REVIEW

Simulation Modeling for the Economic Evaluation of Population-Based Dietary Policies: A Systematic Scoping Review

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ABSTRACT

Simulation modeling can be useful to estimate the long-term health and economic impacts of population-based dietary policies. We conducted a systematic scoping review following the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) guideline to map and critically appraise economic evaluations of population-based dietary policies using simulation models. We searched Medline, Embase, and EconLit for studies published in English after 2005. Modeling studies were mapped based on model type, dietary policy, and nutritional target, and modeled risk factor–outcome pathways were analyzed. We included 56 studies comprising 136 model applications evaluating dietary policies in 21 countries. The policies most often assessed were reformulation (34/136), taxation (27/136), and labeling (20/136); the most common targets were salt/sodium (60/136), sugar-sweetened beverages (31/136), and fruit and vegetables (15/136). Model types included Markov-type (35/56), microsimulation (11/56), and comparative risk assessment (7/56) models. Overall, the key diet-related risk factors and health outcomes were modeled, but only 1 study included overall diet quality as a risk factor. Information about validation was only reported in 19 of 56 studies and few studies (14/56) analyzed the equity impacts of policies. Commonly included cost components were health sector (52/56) and public sector implementation costs (35/56), as opposed to private sector (18/56), lost productivity (11/56), and informal care costs (3/56). Most dietary policies (103/136) were evaluated as cost-saving independent of the applied costing perspective. An analysis of the main limitations reported by authors revealed that model validity, uncertainty of dietary effect estimates, and long-term intervention assumptions necessitate a careful interpretation of results. In conclusion, simulation modeling is widely applied in the economic evaluation of population-based dietary policies but rarely takes dietary complexity and the equity dimensions of policies into account. To increase relevance for policymakers and support diet-related disease prevention, economic effects beyond the health sector should be considered, and transparent conduct and reporting of model validation should be improved. *Adv Nutr* 2021;12:1957–1995.

Keywords: public health nutrition, dietary policy, policy evaluation, simulation modeling, economic evaluation, non-communicable disease prevention, systematic scoping review

Introduction

Noncommunicable diseases (NCDs) are the leading cause of morbidity and mortality, responsible for 73% of deaths and 62% of disability-adjusted life-years (DALYs) globally (1, 2). They also result in a staggering economic burden affecting health care systems and societies at large (3, 4). Unhealthy dietary behavior (especially high salt, sugar, and *trans* fatty acid (TFA) intake; low intake of fruit and vegetables; and high consumption of energy-dense foods) is one of the main modifiable risk factors for cardiometabolic NCDs, such as cardiovascular disease (CVD), type 2 diabetes, and obesity, as well as certain types of cancer (5).

To improve population health, many national and local governments implement population-based dietary policies such as nutrient or food (group)-specific taxes and subsidies, mandatory nutritional standards, or packaging requirements (e.g., labels or size caps), which can be more affordable, sustainable, effective, and cost-effective than downstream prevention or chronic disease care (6–11).

For the economic evaluation of these policies, simulation modeling methods such as comparative risk assessments (CRAs), Markov cohort, or microsimulation models can be used to (ex ante) estimate potentially complex long-term health and economic effects under different scenarios

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and policy options (12). Building on the most recent evidence, these methods can integrate data on relevant dietary components, risk factors, and NCDs from different sources, represent population heterogeneity, and incorporate various uncertainties (12, 13). Because NCD outcomes manifest over decades and policy implementation costs arise immediately, projections from simulation models can provide an important basis for public policy decisions in the absence of direct observational or experimental evidence.

Although simulation models that use an epidemiological model structure to perform economic evaluations of public health interventions—so-called public health economic simulation models [as defined by Briggs et al. (12)]—have been extensively applied in the evaluation of dietary policies (14–16), no systematic assessment and critical appraisal of these studies has been performed (17).

The application of scoping review methodology gives us the opportunity to discuss the range of applied modeling methods, evaluated dietary policies, important contextual factors, and modeling assumptions and limitations in a more open format. The results of this work are relevant for policymakers and applied researchers seeking to conduct and judge dietary policy evaluations.

This systematic scoping review aims to 1) map applications of public health economic simulation models in population-based dietary policy, 2) examine model types that are applied, and 3) discuss the context and limitations of economic evaluations of dietary policies using such models, highlighting gaps and opportunities. We also provide detailed information on important model types and their exemplary implementation in the **Supplemental Material**.

Methods

In this systematic scoping review, we accounted for 3 levels of information: modeling studies, model applications, and model types. We created a systematic overview and mapping of modeling studies and model applications within them. A model application was defined as the public health economic simulation model-based evaluation of a dietary policy in a specific country within a modeling study. We extracted high-level information about each model application with regard to policies and aimed to identify patterns, limitations, and gaps in published research.

In the Supplemental Material, we have described the conceptual model structure, modeling methods, risk factor–outcome mechanisms, main assumptions, limitations, validation information, and transparency of exemplary implementations of important model types in more detail.

PRISMA-ScR and protocol

We followed published methods for the conduct of scoping reviews and reported this review according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (18–21). Our protocol was prospectively registered on the Open Science Framework on 4 February 2020 (osf.io/63kpu and **Supplemental Methods 1**), to which we refer the reader for an extensive account of the methods used in this systematic scoping review.

Eligibility criteria

We included articles if they were 1) original studies, 2) conducting an economic evaluation of 3) explicitly specified population-based dietary policies, and 4) using 1 or more public health economic simulation models.

We used the term economic evaluation in accordance with Drummond et al. (22) denoting the comparative analysis of health outcomes and costs under different policy scenarios.

A population-based dietary policy was defined as a policy with the aim of improving the nutritional status of the general population (adults and children or adults only) on a national or sufficiently large subnational geographic and legislative level, as opposed to specific subgroups, high-risk individuals, or settings. Although dietary policies at a subnational level (e.g., city) might differ from national policies, we included studies evaluating these policies to account for the varying legislative authority of different levels of government in some countries (e.g., taxation at a city level).

Public health economic simulation models are defined in line with Briggs et al. (12) as simulation models that combine an epidemiological model structure with disease cost and health state utility information to perform economic evaluations of public health interventions or policies.

We excluded articles focusing on children, refugees, food system workers, or indigenous people and very specific settings (e.g., workplace cafeterias). This is justified because dietary policies specifically aimed at population subgroups such as children require different, although nonetheless important, policy (and potentially modeling) approaches, which were beyond the scope of this review (23).

In line with our protocol, we decided post hoc to further exclude studies evaluating food-fortification policies or applying macro-econometric modeling.

We treated validation studies of simulation models in the context of dietary policy and publications or reports

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Supplemental Results 1, Supplemental Figure 1, Supplemental Tables 1-4 , and Supplemental Methods 1–4 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances/.

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Abbreviations used: CHD, coronary heart disease; CHEERS, Consolidated Health Economic Evaluation Reporting Standards; CRA, comparative risk assessment; CVD, cardiovascular disease; DALY, disability-adjusted life-year; HALY, health-adjusted life-year; ICER, incremental cost-effectiveness ratio; LY, life-year; LYG, life-years gained; NCD, noncommunicable disease; QALY, quality-adjusted life-year; SSB, sugar-sweetened beverage; TFA, *trans* fatty acid.

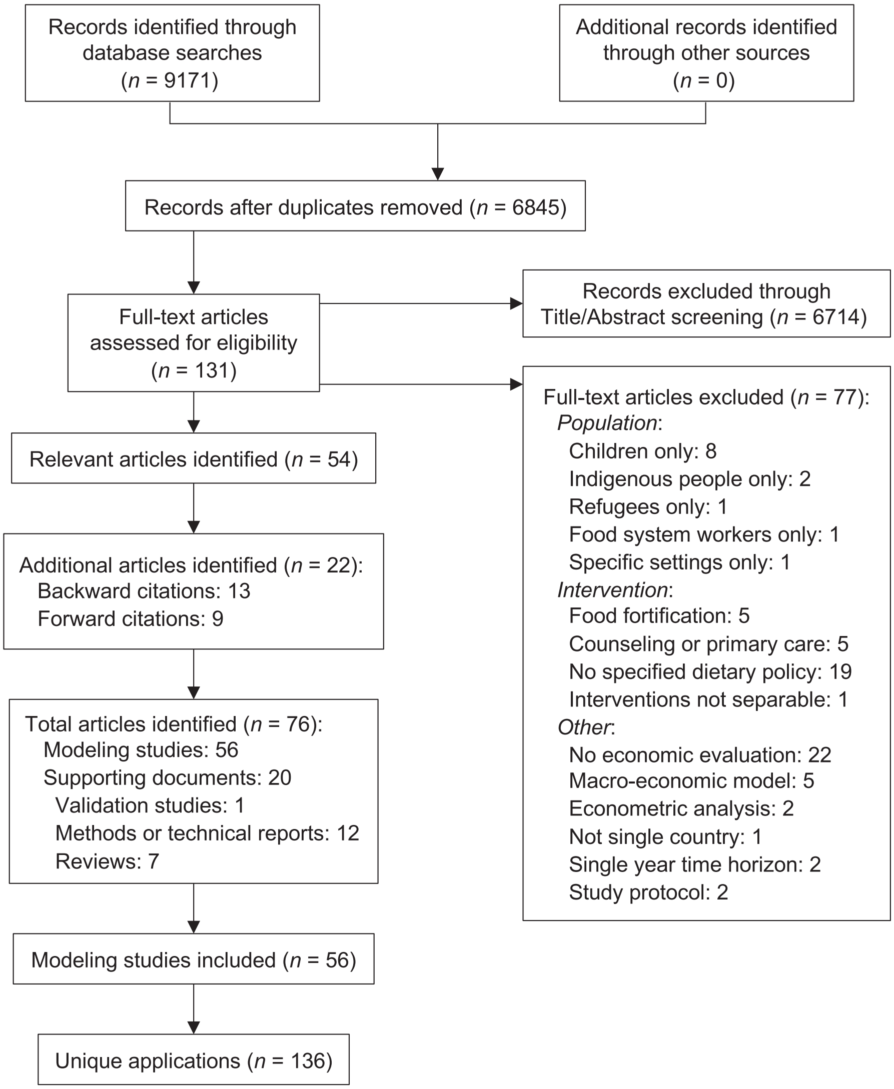

FIGURE 1 PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

concerned with simulation modeling methods in general as supporting documents that were not included in the mapping process. An overview of these can be found in **Supplemental Table 1**.

