Core obesity model to assess the cost-effectiveness of weight management interventions

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Background

- Elevated body mass index (BMI) increases morbidity and mortality from chronic diseases including type 2 diabetes (T2D), cardiovascular disease (CVD), musculoskeletal disorders, hypertension, gallstones and some cancers.[1–3]

Objectives

- The objective of this study was to develop a 'core obesity model' to assess long-term complications and compare costs and benefits of different weight management interventions.
- This poster explores the model structure, its inputs and its clinical outcomes, using an illustrative example.

Methods

- A Markov model was developed (Excel™ 2013; MicroSoft, Redmond, WA, USA) to estimate the costs and effects of a cohort with obesity over a life-time time horizon.
- The model cycle length is 3 months for the first year, allowing for a treatment 'stopping rule' at 12 weeks, and annually thereafter.
- The model is able to compute results for time horizons ranging from 1 to 40 years.

Health states

- Health states are additive and reflective of complications that:
  - » are highly related to obesity according to the World Health Organization[4] (Figure 1);
  - » respond to weight loss;
  - » have substantial effects on costs, quality of life (QoL) and/or life expectancy.
- A graphical representation of the model structure is presented in Figure 1.

Mortality

- General population age and gender-specific all-cause mortality is included in the model, based on country specific life-tables.
- Both long-term and short-term mortality are considered.

Transitions

- Transitions describe the progression of the cohort between health states.
- A systematic review of the literature in 2017 identified risk equations, which can inform the transition probabilities between health states (Table 1).

Clinical and economic outcomes

- The clinical outcomes of the model include:
  - » cumulative incidence of obesity-related complications;
  - » QoL;
  - » life expectancy;
  - » quality-adjusted life-expectancy.
- The economic outcomes of the model include:
  - » incremental cost:utility ratio;
  - » net monetary benefit
- Example risk probability of developing T2D and QoL as a function of BMI are shown in Figure 2A and 2B, respectively.
- Baseline characteristics of the model starting cohort (European NGT population) were defined at model entry (Table 2).

Table 2: Baseline characteristics of the model starting cohort

Characteristic	Cohort 1	Cohort 2
Age, years	45	-
Females, %	78.8	-
Smokers, %	15.9	-
BMI, kg/m^2	37.0	34.0
SBP, mmHg	124.1	-
TC, mmol/L	5.0	-
HDL-C, mmol/L	1.3	-
TG level ≥1.7 mmol/L, %	36	-

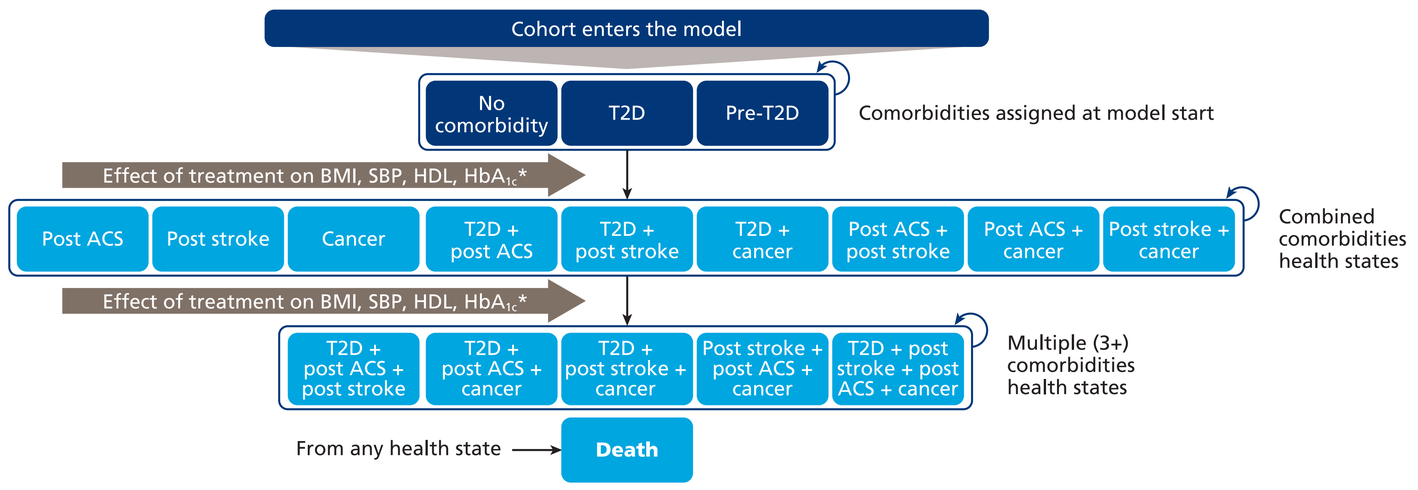
Cohort 2 were assumed to have the same the same baseline characteristics as cohort 1, with the exception of a reduction in BMI to 34 kg/m^2.
BMI, body mass index; HDL-C, high density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol; TG, triglyceride.

