Development and Validation of a Decision Model of Very Brief Interventions (VBIs) Promoting Physical Activity

Vijay GC[1], Ed Wilson[1,2], Marc Suhrcke[1,3] on behalf of the VBI programme team

[1] Health Economics Group, University of East Anglia, [2] Cambridge Centre for Health Services Research, University of Cambridge, [3] Centre for Health Economics, University of York

Outline

- Rationale for the study
- An overview of the VBI cost-effectiveness model
- The VBI model calibration
- Results/Discussion
- Next steps

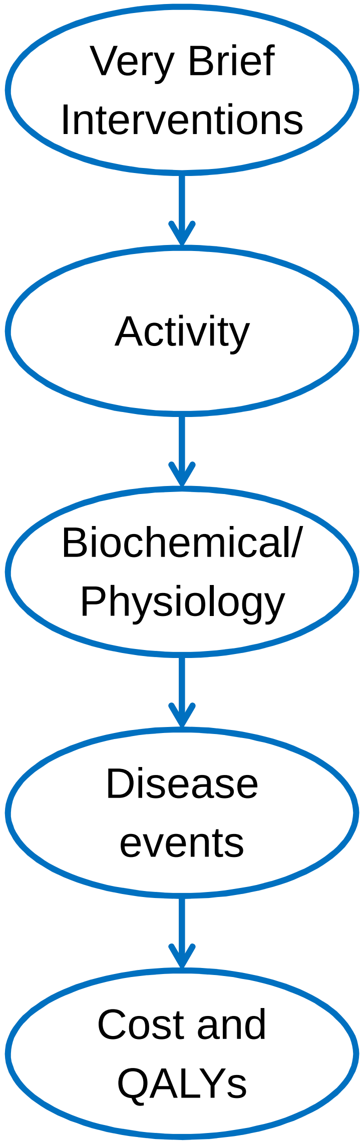
Very Brief Interventions programme

- In England, adults aged 40-74 without pre-existing condition are invited to receive a free “health check” at their general practice (NHS Health Check)
- Ideal opportunity to deliver very brief physical activity interventions
- Aims to develop and evaluate VBIs that could be delivered in 5 minutes in a health check or during other primary care consultation

The VBI model

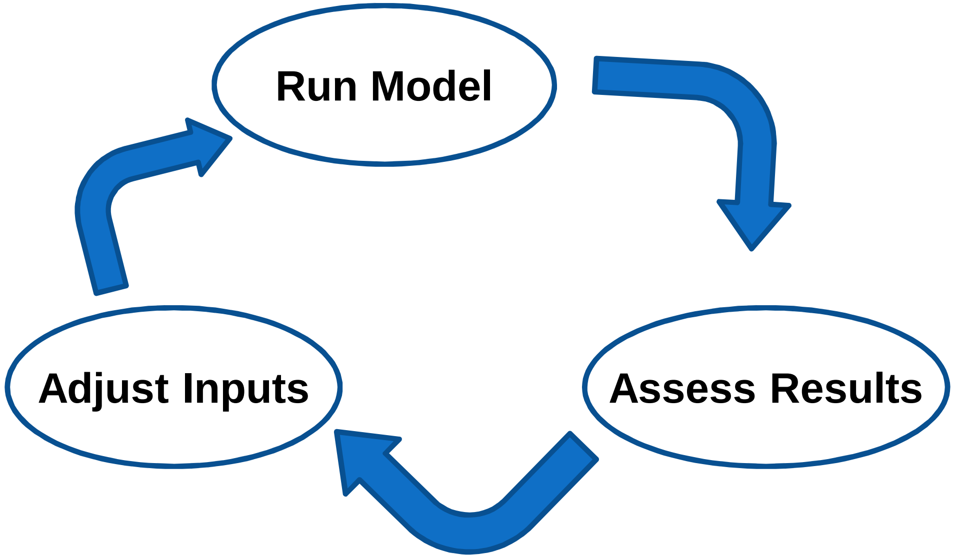
- A micro-simulation model for physical activity interventions
- Follows a simulated cohort of 10,000 individuals over 10 years
- Individual characteristics were based on population level data
- Incorporates intervention effectiveness in terms of MET (metabolic equivalent) hour gains to simulate cost effectiveness over time
- Uses mathematical (risk) functions to predict disease events which are based on changes in the value of biomarkers
- Estimates the long term costs and health gains (QALYs) from very brief physical activity interventions
- Developed using R programming language