Information sources and search strategy

We searched the bibliographic databases Embase, MEDLINE, and EconLit for potentially eligible articles and applied forward and backward citation searching to all eligible articles (**Figure 1**).

The search strategy was pre-tested and comprised 4 broad categories of search terms: diet, policy, economic evaluation, and simulation modeling. Search results were limited to original studies and reviews published in English between 1 January 2005 and 4 February 2020 (**Supplemental Methods 2**).

Selection of sources of evidence, data charting, and data items

Two review authors (KMFE-F, FMK) independently screened the titles and abstracts of potentially eligible articles using Rayyan (24). Conflicts were resolved by consensus and, in the case of continued disagreement, by discussion with a third review author (ML).

One review author (KMFE-F) extracted data from modeling studies, model applications, and model types using a predefined data-extraction form, and all extracted items were checked by a second review author (FMK) (**Table 1**; **Supplemental Table 2** and **Supplemental Methods 3**). Important definitions and key terms are defined below.

For definitions related to cost and costing perspective, we adhered to recommendations from the Second Panel on Cost-Effectiveness in Health and Medicine (25). In health economics, the costing perspective defines the scope and cost

TABLE 1 Summary of included modeling studies and applications conducting an economic evaluation of dietary policies[1]

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Allen et al. 2015 (26), England	1	Ban on TFAs in processed foods	FE - I	Str	7900 QALYs gained; −£264 to −£64 mil net costs	+	Mortality: CHD; LYG; QALYs	HC; IC priv and pub; PC; ICC	English adults aged ≥25 y	IMPACTsec	CRA	S	5 y	Yes	Yes	Assumed decline in CHD mortality proportional to CHD incidence; only TFAs in processed foods; potential measurement bias in relevant TFA intake; effect of TFA based on meta-analysis from 2006; aggregate measure of deprivation
	2	Improved labeling of TFAs (processed foods)	FE - N	S-A	4000 QALYs gained; −£115 to −£22 mil net costs	+										
	3	Ban on TFAs in restaurants (processed foods)	FE - O	Str	2100 QALYs gained; −£47 to £0 mil net costs	+										
	4	Ban on TFAs in takeaways (processed foods)	FE - O	Str	3000 QALYs gained; -£75 to −£13 mil net costs	+										
Amies-Cull et al., 2019 (27), England	5	UK government sugar-reduction program	FE - I	S-A	51,729 QALYs gained; −£286 mil net health care cost	+	Incidence: CVD, stroke, diabetes, cancers, cirrhosis; QALYs	HC	English adults aged 18–80 y	PRIMEtime-CE (based on PRIME and ACE-prevention)	MSLT	(NHS)	10 y	(Y)	No	Potential response bias in underlying data (underreporting in nutrition surveys); relative risks based on observational data; validation with external datasets not possible; simplistic weight change estimation
An, 2015 (28), USA	6	Implementation of Healthy Incentives Pilot in SNAP (FV)	FE - U	S-A	0.082 ΔQALYs/person gained; $1323 Δcost/person; ICER: $16,172/QALY; NMB (WTP: $50k–$100k): $2767–$6857	–	QALYs	IC pub	US SNAP participant households	Generic	Markov	G	L	No	No	Assumed permanent price effect on consumption; dose-response might be nonlinear; health benefit of fruit and vegetables may not be fully captured by reduced mortality (e.g., HRQoL); some costs of the intervention not captured; HRQoL data and life table from 2003 and 2010
Basto-Abreu et al. 2019 (29), Mexico	7	SSB excise tax	FE - U	S-A	1 peso/liter: 55,300 QALYs gained; 5840 DALYs averted; −$91.62 mil net health care costs; $3.98 saved per dollar invested	+	Incidence: diabetes, stroke, IHD, HHD, cancers; QALYs; DALYs	HC; IC pub	Mexican population age 2–100 y	Generic (based on CHOICES/ACE-prevention)	MSLT	EHS	10 y	(Y)	No	Potential response bias in underlying data (dietary recall); effect on weight is assumed to be linear across different intake levels and age ranges; disease effects beyond BMI not modeled

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ^2	VD	Key authors' limitations
Basu et al., 2013 (16), USA	8	SSB purchase ban in SNAP	FE - I	Str	99,000 QALYs gained; −$285 mil net costs; ICER: cost-saving	+	Diabetes PY; mortality: MI, stroke; QALYs	HC; net T and S cost	US adults aged 25–64 y	Generic	Microsimulation	EHS	10 y	(Y)	Yes	Potential response bias in underlying data; assumed stable physical activity levels; direct impact of price changes, not on level of producer; no location-specific data (food deserts); potential unpredictable impact on future food prices; no information on heterogeneity within SNAP population; no children
	9	SSB tax	FE - U	S-A	26,000 QALYs gained; −$13.106 bil net costs; ICER: cost-saving	+										
	10	Fruit and vegetable subsidy	FE - U	S-A	7700 QALYs gained; $6.777 bil net costs: ICER: $876,500/QALY	−										
	11	Fruit and vegetable reward	FE - U	S-A	Not significantly different from zero	−										
Carter et al., 2019 (30), Australia	12	Junk food tax (snacks/sweets and SSBs)	FE - U	S-A	DALYs averted only in graph; -$911 mil net costs	+	Mortality: IHD, HHD, stroke, diabetes, cancers; DALYs; LYG	HC; PC	Australian adults aged ≥20 y	ACE- obesity and LifeLoss-MOD	MSLT and microsimulation	S	27 y	(Y)	No	Productivity impacts of reduced obesity-related morbidity not accounted for; excluded productivity gains from unpaid labor
Cecchini et al., 2010 (14), Brazil	13	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 1642 DALYs per mil population; ICER: cost-saving	+	DALYs; LYs	HC; IC pub	General Brazilian population	OECD-WHO Chronic Disease Prevention Model	Microsimulation	GCEA	100 y	No	No	Not all potential confounding factors considered; potentially unknown (long-term) intervention effects; health behavior of children born during simulation based on mothers; social multiplier effects not accounted for; no difference between urban and rural settings
	14	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 1030 DALYs per mil population; ICER: $9962/DALY	−										
China	15	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 1027 DALYs per mil population; ICER: cost-saving	+			General Chinese population							
	16	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 779 DALYs per mil population; ICER: $71/DALY	−										
England	17	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 1,496 DALYs per mil population; ICER: cost-saving	+			General English population							

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
	18	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 1134 DALYs per mil population; ICER: $12,577/DALY	–										
India	19	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 139 DALYs per mil population; ICER: cost-saving	+			General Indian population							
	20	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 495 DALYs per mil population; ICER: $952/DALY	–										
Mexico	21	Fat tax and healthy subsidy (FV and fat)	FE – U	S-A	20 years: 509 DALYs per mil population; ICER: cost-saving	+			General Mexican population							
	22	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 358 DALYs per mil population; ICER: $3974/DALY	–										
Russia	23	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 1696 DALYs per mil population; ICER: cost-saving	+			General Russian population							
	24	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 1176 DALYs per mil population; ICER: $396/DALY	–										
South Africa	25	Fat tax and healthy subsidy (FV and fat)	FE - U	S-A	20 years: 528 DALYs per mil population; ICER: cost-saving	+			General South African population							
	26	Food labeling (overall nutrient composition)	FE - N	S-A	20 years: 389 DALYs per mil population; ICER: $7953/DALY	–										
Choi et al., 2017 (31), USA	27	Fruit and vegetable subsidy in SNAP	FE - U	S-A	0.24 ΔQALYs/person gained; −$823.74 Δcost/person; ICER: cost-saving	+	Incidence: T2D, MI, stroke, obesity; QALYs	HC; IC pub	General US population	Generic	Microsimulation	EHS	L	(Y)	Yes	Nutritional associations may be false-positive; more evidence on kilocalorie effect size of fruit and vegetable intake needed; potential response bias in underlying data; risk equations may overestimate risk

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Cleghorn et al., 2019 (32), New Zealand	28	SSB serving size cap	FE - I	S-A	82,100 QALYs gained; −\$1.62 bil net cost	+	QALYs	HC	General New Zealand population	BODE[3]	MSLT	HS	L	Yes	No	No package size data availability and assumption that nobody switched to larger serving, potentially leads to overestimation; SSB consumption data from 2008; potential response bias in underlying data (only single dietary recall); impact on dental health not modeled; no children
Cobiac et al., 2010a (33), Australia	29	Voluntary sodium reformulation and labeling (Tick Programme)	FE - I and FE - N	S-A	5300 DALYs averted; −A\$23.3 mil net costs; ICER: cost-saving	+	DALYs	HC; IC priv and pub	General Australian population	ACE- prevention	MSLT	LS	L	No	No	Preventive effects of blood pressure reduction are assumed to be realized within 1 y; assumed gradual decline of CVD incidence and case fatality in first 20 y of analysis
	30	Mandatory sodium reformulation	FE - I	Str	110,000 DALYs averted; −A\$461 mil net costs; ICER: cost-saving	+										
Cobiac et al., 2010b (34), Australia	31	Community events and and promotion of fruit and vegetables	BCC - I	S-A	5200 DALYs averted; −A\$7 mil net costs; ICER: cost-saving; P (<\$50,000/DALY): 94%	+	DALYs	HC; IC pub	General Australian population aged ≥18 y	ACE- prevention	MSLT	EHS	L	No	No	Unknown sustainability of behavior changes; assumed exponential decay of effect at a rate of 50% per year; effect of repeated intervention unclear; health consequences of change in fat intake associated with the intervention not explicitly modeled; relationship between food groups and disease outcomes still poorly understood (micronutrient pathways not modeled); incorporating costs of health for unrelated diseases in added years of life will change results