Figure 1: Model structure and obesity-related complications included in the model.

Key result

Strong evidence of association with obesity
- T2D
- OSA
- ACS (myocardial infarction or unstable angina)
- Stroke (including TIA event)

Moderate evidence of association with obesity
- Colorectal cancer
- Post-menopausal breast cancer
- Post-menopausal endometrial cancer
- Debilitating osteoarthristis leading to knee replacement surgery



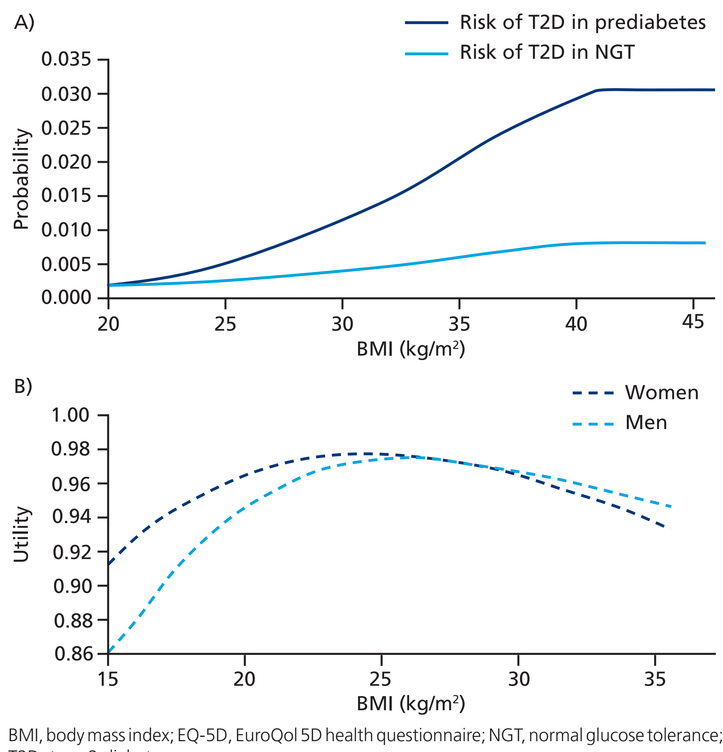
Treatment effect on HbA_{1c} levels is only considered in populations with T2D. Obstructive sleep apnoea, bariatric surgery and knee replacement may occur in any health state and any cycle of the model.
ACS, acute coronary syndrome; BMI, body mass index; HbA_{1c}, glycated haemoglobin, HDL, high-density lipoprotein; OSA, obstructive sleep apnoea; SBP, systolic blood pressure; T2D, type 2 diabetes; TIA, transient ischaemic attack.

Table 1: Source of data determining risk equations used in the model.

