

Supporting Information

Title:

Valuing behavioural interventions for obesity reduction: A scoping review of economic models

Authors:

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Table S1: Definitions of ‘model type’ categories used in data extraction – reproduced from study protocol ¹

Model Type	Definition
Decision tree	Simulate possible decisions and outcomes using branches to represent each potential event.
Comparative risk assessment (CRA)	These are commonly aggregate-level models that use population-attributable fractions to estimate how parameters describing the relationship between a risk factor and disease outcome would change following an intervention. Individuals can be simulated when combined with microsimulation.
Markov models without interaction	Markov models simulate how a population or individual moves between predefined health or disease states at a specific time interval (for example, annually). This incorporates a time component and allows for modelled populations to remain in a health state from one time interval to the next, and to loop back from a diseased state to a healthy state (recur), all based on a given transition probability.
System dynamics models	System dynamics models allow for populations to interact both with each other and with their environment. The probabilities of events occurring in the model (the system) change through feedback as the model runs, governed by algebraic or differential equations.
Markov chain models and Markov individual event history models	In discrete or continuous time Markov chain models, state transition probabilities can depend on (interact with) the proportion of different populations in different disease states, and on the time that has elapsed in the model.
Discrete event simulation (DES)	Discrete event simulation (DES) is an extremely flexible modelling structure that simulates a system changing over time with a sequence of discrete individual events. Rather than simulating populations or individuals through states for a fixed length of time, multiple future events are in competition and the model jumps to whichever event occurs next based on predefined probabilities.
Agent-based simulation (ABS)	ABS models apply rules to agents or groups of agents, and responses depend on individual agent characteristics which can change either over time or following interactions with other agents or the environment. This is compared to system-based rules found in DES
Multistate life tables	Use of multistate life tables can be made with decision tree, comparative risk assessment, and Markov models with no interaction. Multistate life tables are defined as life tables that model an individual's, or proportion of a population's, probability of developing a given disease at different ages and subsequent case fatality rates once the disease is acquired. These can simulate multiple diseases simultaneously and can be used to add a temporal component to decision tree or CRA models.

Microsimulation	<p>Use of microsimulation can be made with individual-level decision tree, comparative risk assessment, and Markov models.</p> <p>In order to overcome the complexity of modelling multiple diseases and heterogeneous populations in decision tree, CRA, and Markov model structures, an alternative approach is to use individual patient simulation models (microsimulation). These allow for a population of heterogeneous individuals to move through the model based on probabilities appropriate to their characteristics (such as demographic factors or physiological characteristics). The model is run at the individual level with all members, or randomly selected members of a predefined population, being simulated until either a prespecified outcome occurs or a certain length of time has elapsed (e.g., death or reaching age 100).</p>
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Table S2: Overview of key expert recommendations for health economic obesity models modified from Schwander et al. 2020 ²

Model aspect	Expert panel recommendations
Time horizon	Lifetime time horizon is optimal Both short and long-term results should be presented
Obesity associated events	No consensus was reached on which clinical events to include. Events with a strong association with obesity and a clear causal relationship to obesity should be included.
Model type	Microsimulation (individual patient) models were the preferred approach.
Event simulation approach	Risk equation approaches were preferred for simulating clinical events.
External validation	External validation is important.

Table S3: Search strategy terms for the health economic scoping review

OVID MEDLINE(R) ALL <1946 TO CURRENT>	
1	body weight changes/ or weight gain/ or weight loss/
2	("body fat" or overweight or over-weight or obes* or adiposity or "body composition" or weight or BMI or "body mass index").tw,kf.
3	1 or 2
4	exp models, economic/
5	*models, theoretical/
6	*models, organizational/
7	markov chains/
8	exp decision theory/
9	(markov* or monte carlo).tw,kf.
10	econom* model*.tw,kf.
11	(decision* adj2 (tree* or analy* or model*)).tw,kf.
12	(microsimulation? or micro-simulation?).tw,kf.
13	discrete event? simulation?.tw,kf.
14	or/4-13
15	3 and 14
16	limit 15 to (english language and humans and yr="2015 -Current")