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Cobiac et al., 2012 (35), Australia	32	Mandatory salt reformulation (breads, margarines, and cereals)	FE – I	Str	80,000 DALYs averted; −A$846 mil net costs; ICER: cost-saving	+	DALYs	HC; IC pub	General Australian population	Generic	Markov	EHS	L	No	No	Average population effect is assumed to be sustained with ongoing implementation
Cobiac et al., 2017 (36), Australia	33	Saturated fat tax	FE - U	S-A	97,000 DALYs averted; −A$1248 mil net costs; ICER: cost-saving; P(<$50,000/DALY): 100%	+	DALYs	HC; IC pub	General Australian population	ACE- prevention	MSLT	EHS	L	No	No	Price elasticity estimates from New Zealand; potential reformulation has no impact on consumer preferences; high uncertainty about the possible causal pathways between diet and disease
	34	Sodium tax	FE - U	S-A	130,000 DALYs averted; −A$1528 mil net costs; ICER: cost-saving; P(<$50,000/DALY): 100%	+										
	35	SSB tax	FE - U	S-A	12,000 DALYs averted; −A$258 mil net costs; ICER: cost-saving; P(<$50,000/DALY): 99%	+										
	36	Fruit and vegetable subsidy	FE - U	S-A	−13,000 DALYs averted; A$2162 mil net costs; ICER: dominated; P(<$50,000/DALY): 16%	−										
	37	Sugar tax	FE - U	S-A	270,000 DALYs averted; −A$2678 mil net costs; ICER: cost-saving; P(<$50,000/DALY): 100%	+										
Collins et al., 2014 (37), England	38	Health promotion campaign (salt) (Change4Life)	BCC - I	Agt	1970 LYG; −£392 mil net costs	+	LYG	HC; IC priv and pub	General English population	IMPACT CHD	CRA	(LS)	10 y	No	No	Assumed single-step change in policy; patient numbers after intervention assumed to remain constant; future health care costs are not included; potential changes in taste of products and preferences of consumers are not considered
	39	Salt labeling	FE - N	S-A	1970 LYG; −£397 mil net costs	+										
	40	Voluntary salt reformulation	FE - I	S-A	14,593 LYG; −£584 mil net costs	+										
	41	Mandatory salt reformulation	FE - I	Str	19,365 LYG; −£669 to −£186 mil net costs	+										

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ^2	VD	Key authors' limitations
Crino et al., 2017 (38), Australia	42	SSB reformulation	FE - I	S-A	144,621 HALYs gained; −$1.3 bil net costs; ICER: cost-saving	+	HALYs	HC; IC priv and pub	General Australian population aged 2–100 y	Generic	MSLT	LS	L	(Y)	No	Direct evidence supporting the impact of the intervention on consumer behavior is weak; SSB package size data not available; costs for changes in packaging and reformulation are not sourced; revenue loss for food industry and impact on consumers not considered
	43	SSB package size cap	FE – I	S-A	73,883 HALYs gained; −$540.9 mil net costs; ICER: cost-saving	+										
Dalziel and Segal, 2007 (39), Australia	44	Information campaign ("2 fruit 5 veg every day")	BCC - I	Agt	0.0048 ΔQALYs/person gained; $0.20 Δcost/person; ICER: $46/QALY	–	QALYs	HC; IC pub	General Australian population	Generic	Markov	EHS	20 y	No	No	Limited quality of the available evidence between intermediate outcomes and health
	45	Information campaign (FFFF) (FV)	BCC - I	Agt	0.0546 ΔQALYs/person gained; $308 Δcost/person; ICER: $5600/QALY	–										
Dodhia et al. 2012 (40), England	46	Sodium reformulation	FE - I	S-A	Three generic reformulation scenarios: 238,043 - 579,869 DALYs gained; −£1.86 to −£0.77 bil net costs; ICER: cost-saving	+	Incidence: IHD, stroke; Mortality: IHD, stroke; DALYs	HC	General English population	Generic	CRA	HS	10 y	No	No	CVD and hypertension data from 2003; non-CVD deaths not affected by the intervention; incidence, case fatality and mortality from cohort studies assumed to be transferable to the English population; assumed average effect size over time horizon; assumption that treatment with no control on hypertension would not reduce risk; effect of prevention interventions starts in the fourth year
Ha and Chisholm, 2011 (41), Vietnam	47	Information campaign and voluntary salt reformulation	BCC - I and FE - I	S-A	46,000 DALYs averted; VND89 bil net costs per year; ACER: VND1,945,002/DALY	–	Incidence: IHD, stroke; DALYs	HC; IC pub	General Vietnamese population	PopMod + WHO CHOICE syntax	Markov	GCEA	10 y	No	No	No original data on salt consumption; not all benefits of interventions considered

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Mantilla Herrera et al., 2018 (42), Australia	48	Voluntary food labeling (overall nutrient composition)	FE – N	S-A	4207 HALYs gained; A$4.5 mil net costs; ICER: A$1728/HALY	−	HALYs	HC; IC priv and pub	General Australian population	CRE- Obesity Model	MSLT	LS	L	No	No	No clear evidence on the effect of labeling on reformulation (reduced energy density); assumption that consumers do not change purchasing or eating behavior; potentially selective adaption of voluntary labeling; cohort model assumes homogeneity within age-sex groups; intervention effect may decline; potential time lag between implementation and reformulation
	49	Mandatory food labeling (overall nutrient composition)	FE - N	S-A	49,949 HALYs gained; A$197.7 mil net costs; ICER: A$4752/HALY	−										
Huang et al., 2019 (15), USA	50	Sugar labeling	FE - N	S-A	727,000 QALYs gained; −$61.92 bil net costs (S persp.); ICER: cost-saving; NMB (WTP: $100,000): $134.78	+	Incidence: CHD, stroke, T2D; Mortality: CHD, stroke, T2D; LYG; QALYs	HC; IC priv and pub; PC; ICC	General US population	IMPACT food policy	Microsimulation	EHS and S	20 y	(Y)	Yes	No causal interpretation possible; average population effects instead of individual interpretation; potential underestimation due to assumed declining added sugar consumption; inclusion of costs from competing diseases could reduce cost-effectiveness; inclusion of health benefits from reduced obesity-related cancers or dental outcomes could increase cost-effectiveness
	51	Sugar labeling and reformulation	FE - I and FE – N	S-A	1,337,000 QALYs gained; −$113.25 bil net costs (S persp.) ICER: cost-saving; NMB (WTP: $100,000): $247.03	+										
Huse et al. 2019 (43), Australia	52	Mandatory restriction on price promotions for SSBs	FE - U	S-A	34,260 HALYs gained; −A$359 mil net costs; ICER: cost-saving	+	Incidence: cancers, IHD, HHD, stroke, T2D, osteoarthritis; HALYs	HC; IC pub	General Australian population	CRE- Obesity model	MSLT	EHS	L	(Y)	No	UK estimates might not translate to Australia; potential response bias in underlying dietary data; costs to Australian consumers and industry were unavailable; real-world retailer and/ormanufacturer response to regulation is unknown; assumption of no compensatory behavior

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Jevdjevic et al., 2019 (44), Netherlands	53	SSB tax	FE - U	S-A	1,030,163 caries lesions prevented; 2.13 caries-free tooth years per person; −€159.01 mil net treatment costs	+	Caries-free tooth-years; Incidence: caries lesions	HC; IC pub; TR	General Dutch population aged 6–79 y	Generic	Markov	LS	L	(Y)	No	No country-specific price and cross-price elasticities; consumption beyond household not included; "Meal deals" could mitigate tax effect; assumption of same sensitivity to taxation across population subgroups; long-term effect of SSB tax limited; extrapolation to other countries limited
Kim et al., 2019 (45), USA	54	Excise tax on processed meat	FE - U	S-A	593,000 QALYs gained; $160 mil net costs (HS persp.); −$2732 mil net costs (S persp.); ICER (HS): $270/QALY; ICER (S): cost-saving	+/−	Incidence: cancers; Mortality: cancers; LYs; QALYs	HC; IC priv & pub; PC; TC	General US population aged ≥20 y	Dietary and Cancer Outcome Model (DICOM)	Markov	EHS & S	L	(Y)	Yes	Risk factor-disease estimates are subject to uncertainty; competing mortality risks not modeled; policy effect sizes derived from taxes on SSBs and warning labels for smoking
	55	Cancer risk labeling of processed meat	FE – N	S-A	−$1259.7 mil net costs (HS) −$4512.7 mil net costs (S); ICER (HS): cost-saving; ICER (S): cost-saving	+										
Lal et al., 2017 (46), Australia	56	SSB sales tax	FE - U	S-A	175,300 HALYs gained; −A$1733 mil net healthcare costs; ICER: cost-saving	+	HALYs	OopC; other HC; IC priv and pub; DWL; Oop tax cost; TR	General Australian population aged 2–100 y	CRE- Obesity model	MSLT	LS	L	Yes	No	Indicator of socioeconomic position (SEIFA); price elasticities for household income groups assumed to be similar to SEIFA groups; potential response bias in underlying dietary data; no cross-price elasticities of food substitutes; real-world prices of SSBs might be different; not all costs available for Australia; intervention effect on oral health not included; indirect costs (lost productivity, absenteeism, presenteeism) not included; HRQoL estimates not available for all child age groups