Outcome	Risk equation
T2D	QDiabetes[5], Framingham Offspring[7]
CVD (primary prevention)	**In NGT:** QRisk[8], Framingham Heart Study: equation with BMI[9]; **In T2D:** UKPDS82[10], QRisk[8], Swedish NDR[11]
CVD (secondary prevention)	**In NGT:** Framingham Recurring Coronary Heart Disease (CHD)[12]; **In T2D:** Framingham Recurring Coronary Heart Disease (CHD)[12], UKPDS82[10]
Colorectal cancer	NI-AARP cohort[13], Schlesinger *et al.* 2015[14]
Post-menopausal breast cancer	Renehan *et al.* 2008[15], Ahn *et al.* 2007[16]
Post-menopausal endometrial cancer	Renehan *et al.* 2008[15], Million Women Study[17]
OSA	Sleep AHEAD[18], Sleep Heart Health Study[19]
Knee replacement surgery	Wendelboe *et al.* 2003[20]

Risk equations used in the illustrative example are coloured. CVD refers to both ACS and stroke.
BMI, body mass index; CVD, cardiovascular disease; NGT, normal glucose tolerance; OSA, obstructive sleep apnoea; T2D, type 2 diabetes.

Figure 2: (A) Risk of progression to T2D as a function of BMI from the QDiabetes[5] study; (B) Estimated relationship between BMI and EQ-5D score after controlling for confounding factors from Søltoft *et al.* 2009.[6]

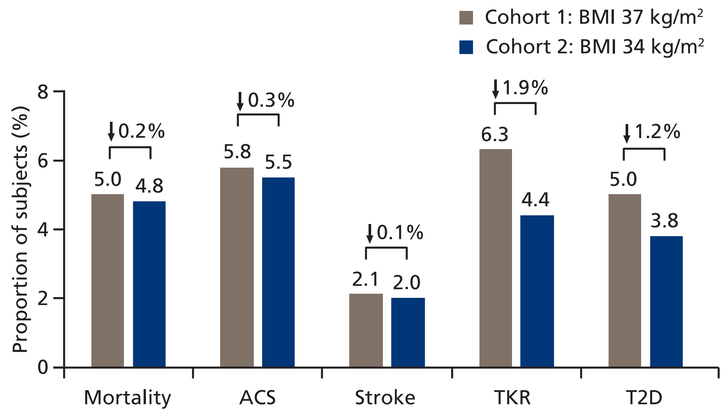


BMI, body mass index; EQ-5D, EuroQol 5D health questionnaire; NGT, normal glucose tolerance; T2D, type 2 diabetes.

Results

- Over a 10-year time horizon, the model predicted 5.0% mortality, 5.8% acute coronary syndrome (ACS) and 2.1% stroke (Figure 3).
  - » Knee replacement occurred in 6.3% of the cohort and the proportion alive with T2D was 5.0%.
- Following a reduction of 3 BMI units, mortality dropped to 4.8%, ACS to 5.5% and stroke incidence to 2.0%.
  - » The incidence of knee replacement was reduced to 4.4% and the proportion alive with T2D was 3.8%.

Figure 3: Change in the incidence of obesity-associated complications in the illustrative example.



Stroke includes TIA.
ACS, acute coronary syndrome; T2D, type diabetes; TIA, transient ischaemic attack; TKR, total knee replacement.

Discussion/Limitations

- Prediabetes is defined at baseline; however, no risk equations for developing prediabetes were identified.
  - » Although its management costs are low, this potentially underestimates future prevalence.
- Some risk equations, for example UKPDS82, do not include BMI as an independent risk factor predicting the risk of CVD.
  - » Other risk equations include BMI but only up to certain BMI levels.
- Finally, this study is limited by lack of prospective long-term data on hard outcomes after intentional weight changes.

Conclusion

- The presented Core Obesity Model is novel in assessing the long-term effects of weight management interventions on such a comprehensive set of obesity medical complications.
- This model could therefore be used to inform cost-effectiveness analyses on treatments for adult patients with obesity.

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