Table S4: Table of studies included in the scoping review

First author	Year	Location of study	Scenario	Aim	Intervention	Model used	Reference
Ahern	2022	UK	intervention	models individual weight management intervention	weight loss programme	School for Public Health Research Diabetes Prevention Model.	³
Ahern	2017	UK	intervention	models individual weight management intervention	weight loss programme	UK Health Forum	⁴
Amies-Cull	2019	UK	hypothetical change	models population obesity reduction impact	sugar reduction	PRIMEtime-CE	⁵
An	2022	N America	hypothetical intervention	models population obesity reduction impact	food labelling	Au	⁶
Ananthapavan	2020	Australia/New Zealand	intervention	models individual weight management intervention	health improvement/prevention intervention	ACE-Obesity Policy model	⁷
Ananthapavan	2022	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	food labelling	ACE-Obesity Policy model	⁸
Ananthapavan	2022	Australia/New Zealand	intervention	models individual weight management intervention	health improvement/prevention intervention	ACE-Obesity Policy model	⁹
Arrospide	2022	Europe (non-UK)	no change, no intervention	models population obesity impact	models impact of obesity	Arrospide	¹⁰
Avenell	2018	UK	intervention	models individual weight management intervention	weight loss programme	UK Health Forum	¹¹
Bastro-Abreu	2019	Other	intervention	models population obesity reduction impact	SSB tax	CHOICES (Childhood Obesity Intervention Cost-Effectiveness Study) model	¹²

Basu	2020	N America	hypothetical intervention	models population obesity reduction impact	SSB ban	Basu	13
Bates	2022	UK	hypothetical change	models population obesity impact	models impact of obesity	School for Public Health Research Diabetes Prevention Model.	14
Bjornelv	2021	Europe (non-UK)	no change, no intervention	models population obesity impact	models impact of obesity	Bjornelv	15
Blakely	2020	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	dietary taxes and subsidies	Blakely	16
Bourke	2018	Other	hypothetical intervention	models population obesity reduction impact	SSB tax	ACE-Prevention	17
Boyers	2021	UK	intervention	models individual weight management intervention	weight loss programme	UK Health Forum	18
Breeze	2017	UK	hypothetical intervention	models population obesity reduction impact	multiple	School for Public Health Research Diabetes Prevention Model.	19
Brown	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	active transport	Brown	20
Brown	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	fuel tax	Brown	21
Brown	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	active transport	ACE-Obesity Policy model	22
Chen	2016	N America	intervention	models individual weight management intervention	health improvement/prevention intervention	Chen	23
Chen	2022	N America	intervention	models individual weight management intervention	health improvement/prevention intervention	Chen	24

Choi	2017	N America	hypothetical intervention	models population obesity reduction impact	food subsidy	Choi	25
Cleghorn	2019	Australia/New Zealand	hypothetical intervention	models individual weight management intervention	weight loss programme	BODE (Burden of Disease Epidemiology, Equity and Cost-Effectiveness) Programme model	26
Cobiac	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	dietary taxes and subsidies	ACE-Obesity Policy model	27
Crino	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	SSB reformulation	ACE-Obesity Policy model	28
Dall	2015	N America	intervention	models individual weight management intervention	health improvement/prevention intervention	Dall	29
Fallah-Fini	2017	N America	no change, no intervention	models population obesity impact	models impact of obesity	Fallah-Fini	30
Galvain	2021	UK	usual care	models individual weight management intervention	usual care	Galvain	31
Goryakin	2019	Europe (non-UK)	hypothetical intervention	models population obesity reduction impact	active transport	OECD SPHeP-NCD (Strategic Public Health Planning for NCDs) model	32
Gray	2018	UK	intervention	models individual weight management intervention	weight loss programme	The Cardiovascular Disease (BMI) Policy model	33
Gulliford	2017	UK	usual care	models individual weight management intervention	usual care	Gulliford	34
Huse	2020	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	SSB promotion ban	ACE-Obesity Policy model	35
Kao	2020	N America	hypothetical intervention	models population obesity reduction impact	SSB tax	ACE-Prevention	36