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Laverty et al., 2019 (47), England	57	UK responsibility deal (private-public partnership to improve population health) (salt)	FE - I	S-A	35,000/6400 additional CVD cases/deaths (probability of superiority: <0.1%); 5300/2500 additional GCa cases/deaths (probability of superiority: 5.8%); £910 mil net CVD costs; £215.4 mil net GCa costs	+	Incidence: CVD, GCa; mortality: CVD, GCa	HC; PC	General English population	IMPACT NCD	Microsimulation	S	15 y	Yes	Yes	No causal interpretation of effect (longitudinal data collection of salt intakes in the same people not available); people aged 64 or older are assumed to have similar trends in salt intake than those in HSE; limited information on the socioeconomic position of survey participants; counterfactual is linear decline in salt intake; costs estimates based on workplace productivity and not other costs including the economic value of a QALY
Lee et al., 2019 (48), USA	58	Fruit and vegetable subsidy in Medicaid and Medicare	FE - U	S-A	4.64 mil QALYs gained; \$83.5 bil net costs (HS persp.); \$68.8 bil net costs (S persp.) ICER (HS): \$18,184/QALY; ICER (S): \$14,576/QALY	–	Incidence: CVD, diabetes; Mortality: CVD; QALYs	HC; IC pub; PC; TC	US adults in Medicaid or Medicare aged 35–80 y	CVD- PREDICT	Microsimulation	EHS and S	L	(Y)	Yes	Only foods purchased at stores accepting EBT cards; no direct; causal evidence; potential over- (residual confounding) or underestimation (measurement error, regression dilution bias) of etiologic effects; health and cost outcomes from other diseases not modeled; political and legal feasibility not considered
	59	Healthy foods subsidy in Medicaid and Medicare	FE - U	S-A	8.40 mil QALYs gained; \$111.1 bil net costs (HS); \$80.5 bil net costs (S); ICER (HS): \$13,194/QALY; ICER (S): \$9497/QALY	–										
Long et al., 2015 (49), USA	60	SSB excise tax	FE - U	S-A	101,000 DALYs averted; 871,000 QALYs gained; −\$23.2 mil net costs; ICERs (all outcomes): cost-saving	+	LYs; QALYs; DALYs	HC; IC priv and pub; TR	General US population aged 2–100 y	CHOICES (based on ACE- prevention)	MSLT	LS	10 y	Yes[3]	No	No direct evidence (all simulation models); limited evidence for some parameters; only BMI-mediated health and economic effects; effects of tax revenue reinvestment not included; indirect costs (productivity, absenteeism, disability early retirement, mortality) of obesity not included

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Long et al., 2019 (50), USA (Maine)	61	SSB excise tax	FE - U	S-A	3560 QALYs gained; −$74.0 mil net costs; ICER: cost-saving	+	Incidence: obesity; QALYs	HC; IC priv and pub	General Maine (US) population aged 2–100 y	CHOICES	Microsimulation	(LS)	10 y	No	No	No direct evidence (all simulation models); industry costs are assumed to be equivalent to government effort; model output requested by stakeholders was beyond scope
	62	SSB restriction in SNAP	FE - I	Str	749 QALYs gained; −$10.9 mil net cost; ICER: cost-saving	+										
Manyema et al., 2015 (51), South Africa	63	SSB tax	FE - U	S-A	Male: 2.8 mil DALYs averted; −ZAR18,590 mil net health care costs; Female: 4 mil DALYs averted; −ZAR49,569 mil net health care costs	+	Incidence: T2D; prevalence: T2D; mortality: T2D; DALYs	HC	South African adult population aged ≥15 y	ACE- prevention	MSLT	(HS)	L	(Y)	No	No South African price elasticities; no price elasticities for skim milk available; substitution effect to other sweetened drinks not modeled; same price elasticities assumed by sex, age, income category, and baseline BMI; no direct impact of sugar intake on diabetes; other causes of diabetes, complications, and associated diseases not modeled; children below 15 y not modeled; BMI trends not included and diabetes incidence assumed to be constant; large proportion of undiagnosed diabetes cases in South Africa; potential underestimation of costs and savings

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Manyema et al., 2016 (52), South Africa	64	SSB tax	FE - U	S-A	550,000 DALYs averted; −ZAR5 bil net health care costs	+	Incidence: stroke; Prevalence: stroke; Mortality: stroke; HALYs	HC	South African adult population aged ≥15 y	ACE- prevention	MSLT	HS	L	(Y)	No	Potential response bias in underlying epidemiological and cost data; no South African price elasticities (cultural context important); only proxy estimates for health care cost data; costs for other diseases, care for elderly, and taxation not accounted for; direct impact of sugar intake on stroke and other relevant diseases not modeled; substitution effect to other sweetened drinks not modeled; same price elasticities by income category assumed
Martin-Saborido et al., 2016 (53), European Union	65	Mandatory TFA labeling	FE - N	S-A	1.39 mil DALYs averted; €89,153 mil net costs; ICER: €64,363/DALY	−	DALYs	HC; IC pub; PC; ICC	General EU population	Generic	Markov	S	L	(Y)	No	Potential response bias in underlying data; CAD-related hospital discharges instead of events used in modeling; high variation in several variables across EU countries
	66	Voluntary TFA reformulation	FE - I	S-A	2.93 mil DALYs averted; −€35,603 mil net costs; ICER: cost-saving	+										
	67	Mandatory TFA limits	FE - I	Str	5.32 mil DALYs averted; −€76,478 mil costs saved; ICER: cost-saving	−										

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Mason et al. 2014 (54), Tunisia	68	Health promotion campaign (Salt)	BCC - I	Agt	1151 life-years gained; PPP$17 mil net costs	−	LYG	HC; IC priv and pub	General Tunisian population	IMPACT CHD	CRA	(LS)	10 y	No	No	Unrelated health care costs, indirect costs and tax revenue not included; methodology of cost data collection varies between countries and limits comparability; policy effectiveness based on few other observed countries; not all parameters varied in sensitivity analysis; only deterministic sensitivity analysis; CHD rates are assumed to continue for 10 y; reformulation cost estimate from manufacturers may be biased; assumed single-step change in policy; assumed demand on reformulated products remains constant
	69	Food labeling (salt)	FE - N	S-A	2272 life-years gained; −PPP$39 mil net costs	+										
	70	Mandatory salt reduction in processed foods	FE - I	Str	2272 life-years gained; −PPP$39 mil net costs	+										
	71	Health promotion campaign, food labeling, and mandatory salt reduction in processed foods	BCC - I, FE – I, and FE – N	S-A	6455 life-years gained; −PPP$235 mil net costs	+										
Syria	72	Health promotion campaign (salt)	BCC – I	Agt	5679 life-years gained; −PPP$5 mil net costs	+			General Syrian population							
	73	Food labeling (salt)	FE - N	S-A	11,192 life-years gained; −PPP$34 mil net costs	+										
	74	Mandatory salt reduction in processed foods	FE - I	Str	11,192 life-years gained; −PPP$61 mil net costs	+										
	75	Health promotion campaign, food labeling, and mandatory salt reduction in processed foods	BCC - I, FE – I, and FE - N	S-A	31,674 life-years gained; −PPP$39 mil net costs	+										
Palestine	76	Health promotion campaign (salt)	BCC - I	Agt	479 life-years gained; −PPP$7 mil net costs	+			General Palestinian population							
	77	Food labeling (salt)	FE - N	S-A	945 life-years gained; −PPP$9 mil net costs	+										
	78	Mandatory salt reduction in processed foods	FE - I	Str	945 life-years gained; PPP$0.13 mil net costs	−										
	79	Health promotion campaign, food labeling, and mandatory salt reduction in processed foods	BCC - I, FE – I, and FE – N	S-A	2,682 life-years gained; −PPP$6 mil net costs	+										
Turkey	80	Health promotion campaign (salt)	BCC - I	Agt	68,816 life-years gained; −PPP$949 mil net costs	+			General Turkish population							
	81	Food labeling (salt)	FE - N	S-A	135,221 life-years gained; −PPP$1043 mil net costs	+										
	82	Mandatory salt reduction in processed foods	FE - I	Str	135,221 life-years gained; −PPP$965 mil net costs	+										

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
	83	Health promotion campaign, food labeling, and mandatory salt reduction in processed foods	BCC - I, FE – I, and FE – N	S-A	199,303 life-years gained; −PPP$1324 mil net costs	+										
Mekonnen et al., 2013 (55), USA (CA)	84	SSB tax	FE - U	S-A	10% reduction in SSB consumption: 6000 fewer CHD cases; 2700 fewer MI cases; 1600 fewer all-cause deaths; −$873 mil net diabetes and CHD costs	+	Incidence: CHD, diabetes; Mortality: CHD, AC; Total cases: MI	HC	General Californian population	CVD policy model - CA	Markov	(HS)	10 y	Yes	No	No direct evidence (all simulation models); effect measures based on published analyses of observational studies potentially subject to residual or unmeasured confounding; real-world consumer behavior different; potential response bias in underlying dietary data; did not account for artificially sweetened beverage consumption and disease risk; lost productivity not accounted for; children and adolescents not included
Mozaffarian et al., 2018 (56), USA	85	Fruit and vegetable subsidy	FE - U	S-A	20 years: 155,792 QALYs gained; −$6.69 bil net costs (S persp.); $29.66 bil food subsidy costs (G); ICER (S): cost-saving; ICER (G): $168,455/QALY	+/−	Incidence: diabetes, CVD; Mortality: CVD; QALYs	HC; IC pub	US population aged 35–80 y participating in SNAP	CVD- PREDICT	Microsimulation	EHS and G	L	(Y)	Yes	No causal interpretation possible; potential long-term change in effect; CVD risk calculations do not incorporate ethnicity; indirect costs (lost productivity) not included
	86	Fruit and vegetable subsidy and SSB restriction	FE - U and FE - I	S-A	20 years: 457,184 QALYs gained; −$17.60 bil net costs (S); $29.69 bil food subsidy costs (G); ICER (S): cost-saving; ICER (G): 26,435/QALY	+/−										
	87	Incentive/ disincentive program (SNAP-plus) (healthy and unhealthy foods)	FE - U	S-A	20 years: 551,824 QALYs gained; −$19.61 bil net costs (S); −$15.0 bil food subsidy costs (G); ICER (S): cost-saving; ICER (G): cost-saving	+										