The model structure



The model calibration

- Input parameters are informed by data available from varied sources
- Identifies the best set of input parameter values
- Ensure credibility of the results



Model calibration cycle [1]

[1] Taylor DC. Methods of model calibration: a comparative approach. ISPOR, May 19-23, 2007

Calibration targets

	RR/Rate	METs*	Evidence from	Source
CHD prevalence	5.3%	-	National-level data	Scarborough et al 2010
Diabetes prevalence	5.5%	-	QOF 2011	Diabetes UK 2012
MI incidence	144.5‡	-	National-level data	Scarborough et al 2010
Stroke incidence	158.5‡	-	National-level data	Scarborough et al 2010
CHD risk	0.86 (0.77-0.96)	11.25	MA, 33 cohort studies	Sattelmair et al 2011
Stroke risk	0.89 (0.85-0.94)	11.5	MA, 13 cohort studies	Diep et al 2010
All cause mortality risk	0.81 (0.76-0.85)	11	MA, 22 cohort studies	Woodcock et al 2011

CHD: Coronary Heart Disease; MA: Meta-analysis; METs: Metabolic Equivalent of Task; MI: Myocardia Infarction; QOF: Quality and Outcome Framework; RR: Relative Risk

‡ Rates per 100,000; * MET hour per week

Goodness of Fit (GOF) measure

- Assesses how well model outputs match observed data
- Weighted mean deviation[1] was used as GOF measure that captures magnitude of deviations

$$Weighted\ Mean\ Deviation = \sum_{i=1}^{n} w_i \frac{|pred_i - obs_i|}{obs_i}$$

n	= number of end points
$pred_i$	= model-based estimates of the i^{th} end point
obs_i	= data-based target value of the i^{th} end point
w_i	= weight assigned to the i^{th} end point.

[1] Taylor DC, Pawar V, Kruzikas D, et al. Methods of model calibration: observations from a mathematical model of cervical cancer. *Pharmacoeconomics* 2010;28:995-1000.