Kent	2019	UK	intervention	models individual weight management intervention	weight loss programme	PRIMEtime-CE	37
Kianmehr	2022	N America	hypothetical change	models population obesity reduction impact	models impact of weight loss	BRAVO (Building, Relating, Assessing, and Validating Outcomes) diabetes microsimulation model	38
Kingston	2021	Australia/New Zealand	no change, no intervention	models population obesity impact	models impact of obesity	Kingston	39
Lal	2020	Australia/New Zealand	hypothetical change	models population obesity reduction impact	dietary change	ACE-Obesity Policy model	40
Lal	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	SSB tax	CRE-Obesity model based on the Assessing Cost-Effectiveness in Prevention (ACE-Prevention) obesity model	41
Laxy	2020	N America	hypothetical intervention	models individual weight management intervention	health improvement/prevention intervention	CDC-RTI diabetes computer simulation model	42
Liu	2022	N America	hypothetical intervention	models population obesity reduction impact	SSB tax	Liu	43
Liu	2020	N America	intervention	models population obesity reduction impact	food labelling	CVD-PREDICT (Cardiovascular Disease Policy Model for Risk, Events, Detection, Interventions, Costs, and Trends) model	44
Long	2019	N America	hypothetical intervention	models population obesity reduction impact	SSB tax	CHOICES (Childhood Obesity Intervention Cost-Effectiveness Study) model	45
Long	2015	N America	hypothetical intervention	models population obesity reduction impact	SSB tax	ACE-Obesity Policy model	46
Lymer	2018	Australia/New Zealand	intervention	models individual weight management intervention	weight loss programme	NCDMod	47

Mantilla-Herrera	2018	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	food labelling	CRE-Obesity model based on the Assessing Cost-Effectiveness in Prevention (ACE-Prevention) obesity model	48
Michaud	2017	N America	intervention	models individual weight management intervention	weight loss programme	Michaud	49
Mytton	2018	UK	intervention	models individual weight management intervention	health improvement/prevention intervention	Mytton	50
Neumann	2016	Europe (non-UK)	hypothetical intervention	models individual weight management intervention	health improvement/prevention intervention	Neumann	51
Nomaguchi	2017	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	SSB tax	ACE-Prevention	52
Nuijten	2018	N America	intervention	models individual weight management intervention	weight loss programme	Nuijten	53
Pitt	2020	N America	hypothetical intervention	models population obesity reduction impact	meat price increase	Pitt	54
Robinson	2020	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	alcohol pricing	ACE-Obesity Policy model	55
Rognoni	2020	Europe (non-UK)	intervention	models individual weight management intervention	weight loss programme	Rognoni	56
Sanchez-Romero	2016	Other	hypothetical change	models population obesity reduction impact	sugar reduction	The Cardiovascular Disease (BMI) Policy model	57
Schell	2020	N America	no change, no intervention	models population obesity impact	models impact of obesity	Schell	58

Shangguan	2021	N America	hypothetical change	models population obesity reduction impact	sugar reduction	CVD-PREDICT (Cardiovascular Disease Policy Model for Risk, Events, Detection, Interventions, Costs, and Trends) model	59
Smith	2016	N America	intervention	models individual weight management intervention	health improvement/prevention intervention	Smith	60
Sonntag	2017	Europe (non-UK)	no change, no intervention	models population obesity impact	models impact of obesity	DC-Obesity	61
Springmann	2016	Global	hypothetical change	models population obesity reduction impact	dietary change	Springmann	62
Su	2018	N America	hypothetical change	models population obesity reduction impact	models impact of weight loss	Dall	63
Su	2016	N America	intervention	models individual weight management intervention	health improvement/prevention intervention	Dall	64
Su	2015	N America	no change, no intervention	models population obesity impact	models impact of obesity	Dall	65
Thomas	2017	UK	intervention	models individual weight management intervention	health improvement/prevention intervention	School for Public Health Research Diabetes Prevention Model.	66
Thomas	2022	UK	intervention	models population obesity reduction impact	advertising ban	School for Public Health Research Diabetes Prevention Model.	67
Veerman	2016	Australia/New Zealand	hypothetical intervention	models population obesity reduction impact	SSB tax	ACE-Prevention	68
Verhaeghe	2016	Europe (non-UK)	hypothetical change	models population obesity reduction impact	models impact of weight loss	Verhaeghe	69