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Nghiem et al., 2015 (57), New Zealand	88	Voluntary sodium reformulation and labeling (Tick Programme)	FE - N	S-A	7900 QALYs gained; −$34 mil net costs; ICER: cost-saving	+	Mortality rate: CVD; QALYs	HC; IC priv and pub	General New Zealand population aged ≥35 y	BODE[3]	Markov	LS	L	Yes	Yes	Structural model uncertainty not assessed; potential response bias in underlying data and intervention effects; public, consumer, and industry responses to policies unknown; no full societal perspective
	89	Mandatory sodium reformulation (breads, processed meats and sauces)	FE – I	Str	61,700 QALYs gained; −$340 mil net costs; ICER: cost-saving	+		HC; IC pub				EHS				
	90	Mandatory sodium reformulation	FE – I	Str	110,000 QALYs gained; −$600 mil net costs; ICER: cost-saving	+										
	91	Health promotion campaign, voluntary sodium reformulation and sodium labeling (sodium)	BCC - I, FE – I, and FE – N	S-A	85,100 QALYs gained; −$440 mil net costs; ICER: cost-saving	+		HC; IC priv and pub				LS				
	92	Health promotion campaign (salt)	BCC - I	Agt	25,200 QALYs gained; −$120 mil net costs; ICER: cost-saving	+										
	93	Sodium tax	FE - U	S-A	195,000 QALYs gained; −$1000 mil net costs; ICER: cost-saving	+		HC; IC pub				EHS				
	94	Salt market restriction ("sinking lid") (sodium)	FE - I	Str	211,000 QALYs gained; −$1110 mil net costs; ICER: cost-saving	+										
Nghiem et al. 2016 (58), New Zealand	95	Sodium substitution (processed foods)	FE - I	Str	294,000 QALYs gained; −$1500 mil net costs; ICER: cost-saving	+	QALYs	HC; IC pub	General New Zealand population aged ≥35 y	BODE[3]	Markov	EHS	L	Yes	Yes	Structural model uncertainty not assessed; not all potentially relevant diseases modeled; minimum risk exposure level of sodium is still debated; potential response bias in underlying data; sodium reduction might impact palatability and thus lead to more added sugar by industry or salt at the table

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
	96	Sodium substitution (low-level) (processed foods)	FE - I	Str	121,000 QALYs gained; −$620 mil net costs; ICER: cost-saving	+										
	97	Mandatory sodium reformulation (breads)	FE - I	Str	43,500 QALYs gained; −$220 mil net costs; ICER: cost-saving	+										
	98	Mandatory sodium reformulation (low-level) (breads)	FE – I	Str	15,600 QALYs gained; −$83 mil net costs; ICER: cost-saving	+										
Nomaguchi et al., 2017 (59), Australia	99	SSB tax	FE - U	S-A	63,000 DALYs gained; $2347 mil net economic gain (HCA); $1748 mil net economic gain (FCA 3 months)	+	Prevalence: obesity; LYs; DALYs	HC; PC (unpaid and paid)	General Australian population aged ≥20 y	Generic (based on ACE- prevention)	MSLT	S	L	No	No	Potential information bias in underlying data; comorbidities are assumed to be random, instead of clustered in high-risk individuals; epidemiological and cost parameters are assumed to remain stable into the future; equity impacts not analyzed; wages remain unaffected by labor supply changes; productivity effects not adjusted for potential confounders like education or income level; disease frequency data from 2003
Pearson- Stuttard et al., 2017 (60), England and Wales	100	Ban on TFAs in processed foods	FE - I	Str	Equal intake across SEC: 13,600 life-years gained; 4000 hospital admissions averted; ICER: £3100/LYG; unequal intake across SEC: 15,400 LYG; 4400 hospital admissions averted; ICER: £2700/LYG	−	Mortality: CHD; LYG; QALYs; health care utilization: CHD hospital admissions	HC; IC priv and pub; PC	General adult English and Welsh population	IMPACTecon	CRA	S	10 y	Yes	Yes	Area-based measure of deprivation; model assumes immediate health benefits; ruminant and industrial TFAs are assumed to be equally associated with mortality; estimates for reformulation costs have high variation

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
	101	Ban on TFAs	FE - I	Str	Equal intake across SEC: 27,200 LYG; 8000 hospital admissions averted; ICER: £1600/LYG; unequal intake across SEC: 29,000 LYG; 8400 hospital admissions averted; ICER: £1400/LYG	–										
Pearson- Stuttard et al., 2018 (61), USA	102	Voluntary sodium reformulation	FE - I	S-A	0.69 mil QALYs gained; −$9.7 bil net costs (health care); −$12 bil net costs (societal); ICER: cost-saving; NMB (WTP: $100,000): $81 bil	+	Mortality: AC; CHD, stroke, Incidence: CHD, stroke; LYG; QALYs	HC; IC priv and pub; PC	General US adult population aged 30–84 y	IMPACT food policy	Microsimulation	HS and S	20 y	Yes[4]	Yes	Potential information bias in underlying data; decline in sodium trends assumed to continue; only disease mediated through blood pressure evaluated; additional potential benefit through increased potassium intake not modeled; unrelated medical costs not included
Rubinstein et al., 2009 (62), Argentina (Buenos Aires)	103	Health promotion campaign (healthy foods, salt and fat)	BCC - I	Agt	1158 DALYs averted per year; ARS$634,000 total costs per year; ICER: ARS$547/DALY	–	DALYs	PLC; IC	General population of Buenos Aires	PopMod	Markov	GCEA	10 y	No	No	Not reported
	104	Voluntary salt reformulation (breads)	FE - I	S-A	579 DALYs averted per year; ARS$87,000 total costs per year; ICER: ARS$151/DALY	–										

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Rubinstein et al., 2010 (63), Argentina	105	Voluntary salt reformulation (breads)	FE - I	S-A	672.80 DALYs averted; −I$947,581 net costs; ICER: cost-saving	+	DALYs	HC; IC pub	General Argentinian population aged ≥35 y	Generic	CRA	EHS	5 y	(Y)	No	Only risk factors with available data from the underlying survey could be included; data on risk factor prevalence were categorical or dichotomous, prohibiting a continuous estimation; limited scope of interventions; no direct evidence (all simulation models); not all input parameters were country specific
Rubinstein et al., 2015 (64), Argentina	106	Mandatory TFA reformulation	FE - I	Str	5237 DALYs averted; −$17.3 mil net costs	+	Mortality: CHD, MI; Incidence: CHD; DALYs	HC; IC pub	General Argentinian population aged ≥35 y	Generic	—	EHS	10 y	(Y)	No	CHD risk based on old equations; global estimates used to adjust for underreporting of CHD; industry reformulation costs not included; no precise data on baseline TFA intake
Sacks et al., 2011 (65), Australia	107	Food labeling (overall nutrient composition)	FE - N	S-A	45,100 DALYs averted; A$455 mil total cost offsets; gross ICER: A$1800/DALY; net ICER: cost-saving	+/−	DALYs	HC; IC priv and pub	Australian adults aged ≥20 y	ACE- prevention	MSLT	LS	L	(Y)	No	Direct evidence of intervention impact relatively weak; analyses conducted on the food category rather than on the product level
	108	Junk food tax (snacks/sweets and SSBs)	FE - U	S-A	559,000 DALYs averted; A$5550 mil total cost offsets; gross ICER: $30/DALY; net ICER: cost-saving	+/−										

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Salomon et al., 2012 (66), Mexico	109	Voluntary salt reformulation	FE - I	S-A	19,000 DALYs averted per year; I$11 mil net annual cost; ICER: $570/DALY	–	DALYs	PLC; IC	General Mexican population	PopMod	Markov	GCEA	100 y	No	No	Potential bias due to extrapolation of evidence and assumptions from other countries; no exhaustive details on uncertainty around point estimates or parameter values and assumptions
	110	Mandatory salt reformulation	FE - I	Str	37,000 DALYs averted per year; I$11 mil net annual cost; ICER: $293/DALY	–										
	111	Health promotion campaign (cholesterol and energy intake)	BCC – I	Agt	38,000 DALYs averted per year; I$22 mil net annual cost; ICER: $567/DALY	–										
Sánchez- Romero et al., 2016 (67), Mexico	112	SSB tax	FE - U	S-A	66,000 cases of diabetes prev.; 5100 cases of CHD prevented; 1800 cases of stroke prevented; 4200 fewer all-cause deaths prev.; −I$483 mil net diabetes health care costs	+	Incidence: diabetes, CHD, stroke; Mortality: CHD, stroke, AC; Total cases: MI	HC	General Mexican population aged 35–94 y	CVD policy model - Mexico	Markov	(HS)	10 y	(Y)	Yes	Reliance on US input parameters where Mexico-specific data were lacking; limited data on health care costs other than those related to diabetes; lack of information on long-term SSB price elasticities that are specific to subgroups
Saxena et al., 2019a (68), South Africa	113	SSB tax	FE - U	S-A	7898 T2D deaths avoided; −ZAR1,701.1 mil net costs; ZAR5,490 mil annual tax revenue; 12,179 cases of poverty avoided; 32,377 cases of catastrophic expenditure averted	+	Mortality: T2D	OopC; PC; HC; TR; CHE	General South African population	ACE- prevention	MSLT	(S)	20 y	Yes	No	No direct estimates for the price elasticities of SSB consumption by income; no substitution effects to other drinks or complementary foods considered; only T2D-related mortality; indirect costs did not account for labor force dropout, premature mortality, or others; no subgroup effects for race, sex, and age modeled (only population average)