Model calibration approaches used

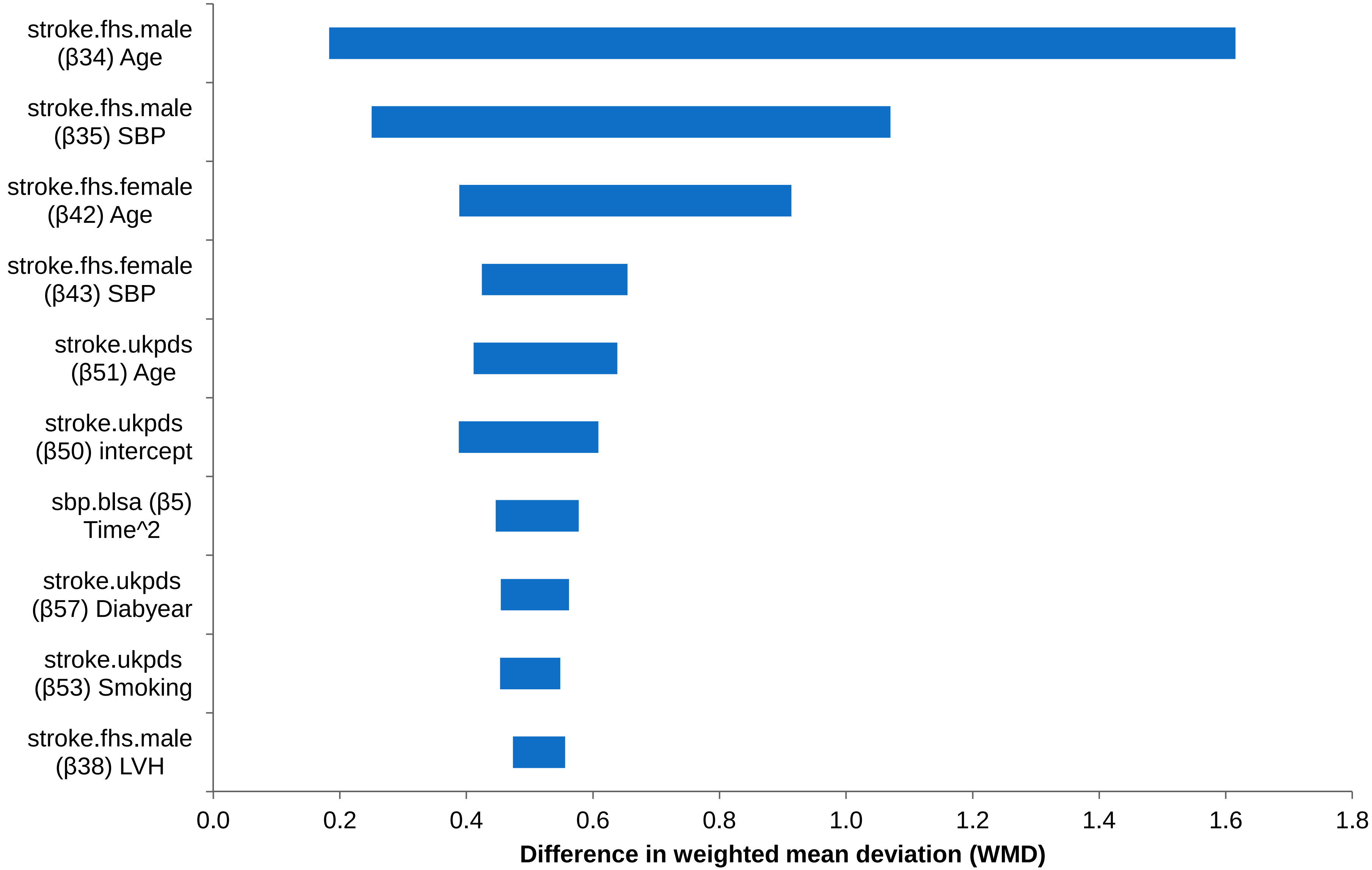
1. Nelder-Mead method (Nelder & Mead, 1965)
    - A direct search algorithm for minimising an objective function
    - Computer uses geometric algorithms to find an optimal set of input parameters
2. Random search method
    - Generated 100,000 sets of input parameters by sampling uniformly from the plausible ranges
    - Model outcomes were evaluated based on the objective function for each parameter set

Nelder JA, Mead R. A Simplex-Method for Function Minimization. Comput J 1965;7:308-13.