Vreman	2017	N America	hypothetical change	models population obesity reduction impact	sugar reduction	Vreman	70
Walter	2022	Europe (non-UK)	usual care	models individual weight management intervention	usual care	Walter	71
Wilde	2019	N America	hypothetical intervention	models population obesity reduction impact	SSB tax	CVD-PREDICT (Cardiovascular Disease Policy Model for Risk, Events, Detection, Interventions, Costs, and Trends) model	72
Willems	2020	Europe (non-UK)	intervention	models individual weight management intervention	health improvement/prevention intervention	ToyBOX study model	73
Wilson	2015	N America	intervention	models individual weight management intervention	weight loss programme	Archimedes model	74
Zomer	2016	UK	hypothetical change	models population obesity reduction impact	models impact of weight loss	Zomer	75

Table S5: Actual and hypothetical interventions modelled

Intervention	Examples	n (%)	of which were hypothetical
Taxation or subsidy	Sugar-sweetened beverage tax, vegetable subsidy	16 (27%)	15 (94%)
Individual weight management intervention	In person or digitally delivered group weight management course. Includes usual care.	15 (26%)	2 (13%)
Health improvement or prevention intervention	Diabetes prevention programme, mass healthy lifestyle campaign	12 (21%)	3 (25%)
Regulation	Food labelling, sugar-sweetened beverage reformulation	7 (12%)	5 (72%)
Population dietary change	Achievement of government dietary guidelines or sugar reduction strategy	5 (9%)	5 (100%)
Active transport	Policy introduction to support active transport use	3 (5%)	3 (100%)
	TOTAL	58	

Table S6: Frequency of model use

Model name	Frequency of use	% of included studies
ACE-Obesity (Assessing Cost-Effectiveness in Obesity) Policy model	10	14%
School for Public Health Research Diabetes Prevention model	5	7%
ACE-Prevention (Assessing Cost-Effectiveness in Prevention) model	4	6%
Dall	4	6%
CVD-PREDICT (Cardiovascular Disease Policy Model for Risk, Events, Detection, Interventions, Costs, and Trends) model	3	4%
UK Health Forum model	3	4%
Brown	2	3%
Chen	2	3%
CHOICES (Childhood Obesity Intervention Cost-Effectiveness Study) model	2	3%
CRE-Obesity model	2	3%
PRIMEtime-CE	2	3%
The Cardiovascular Disease (BMI) Policy model	2	3%
Models used once only	32	44% (1% each)

Table S7: Table of the models included in the scoping review

Model name	Health economic measure(s)	Model type	Event simulation approach	Time horizon(s)	Validation	Reference
ACE-Obesity Policy model	HALYs QALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Lifetime	Y	⁷
ACE-Prevention	DALYs HALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Lifetime	Y	⁷⁶
An	Direct BMI to cost calculation	Microsimulation	BMI Function / Change in BMI	Short term, Long term	N	⁶
Archimedes model	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Short term, Long term	Y	⁷⁷
Arrospide	QALYs	Discrete event simulation	Disease Incidence Estimate /BMI Group related RR	Lifetime	Y	¹⁰
Basu	QALYs	Microsimulation	Others / Others	Long term, lifetime	N	¹³
Bjornelv	Direct BMI to cost calculation	Markov models without interaction	BMI Group Function / Change in BMI Group	Short term, Long term, Lifetime	N	¹⁵
Blakely	HALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Lifetime	Y	¹⁶
BODE (Burden of Disease Epidemiology, Equity and Cost-Effectiveness) Programme model	QALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Lifetime	Y	⁷⁸
BRAVO (Building, Relating, Assessing, and Validating Outcomes) diabetes microsimulation model	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Short term, Long term, Lifetime	Y	⁷⁹
Brown	HALYs	Multistate life tables	Disease Incidence Estimate / BMI related relative risk (RR)	Lifetime	N	²⁰
CDC-RTI diabetes computer simulation model	QALYs	Markov chain models and Markov individual event history models	Risk Equation / Change in Risk Factors	Lifetime	Y	⁸⁰
Chen	Direct health status to cost calculation	Microsimulation	Risk Equation / Change in Risk Factors	Short term, Long term	N	²⁴