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Saxena et al., 2019b (69), Philippines	114	SSB tax	FE - U	S-A	5913 T2DM deaths avoided; 10,339 IHD deaths avoided; 7950 stroke deaths avoided; −P31.6 bil net health care costs; −P18.6 bil out-of-pocket costs; P41 bil annual tax revenue; 13,890 cases of catastrophic expenditure averted	+	Mortality: diabetes, IHD, stroke; Incidence: diabetes, IHD, stroke	OopC; HC; TR; CHE	General Filipino population	ACE- prevention	MSLT	(LS)	20 y	Yes	No	No direct estimates for the price elasticities of SSB consumption by income; no substitution effects to other foods considered (cross-price elasticities); no data on composition of all SSBs; potential reformulation due to 2-tier tax structure not modeled; no subgroup data on health care use and disease conditions; inpatient costs instead of primary care costs; nonmedical costs not considered (lost productivity, transportation, caregiver)
Schwendicke et al., 2016 (70), Germany	115	SSB tax	FE - U	S-A	750,000 less caries teeth; −€80 mil net costs; €37.99 bil tax revenue	+	Incidence: caries	HC; TR	General German population aged 14–79 y	Generic	Microsimulation	HS	10 y	Yes	No	Potential information bias in underlying data; data from before 2009; increasing consumption of SSBs (especially in low-income groups) not accounted for; no German, age-dependent elasticities; substitution to sugary foods was not modeled; long-term costs higher (re-interventions); no implementation and administration cost

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TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Smith-Spangler et al., 2010 (71), USA	116	Voluntary sodium reformulation	FE - I	S-A	2,060,790 QALYs gained; −$32.1 bil net costs	+	Incidence: MI, stroke; LYs; QALY	HC; P-PCC	General US population aged 40–85 y	Generic	Markov	LS	L	(Y)	Yes	Intervention might produce unpredictable dietary changes (e.g., substitution); potential unintended consequences of modest sodium reduction not included; cost-savings not from all relevant diseases included; minority populations underrepresented in cardiovascular risk equations
	117	Sodium tax (processed foods)	FE - U	S-A	1,313,304 QALYs gained; −$22.4 bil net costs	+										
Sowa et al., 2019 (72), Australia	118	SSB tax	FE - U	S-A	3.89 mil less DMFT; −A$666 mil net costs	+	Incidence: DMFT	HC	General Australian adult population	Generic	(Markov)	HS	10 y	No	No	No direct evidence; potential unpredictable substitution effects in industry and individual responses; market distortions and potential deadweight loss may be very high
Veerman et al., 2016 (73), Australia	119	SSB tax	FE - U	S-A	167,993 DALYs averted; −A$581.4 mil net costs; A$400 mil tax revenue per year	+	Prevalence/ incidence/ mortality: obesity, IHD, HHD, stroke, T2D, osteoarthritis, cancers; HALYs; DALYs	HC; IC pub; TR	Australian adults aged ≥20 y	ACE- prevention	MSLT	EHS	L	No	No	Potential information bias in the underlying data; impact on different socioeconomic groups not modeled
Wang et al., 2012 (74), USA	120	SSB tax	FE - U	S-A	2,377,000 less diabetes person-years; 95,000 cases of CHD prevented; 30,000 cases of MI prevented; 8000 cases of stroke prevented; 26,000 deaths prevented; −$17.1 bil net costs	+	Diabetes PY; Incidence: CHD; Total cases: MI, stroke; Mortality: AC	HC; TR	General US adult population aged 25–64 y	CVD policy model - USA	Markov	HS	10 y	(Y)	Yes	Potential information bias in the underlying data; not all relevant diseases included; empirical evidence for some key assumptions still inconclusive (industry response, consumer behavior, substitution effects)

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Wang et al., 2016 (75), China	121	Health promotion salt campaign (cooking education)	BCC - I	Agt	401,000 QALYs gained; −I$1,406 mil net CVD health care costs per year	+	Incidence: CVD; Mortality: CVD; QALYs	HC	General Chinese adult population aged 35–94 y	CVD policy model - China	Markov	HS	10 y	(Y)	Yes	Potential bias due to data inputs from diverse studies; salt-related change in blood pressure based on study including normo- and hypertensive patients and long-term follow-up unclear; implementation costs and potential costs of adverse effects not included
	122	Health promotion campaign (sodium substitution)	BCC - I	S-A	1,185,000 QALYs gained; −I$4,126 mil net CVD health care costs per year	+										
Wilcox et al., 2014 (76), Syria	123	Health promotion campaign (salt)	BCC - I	Agt	5679 LYG; −PPP$5,346,438 net costs; ICER: cost-saving	+	LYG	HC; IC priv and pub	Syrian adult population aged ≥25 y	IMPACT CHD - Syria	CRA	(LS)	10 y	No	Yes	Incomplete data for target population; dietary salt intake and intervention effectiveness data (potentially large cultural heterogeneity) extracted from other countries; no data on productivity loss associated with CHD; CHD rates assumed to persist for 10 y
	124	Salt labeling	FE - N	S-A	11,192 LYG; −PPP$34,952,472 net costs; ICER: cost-saving	+										
	125	Salt reformulation	FE - I	Str	11,192 LYG; PPP$61,032,931 net costs; ICER: PPP$5,453/LYG	-										
	126	Health promotion campaign, salt reformulation, and salt labeling	BCC - I, FE - I, and FE - N	S-A	31,674 LYG; −PPP$39,190,619 net costs; ICER: cost-saving	+										
Wilde et al., 2019 (77), USA	127	SSB tax	FE - U	S-A	0.0201 ΔQALYs/person gained; −$270 Δcosts/person cost (HS); −$43.16 bil net costs (S); ICER (HS): cost-saving; ICER (S): cost-saving	+	Total cases: MI, IHD; Mortality: stroke, IHD; LE; QALYs	HC; IC priv and pub; TR	General US population aged 35–85 y	CVD- PREDICT	Microsimulation	HS, S and SH	L	No	Yes	Not all relevant diseases attributable to SSB intake modeled; indirect costs (lost productivity) not included; children and adolescents not included; time lags of effect could be longer than assumed (1 y); modeling of industry profit function not attempted; no specific replacement scenarios modeled

(*Continued*)

TABLE 1 (*Continued*)

Study, year, country	No.	Policy (details)	NOURISHING	S-A	Cost-effectiveness results	CS?	Health outcomes	Cost outcomes	Population	Model name	Method	Cost persp.	Time horizon	EQ[2]	VD	Key authors' limitations
Wilson et al., 2016 (78), New Zealand	128	Mandatory sodium reformulation (all packaged foods, fast food/ restaurants, and discretionary use)	FE – I	S-A	235,000 QALYs gained; −NZ$1260 mil net health system costs; ICER: cost-saving	+	QALYs	HC; IC pub	General New Zealand population aged ≥35 y	BODE[3]	Markov	EHS	L	Yes	Yes	No direct evidence; structural model uncertainty not assessed; not all potentially relevant diseases modeled; potential bias in underlying data and intervention effects; public, consumer, and industry responses to policies unknown
	129	Reformulation (packaged foods)	FE - I	Str	122,000 QALYs gained; −NZ$660 mil health system costs; ICER: cost-saving	+										
	130	Mandatory sodium reformulation (breads)	FE - I	Str	8900 QALYs gained; −NZ$45.2 mil health system costs; ICER: cost-saving	+										
	131	Mandatory sodium reformulation (processed meats)	FE - I	Str	13,400 QALYs gained; −NZ$70 mil health system costs; ICER: cost-saving	+										
	132	Mandatory sodium reformulation (sauces)	FE - I	Str	20,000 QALYs gained; −NZ$106 mil health system costs; ICER: cost-saving	+										
	133	Mandatory sodium reformulation (snack foods)	FE - I	Str	6,100 QALYs gained; −NZ$30.3 mil health system costs; ICER: cost-saving	+										
	134	Mandatory sodium reformulation (All bakery products)	FE - I	Str	20,400 QALYs gained; −NZ$108 mil health system costs; ICER: cost-saving	+										
	135	Mandatory sodium reformulation (cheese)	FE - I	Str	8800 QALYs gained; −NZ$44.6 mil health system costs; ICER: cost-saving	+										
	136	Mandatory sodium reformulation (fast food/restaurants)	FE - I	Str	68,700 QALYs gained; −NZ$370 mil health system costs; ICER: cost-saving	+										

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[1] AC, all-cause; ACE, Assessing Cost-Effectiveness; ACER, average cost-effectiveness ratio; Agt, agentic; BCC-I, Behavior Change Communication; bil, billion; CHD, coronary heart disease; CHE, catastrophic health expenditure; CRA, Comparative risk assessment; CS?, Cost-saving?; DMFT, decayed, missing, or filled teeth; DWL, deadweight loss; EHS, extended health care sector; EQ, equity analysis; FCA, friction cost approach; FE - I, food environment–food supply chain; FE - N, food environment–food labels; FE - U, food environment–economic tools; FV, fruit and vegetables; G, government; GCa, gastric cancer; GCEA, generalized cost-effectiveness analysis; HALY, health-adjusted life-year; HC, health care cost; HCA, human capital approach; HHD, hypertensive heart disease; HRQoL, health-related quality of life; HS, health sector; IC, implementation cost; ICC, informal care cost; ICER, incremental cost-effectiveness ratio; IHD, ischemic heart disease; L, lifetime; LE, life expectancy; LS, limited societal; LY, life-year; LYG, life-years gained; MI, myocardial infarction; mil, million; MSLT, proportional Markov multistate life table; NHS, National Health Service; NMB, net monetary benefit; OopC, out-of-pocket cost; PC, productivity cost; persp., perspective; PLC, patient-level cost; P-PCC, public-private collaboration cost; priv, private sector; pub, public sector; PY, person-years; QALY, quality-adjusted life-year; S, societal; S-A, structural-agentic; SH, stakeholders; SNAP, Supplemental Nutritional Assistance Program; SSB, sugar-sweetened beverage; Str, structural; TC, time cost; TFA, *trans* fatty acid; TR, tax revenue; VD, validation information; WTP, willingness-to-pay.

[2] Extent of equity analysis: Yes, formal equity analysis; No, no equity analysis; (Y), only health outcomes stratification.

[3] Only qualitative equity analysis.

[4] Subgroups are analyzed and reported but equity implications are only mentioned in the Discussion section.

components of an economic evaluation depending on the relevant stakeholders and payers.