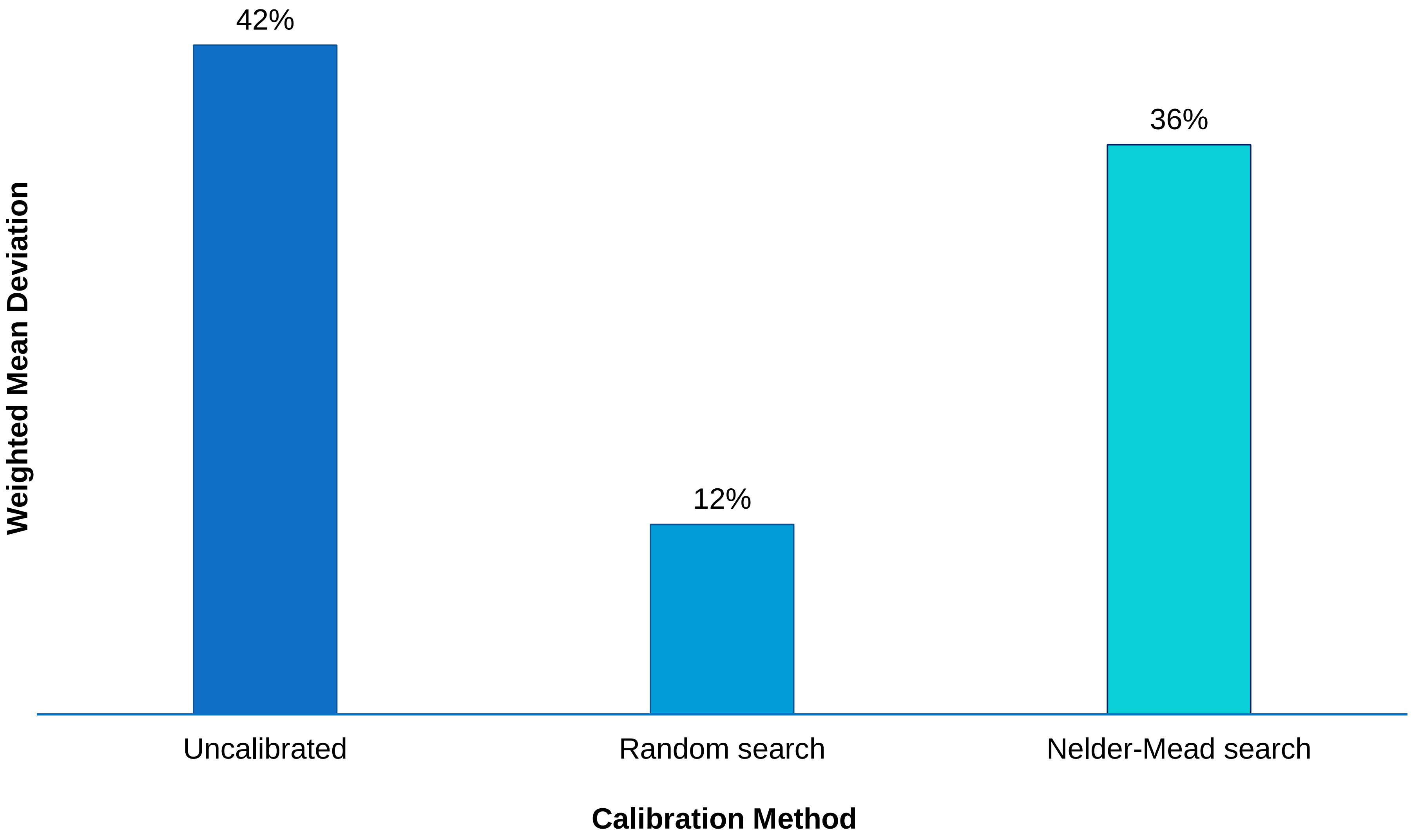
Parameter identification

- Total number of input parameters = 143
- Run the model with 95% lower and upper values for each parameter
- Calculated GOF for 143×2 parameter sets
- Presented the difference between higher and lower values of parameters in a tornado diagram