Choi	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Lifetime	Y	25
CHOICES (Childhood Obesity Intervention Cost-Effectiveness Study) model	Direct BMI to cost calculation	Microsimulation	BMI Function / Change in BMI	Short term, Long term	N	81
CRE-Obesity model	HALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Long term, lifetime	N	41
CVD-PREDICT (Cardiovascular Disease Policy Model for Risk, Events, Detection, Interventions, Costs, and Trends) model	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Short term, lifetime	Y	82
Dall	Direct health status to cost calculation	Microsimulation	Risk Equation / Change in Risk Factors	Lifetime	Y	65
DC (Differential Costs)-Obesity	Direct BMI to cost calculation	Markov chain models and Markov individual event history models	Risk Equation / Change in Risk Factors	Lifetime	N	61
Fallah-Fini	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Lifetime	N	30
Galvain	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Lifetime	N	31
Gulliford	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Lifetime	N	34
Kingston	only uses DFLE (uncosted)	Markov chain models and Markov individual event history models	Disease Incidence Estimate /Obesity related RR	Lifetime	N	39
Liu	DALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Lifetime	N	43
Michaud	Direct health status to cost calculation	Markov models without interaction	Disease Incidence Estimate / BMI related relative risk (RR)	Lifetime	N	49
Mytton	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Lifetime	Y	83
NCDMod	Direct health status to cost calculation	Microsimulation	Risk Equation / Change in Risk Factors	Long term	Y	84

Neumann	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Lifetime	N	51
Nuijten	Direct health status to cost calculation	Decision tree	Disease Incidence Estimate /Obesity related RR	Short term, Long term	Y	53
OECD SPHeP-NCD (Strategic Public Health Planning for NCDs) model	Mortality and years lived in good health	Microsimulation	Risk Equation / Change in Risk Factors	Long term	N	85
Pitt	QALYs	Microsimulation	BMI Function / Change in BMI	Long term	N	54
PRIMEtime-CE	QALYs	Multistate life tables	Risk Equation / Change in Risk Factors	Short term, Long term, Lifetime	Y	86
Rognoni	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Lifetime	Y	56
Schell	Direct BMI to cost calculation	Markov models without interaction	BMI Group Function / Change in BMI Group	Lifetime	N	58
School for Public Health Research Diabetes Prevention Model	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Long term, lifetime	Y	76
Smith	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Short term	N	60
Springmann	Direct health status to cost calculation	Comparative risk assessment	Risk Equation / Change in Risk Factors	Long term	N	62
The Cardiovascular Disease (BMI) Policy model	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Long term, lifetime	Y	33
ToyBOX study model	QALYs	Markov models without interaction	Disease Incidence Estimate /BMI Group related RR	Long Term	N	87
UK Health Forum	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Long term, lifetime	Y	11
Verhaeghe	QALYs	Markov models without interaction	BMI Function / Change in BMI	Long Term	N	69
Vreman	DALYs	Microsimulation	Risk Equation / Change in Risk Factors	Long Term	Y	70
Walter	QALYs	Microsimulation	Risk Equation / Change in Risk Factors	Long Term	N	71

Zomer	QALYs	Markov models without interaction	Risk Equation / Change in Risk Factors	Long Term	N	⁷⁵
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