Due to inconsistencies in reporting and definitions, we re-defined the costing perspective for each study according to the following hierarchy. Studies including only health sector costs were assigned a "health sector" perspective. Studies additionally including public sector policy implementation costs were assigned an "extended health sector" perspective. Studies further including private sector policy implementation costs were assigned a "limited societal" perspective, and finally, studies also including productivity costs were assigned a (full) "societal" perspective. All costing perspectives include the cost components of the respective less-extensive perspective.

To be consistent, we defined savings as negative costs, reported net costs where possible, and did not report the numerical value of negative incremental cost-effectiveness ratios (ICERs). The ICER is a measure combining incremental health gains with incremental costs [e.g., additional cost per quality-adjusted life-year (QALY) gained] that has no meaningful interpretation below zero (79).

We also classified policies according to NOURISHING, a framework from the World Cancer Research Fund providing global-level recommendations for dietary policy, and categorized them based on a definition from McLaren et al. (80) according to which population-based policies can fall on a continuum from agency (referring to individual ability to make the choice to act) to structure (referring to institutions and norms that shape individual behavior).

Finally, we indicated whether validation information was available for studies, which was defined as information about any type of conceptual, computer implementation, or internal or external operational validation procedure, as defined by the Assessment of the Validation Status of Health-Economic decision models tool (81).

Critical appraisal

We deviated from our protocol and—although not considered essential for scoping reviews—undertook a quality appraisal of the included modeling studies. We extended the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist for the adequate reporting of economic evaluations (82) based on recent recommendations made by the Second Panel on Cost-Effectiveness in Health and Medicine (83) and a checklist developed for the quality assessment of nutrition simulation models (84). The revised checklist contains a total of 31 items that were rated as fulfilled, partially fulfilled, or not fulfilled (**Supplemental Methods 4**).

Synthesis

Results were synthesized in narrative, tabular, and graphical mapping formats. We summarized studies according to publication year, country, quality, model types, modeled risk factor–outcome pathways, model validation information and uncertainty, reported health, cost and cost-effectiveness outcomes, and limitations reported by authors. We summarized model applications according to policy types and nutritional targets.

To visualize the results of the mapping, we used circos (**Figure 2**), alluvial (**Figure 3**), and bar (**Figures 4** and **5**) plots. Circos plots enable the visual representation of conditional frequencies of variables. In our case, the application frequency of nutritional targets can be analyzed conditional on policy and model type. Alluvial plots follow a similar rationale and are chosen here to intuitively visualize the frequency with which risk factor to outcome pathways have been modeled.

Results

A description of the included modeling studies and model applications in the first stage is given in Table 1. Additional information is available in Supplemental Tables 1 and 2.

Flow diagram

We identified 9171 records, of which 6845 remained after de-duplication. Of 6845 titles and abstracts screened, 131 articles were assessed, and 54 subsequently deemed eligible. Finally, through backward and forward citation searching, 22 additional articles were identified of which 2 were eligible and 20 classified as supporting documents (Figure 1). In total, we included 56 modeling studies performing an economic evaluation of dietary policies, which contained 136 model applications after disaggregation.

General information

Of the 56 modeling studies included in the first stage, 88% were published after 2010, with a clustering of studies after 2015 and 15 studies published very recently in 2019 (**Supplemental Figure 1**).

Fourteen studies modeled dietary policy in Australia (30, 33–36, 38, 39, 42, 43, 46, 59, 65, 72, 73); 14 in the United States (15, 16, 28, 31, 45, 48–50, 55, 56, 61, 71, 74, 77); 6 in England (14, 26, 27, 37, 40, 47); 4 each in South Africa (14, 51, 52, 68), New Zealand (32, 57, 58, 78), and Mexico (14, 29, 66, 67); 3 in Argentina (62–64); 2 each in Syria (54, 76) and China (14, 75); and a single study each in Vietnam (41), Turkey (54), Tunisia (54), Russia (14), the Netherlands (44), the Philippines (69), Palestine (54), India (14), Germany (70), the European Union (53), England and Wales combined (60), and Brazil (14). Two of the US studies were from single states, one from Maine (50) and one from California (55). One study from Argentina involved only the city of Buenos Aires (62).

Quality appraisal

Approximately half of the studies (29/56) fulfilled 90% or more of all quality criteria on our checklist at least partially. Across all studies, model validation (item 22), transparency reporting (item 23), and characterization of heterogeneity (item 27) were the least reported items. Beyond these, the primary reasons some studies achieved less than the aforementioned threshold were an incomplete description of the event pathway (item 18), not defining the software

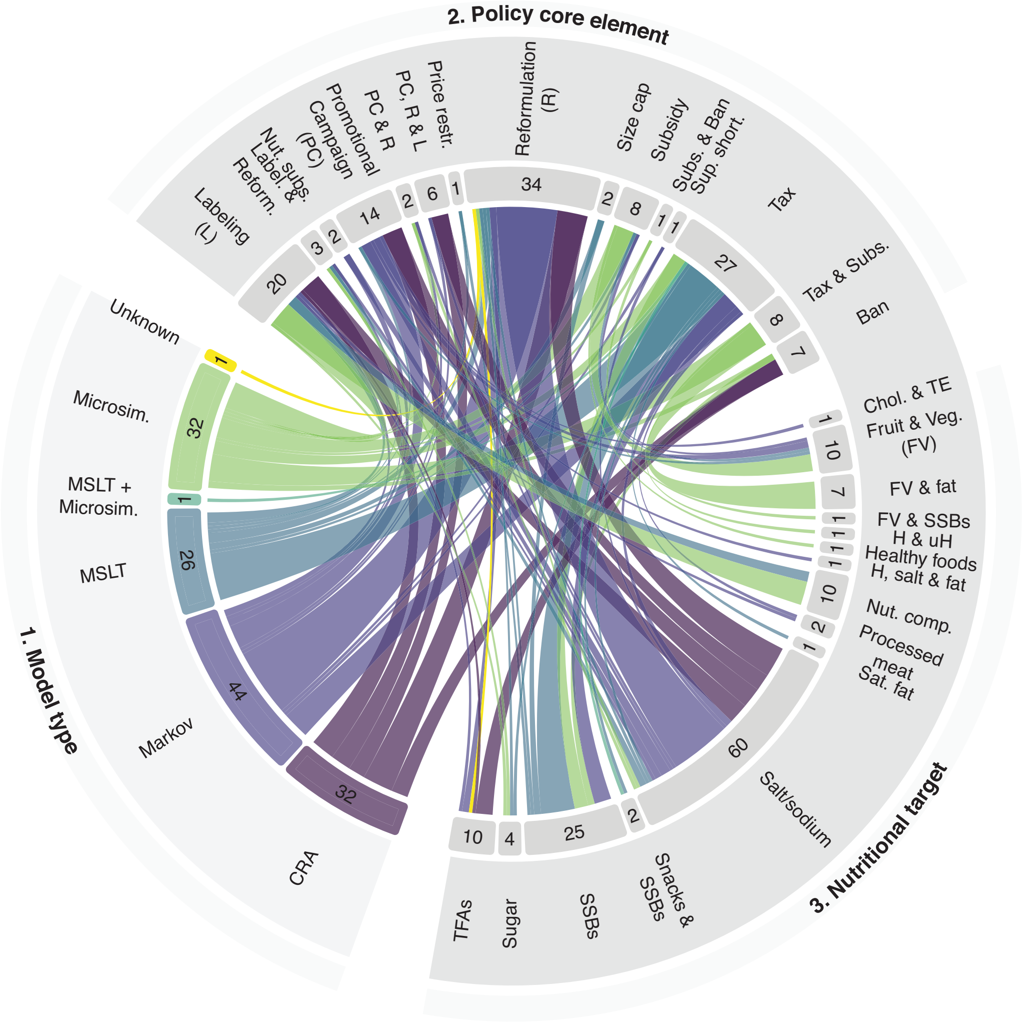

FIGURE 2 Circos plot of model application frequency by model type, policy core element, and nutritional target. $n = 136$ applications from 56 modeling studies. Color represents model type. First (outermost) circle: variable name; second circle: variable level; third circle: application frequency. Chol, cholesterol; CRA, comparative risk assessment; FV, fruit and vegetables; H, healthy foods; L, labeling; Microsim, microsimulation; MSLT, proportional Markov multistate life table; Nut comp, overall nutrient composition; Nut subs, Nutrient substitution; PC, promotional campaign; Price restr, price restriction; R, reformulation; Sat fat, saturated fat; SSB, sugar-sweetened beverage; Subs, subsidy; Sup short, supply shortage; TE, total energy intake; TFA, *trans* fatty acid; uH, unhealthy foods.

used to implement the model (item 19), nondisclosure of conflicts of interest (item 31), and not identifying the study as an economic evaluation in the title (item 1) (**Supplemental Table 3**).

Dietary policies

Across all 136 model applications, at the most granular level, 78 unique policies (e.g., cancer risk labeling of processed meats, "2 fruit 5 veg every day" campaign) were evaluated. We clustered these (post hoc) into 15 broader policy types based on core policy mechanisms (Table 1 and Figure 2), comprising the following concepts and their combinations: reformulation ($n = 33$ applications); tax ($n = 27$); labeling ($n = 20$); promotion campaign ($n = 14$); subsidy (including incentive policies) ($n = 8$); tax and subsidy ($n = 8$); total ban ($n = 7$); promotion campaign, labeling, and reformulation ($n = 6$); labeling and reformulation ($n = 3$); promotion campaign and reformulation ($n = 2$); nutrient substitution ($n = 2$); size cap ($n = 2$); promotion restriction ($n = 1$); subsidy and total ban ($n = 1$); and supply shortage ($n = 1$).

