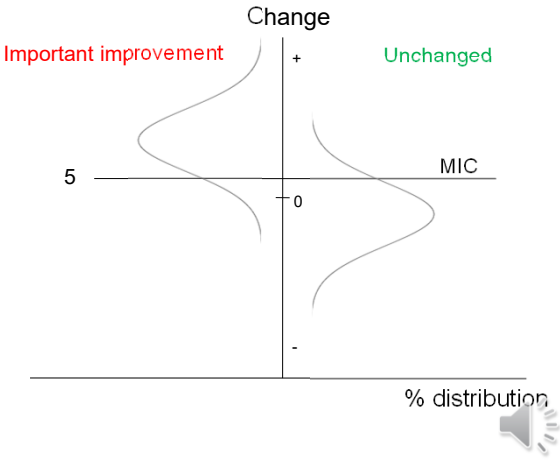
Step 5

5. Insert MIC in the graph



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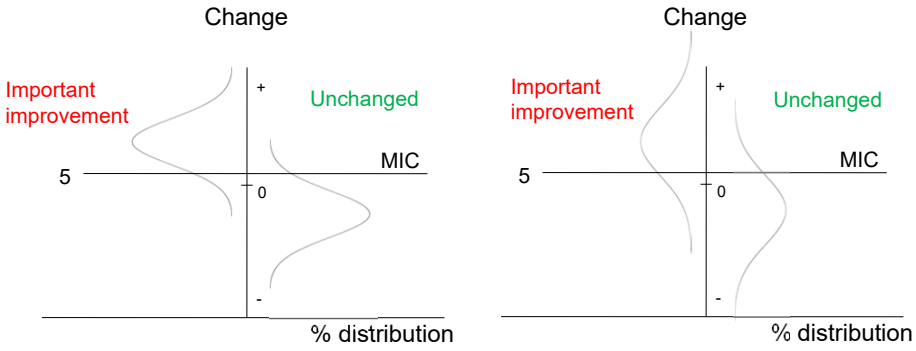
Interpretation of the graphs



Assess the hight of the curves:
Peaked curves → high correlation between anchor and score → High discrimination of the anchor

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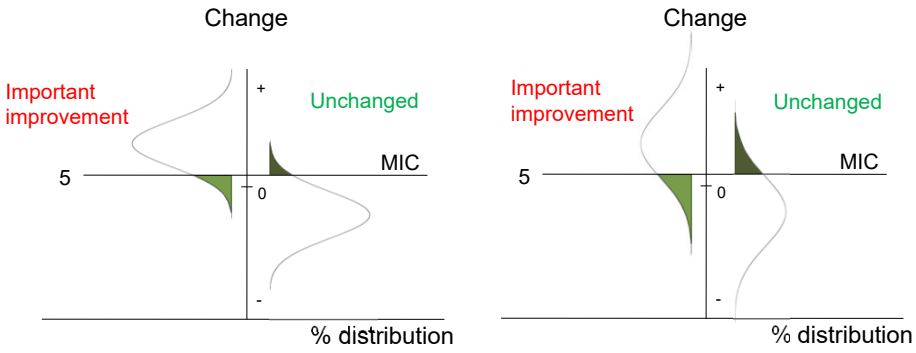
Interpretation of the graphs



Assess misclassification of the curves:

- = false positive (1 – specificity) according to cut-point
- = false negative (1 – sensitivity) according to cut-point

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Limitation of MIC determined using ROC

1. Very sensitive to random sample variations (esp. small samples)
2. Difficult to obtain CI – requires non-parametric bootstrapping
3. Does not allow for accomodation of external factors (effect modifiers)
    - E.g. baseline score (except for % change when proportionate to baseline severity)

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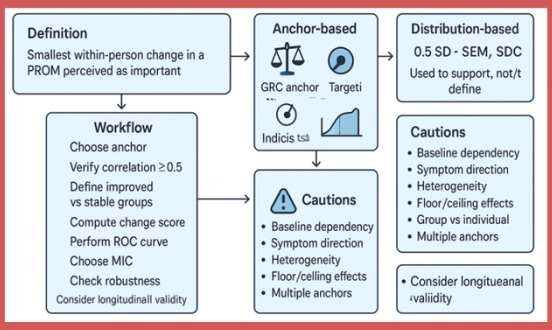

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The predictive modelling approach

A model which 'predicts' if a patient belongs to the 'improved' or 'not improved' group

Makes use of:

- A logistic regression model with an anchor as the dependent variable and instrument change score as independent variable
- The likelihood ratio

Accommodates the limitations of the ROC method

Complex statistical method

Terluin et al. J Clin Epidemiol. 2017; Terluin et al. J Clin Epidemiol. 2015

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Regression model

Intercept

$Odds_{post}$ = odds of belonging to the improved group given a certain change score X

Regression coefficient B of the change score X

$$\ln(odds_{post} | X) = C + B_x \times X$$

$$odds_{post}(X) = e^{C+B_x \times X}$$

$$LR(X) = \frac{e^{C+B_x \times X}}{odds_{pre}}$$

Solve the equation

$$MIC_{predictive} = \frac{\ln(odds_{pre}) - C}{B_x}$$

Applying the likelihood ratio: $LR = \frac{\text{odds}_{post}}{\text{odds}_{pre}}$

LR = 1 gives a change score that separates patients with a *relatively large probability of belonging to the improved group* from patients with a *relatively small probability of belonging to the improved group* (relative to the pretest probability)