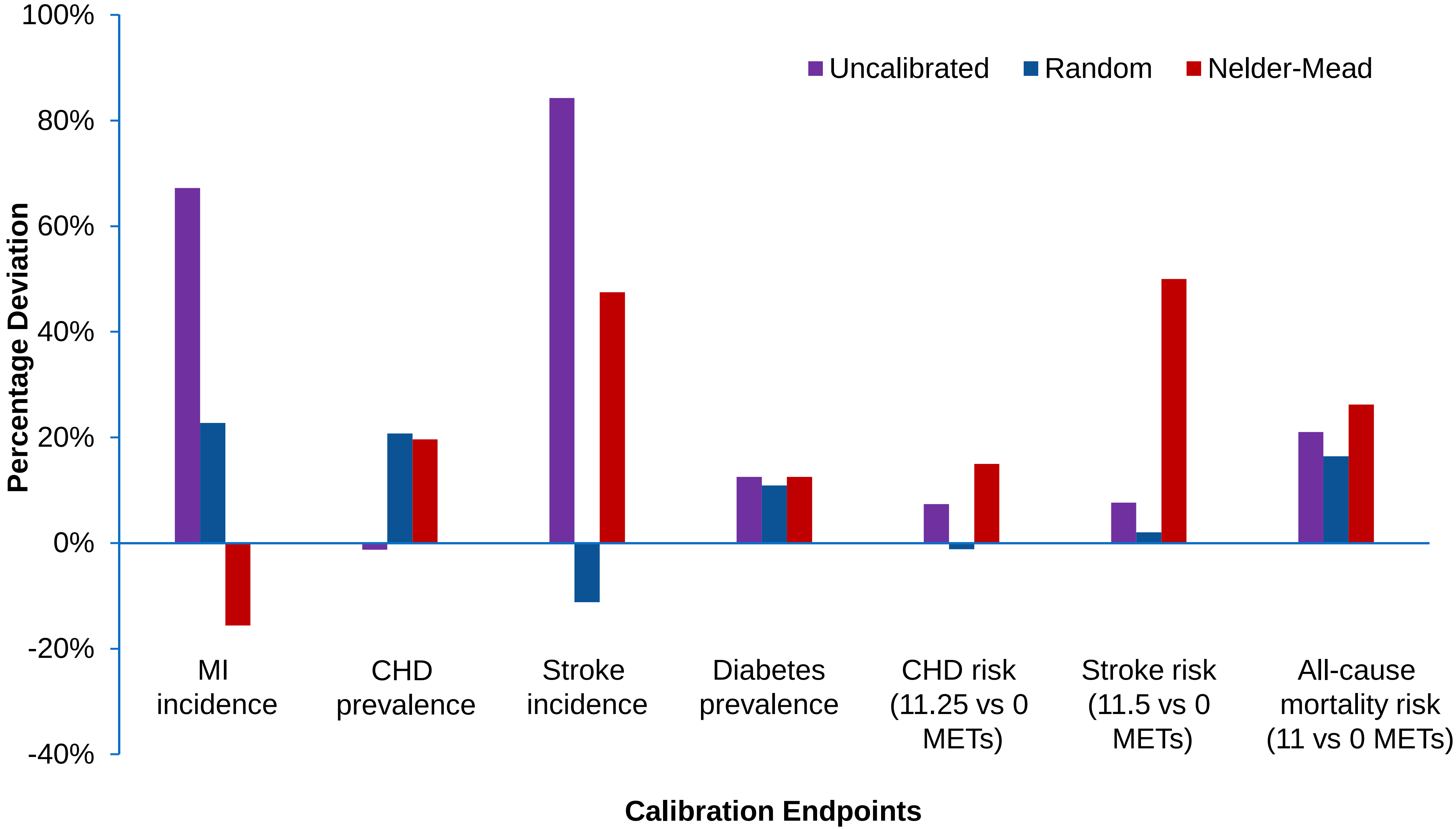
Tornado diagram



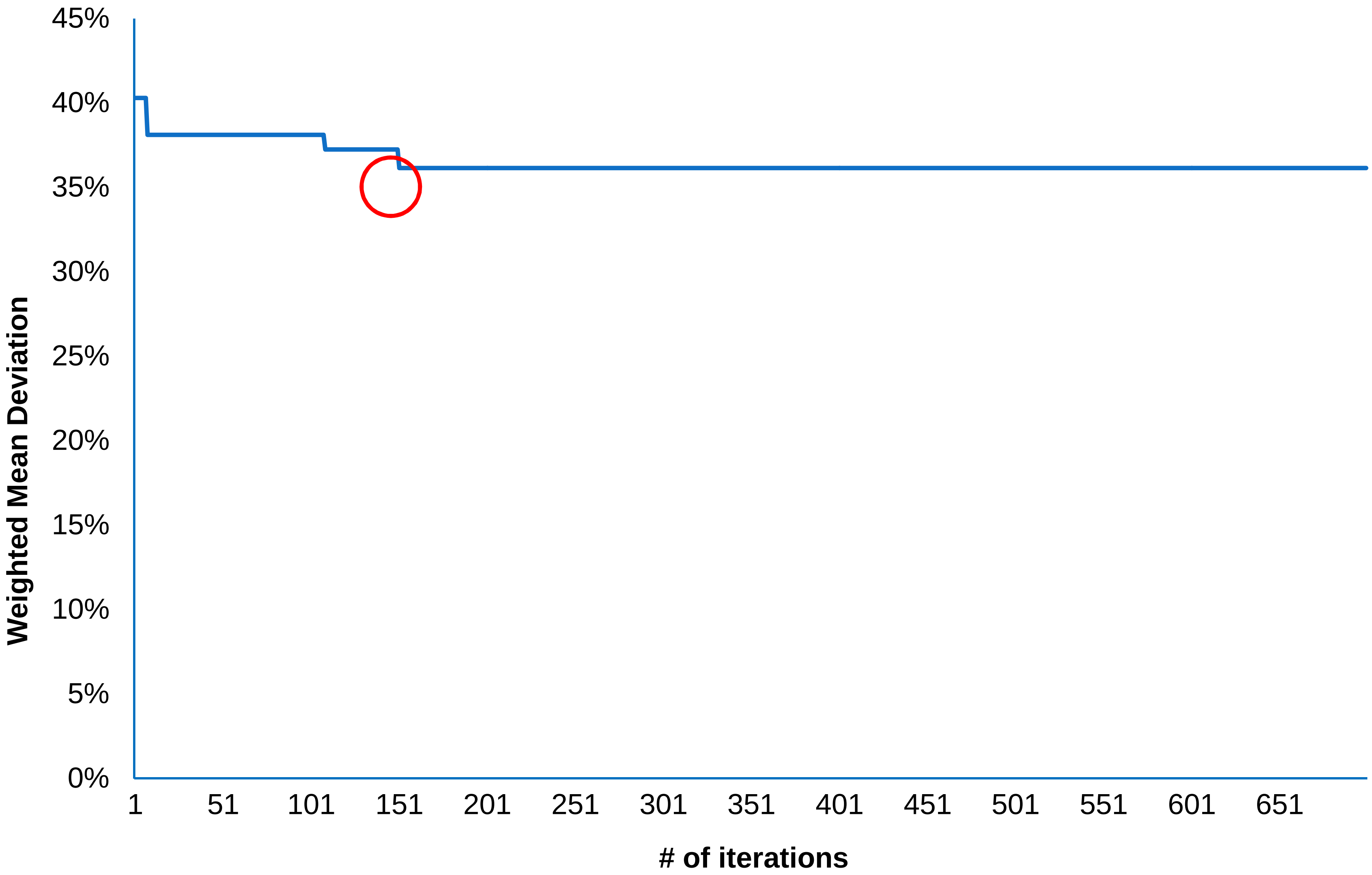
Calibration results



Comparison of endpoints by calibration method



Nelder-Mead search results



Discussion

- Random search produced better results
  - Percentage deviation for random search: -11% to 23%
  - Nelder-Mead endpoints ranged from -15% to 50%
- Computation time
- Nelder-Mead could not converge further – ‘many local minima’ (complex model?)
- Feasibility of optimising all input parameters using Nelder-Mead method

Next steps

- Hybrid approach to calibration
  - Random search calibration to be used to initialise Nelder-Mead search
- Perform cost-effectiveness analysis using optimised set of input parameters

Thank you!

vijay.gc@uea.ac.uk

Acknowledgements

This presentation presents independent research funded by the National Institute for Health Research (NIHR) under its Programme Grants for Applied Research Programme (Grant Reference Number RP-PG-0608-10079). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.