= MIC based on predictive modeling ($MIC_{predictive}$)

Our starting point for improvement for the group



Pre-odds (baseline)
≈ 1:1 (50 % Improved)

For a full explanation please see below articles

Terluin et al. J Clin Epidemiol. 2015

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Correction formula

'Genuine' MIC = mean individual MIC (iMIC) in a patient sample

Small bias in ~0.30–0.70 range

Overestimate MIC

Underestimate MIC

MIC_{pred} is a biased estimate of gMIC if proportion of improved is > or < 0.5

$$MIC_{Adjusted} = MIC_{Pred} - (0.09 + 0.103 * Cor) * SD_{change} * \log{-}odds(imp)$$

SD_{change} = standard deviation of the instrument change score
log-odds(imp) = log-odds of improvement = natural logarithm of [proportion improved/(1-proprotion improved)]
Cor = point biserial correlation between instrument change score and anchor

A measurement of the strength and direction of the association that exists between one *continuous* variable and one *dichotomous* variable (a special case of Pearson's correlation)



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Terluin et al. J Clin Epidemiol. 2017

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Including anchor reliability

Unreliable transition ratings amplify the bias when proportion improved ≠ 50%. Updated formula:

$$MIC_{Improved\ adjusted} = MIC_{Pred} - \left(\frac{0.8}{Rel_{TR}} - 0.5\right) * SD_{change} * Cor * \log{-}odds(imp)$$

Rel_{TR} = Reliability of the transition rating

- Gives unbiased MIC, however, works best if proportion of improved is ~30-70%
- Precision falls with smaller n



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Terluin et al. J Clin Epidemiol. 2022

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MIC_{IAPM} summary

- Choose transition rating → dichotomise it (improved vs. unchanged)
- Fit logistic model (improved ~ ΔScore)
- Compute MIC_{pred} (AKA MIC_{PM})
- Adjust the MIC using the correction formula from Terluin et al. 2022
  - Plug in proportion of improved, Sd_{change}, correlation and $TR_{reliability}$
- Report
  - MIC_{IAPM} with CI's
  - Anchor-change correlation (preferred ≥ 0.3)
  - Anchor reliability
  - Proportion of improved
  - Sample size



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The longitudinal confirmatory factor analysis approach

Another method to estimate the MIC which is based confirmatory factor analysis

MIC depends on the baseline scores

Eliminates common biases:

- Baseline severity drift
- Uneven % of improved patients
- Present state bias

E.g. ↑ % improved → higher MIC

LCFA based on complex statistical methods

Patients judge their change mainly by how they feel **now**, so transition ratings reflect current status more than the true baseline-to-follow-up difference.



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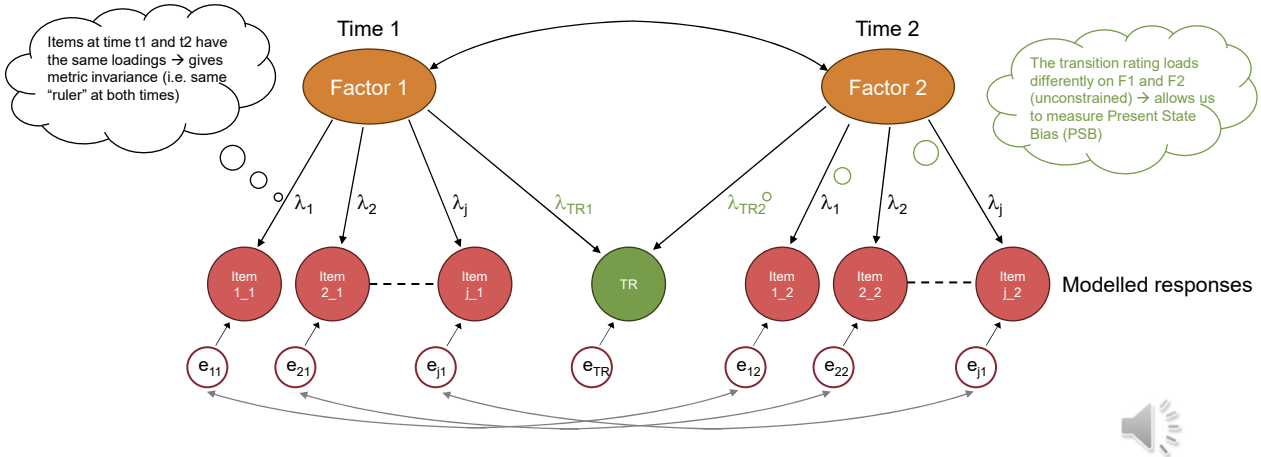
The concept of LCFA modelling (simplified)



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MIC_{LCFA} summary

MIC_{LCFA} fits a CFA model and uses IRT to estimate latent scores (θ)

MIC_{LCFA} is estimated in both latent scores (θ) and raw scores

Allows estimation of PSB of the transition rating (TR)

- MIC_{LCFA} (unconstrained model) is robust to PSB

n > 125 recommended for stable estimates - smaller n lowers precision (↑ CI)

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How to calculate MIC_{IAPM} , MIC_{LCFA} , CI's, $TR_{reliability}$ and PSB



Calculate them using the MIC package

https://github.com/iriseekhout/MIC

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Video 3

- We will look at
  - MIC credibility
  - MIC and measurement error
  - Responder analysis



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