Nutritional targets

Overall, 29 unique nutrients, food groups, or their combinations were targeted by policies. We broke these down into 15 core nutritional categories, which reflect key policy targets analyzed in the included studies. By this means, we reduced the number of categories but still ensured that similar nutrients or food groups addressed using distinct types of

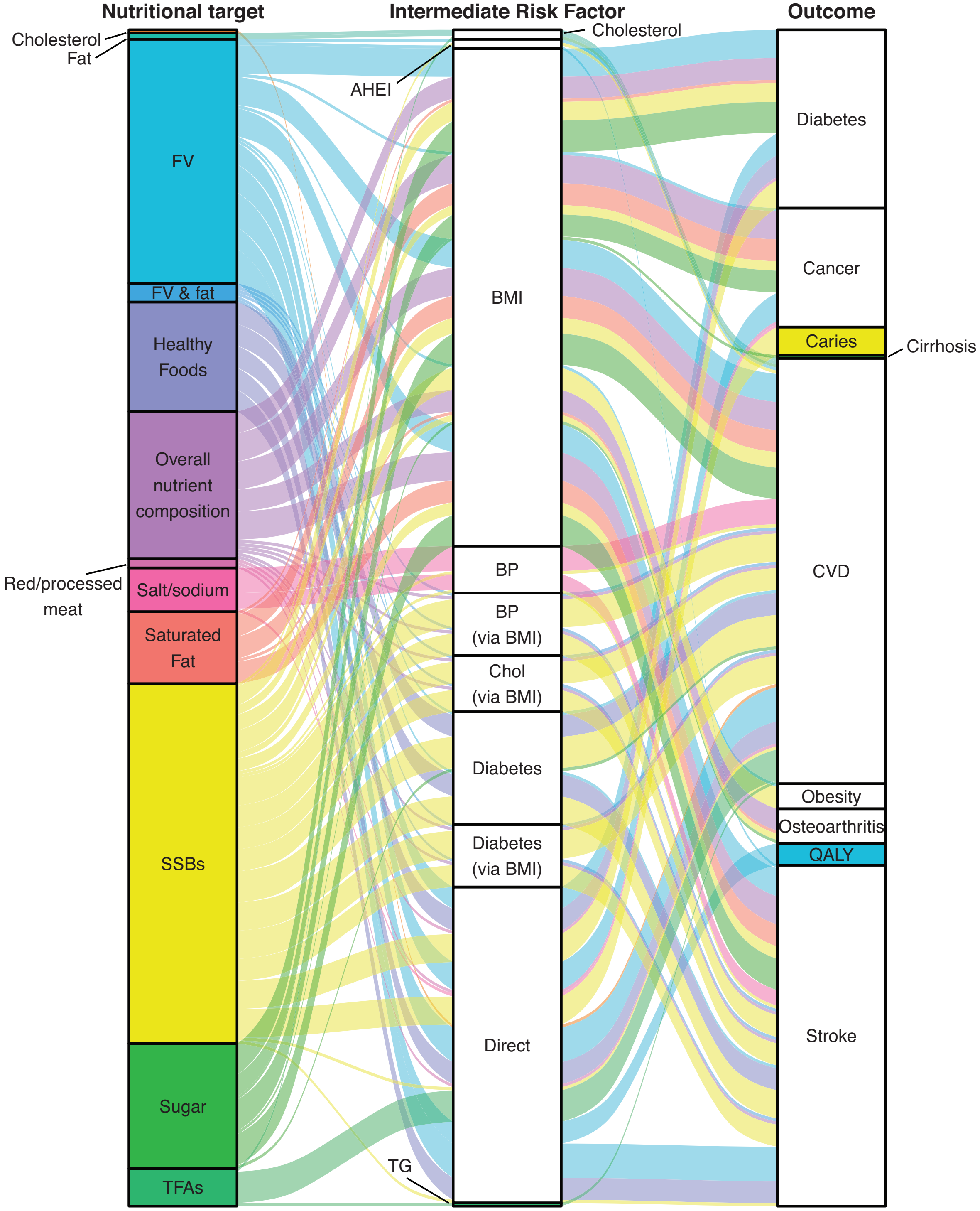

FIGURE 3 Alluvial plot of implemented diet, risk factor, and outcome pathways across all studies. Reading from left to right. Based on 56 modeling studies. The number of modeled pathways per study varies. Vertical axis (number of pathways) not shown. Color coding of outcomes shows exclusive pathways. AHEI, Alternative Healthy Eating Index; BP, blood pressure; Chol, cholesterol; CVD, cardiovascular disease; FV, fruit and vegetables; QALY, quality-adjusted life-year; SSB, sugar-sweetened beverage; TFA, *trans* fatty acid; TG, triglycerides.

policies were separated. These categories were (combinations are disaggregated): salt/sodium ($n = 61$ applications), sugar-sweetened beverages (SSBs) ($n = 31$), fruit and vegetables ($n = 15$), TFAs ($n = 10$), overall nutrient composition ($n = 10$), fat ($n = 8$), sugar ($n = 4$), healthy foods ($n = 3$), processed meat ($n = 2$), snacks and sweets ($n = 2$), saturated fat ($n = 1$), cholesterol ($n = 1$), unhealthy foods ($n = 1$), and energy intake ($n = 1$) (Figure 2).

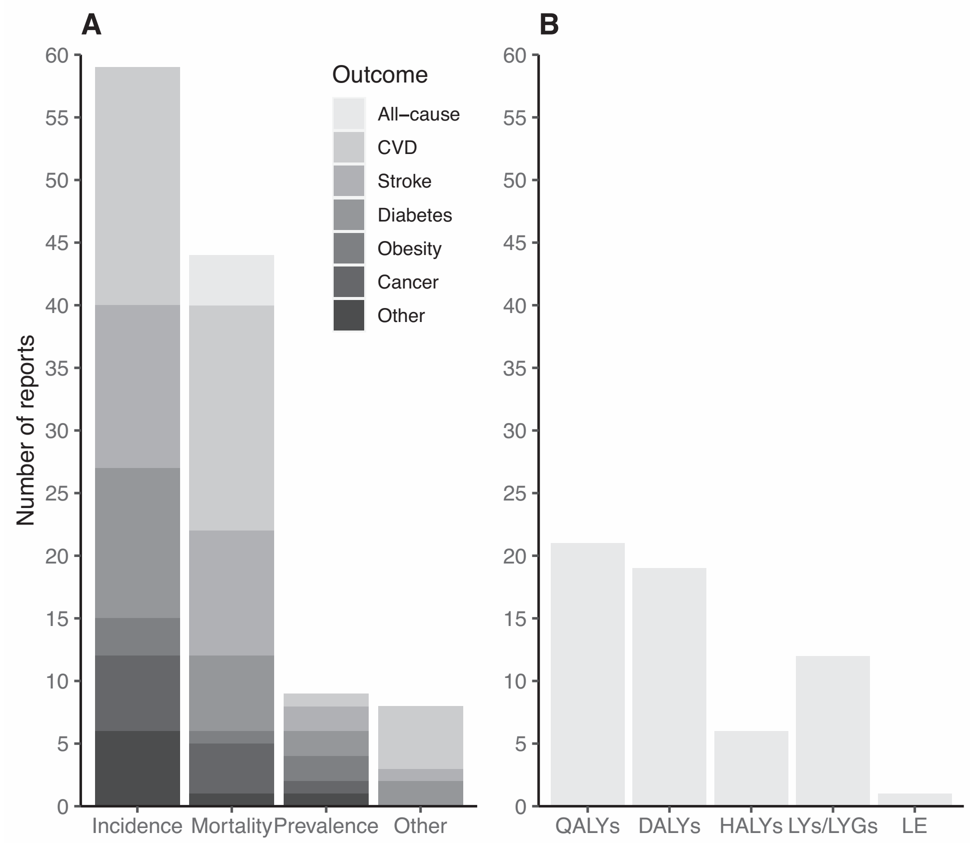

FIGURE 4 Bar plot of number of studies reporting different types of population health metrics by outcome category. (A) Frequency of reported epidemiological metrics by metric type and outcome based on 56 modeling studies. A single study may report multiple incidence, prevalence, or mortality values. (B) Frequency of reported types of adjusted or unadjusted life-year–based metrics based on 56 modeling studies. CVD, cardiovascular disease; DALY, disability-adjusted life-year; HALY, health-adjusted life-year; LE, life expectancy; LY, life-year; LYG, life-year gained; QALY, quality-adjusted life-year.

Few model applications (23/136) evaluated policies that were specifically restricted to subgroups such as sodium in breads, processed meats, and sauces [e.g., Nghiem et al. (57)].

When analyzing the combination of policy types and nutritional targets, some patterns emerged. First, economic evaluations of policies aiming to reduce SSB intake mainly focused on taxes (Figure 2). Very few evaluated other SSB policy types such as serving-size caps. Second, economic evaluations of salt/sodium and TFA policies focused almost exclusively on 2 types of strategies: structural policies such as reformulation or total bans and predominantly agentic policies such as labeling (Figure 2). Third, the evaluated policies that addressed an insufficient intake of fruit and vegetables were either promotional campaigns or subsidy policies, sometimes combined with a tax on other unhealthy nutrients and food groups (Figure 2 and Table 1).

Model types

We identified 4 major types of simulation models used for the economic evaluation of population-based policies addressing these nutritional targets (Table 1). Markov cohort models combined with a proportional multistate life table were the most popular approach used in 18 studies. Seventeen studies used standard Markov cohort models, 11 studies applied microsimulation, and 7 studies used CRA methods. In addition, 1 study used results from a Markov multistate life table approach as inputs for a microsimulation. For 1 study, the model type was unknown.

Figure 2 visualizes patterns of model type, policies, and nutritional targets. Starting at the bottom left and following the respective color code of each model type, the circos plot displays the application frequency with which, for example, Markov models (blue-gray) have been used to evaluate taxes (upper right side), which addressed SSBs (bottom).

CRA (purple) and Markov cohort models (blue-gray) have mainly been used to evaluate salt/sodium or TFAs using reformulation, labeling, or promotional campaign policies, including their combinations. Markov multistate life table models (turquoise) were primarily used for SSB taxes and reformulation strategies. Microsimulations (green) were regularly applied to more complex policies (e.g., tax and

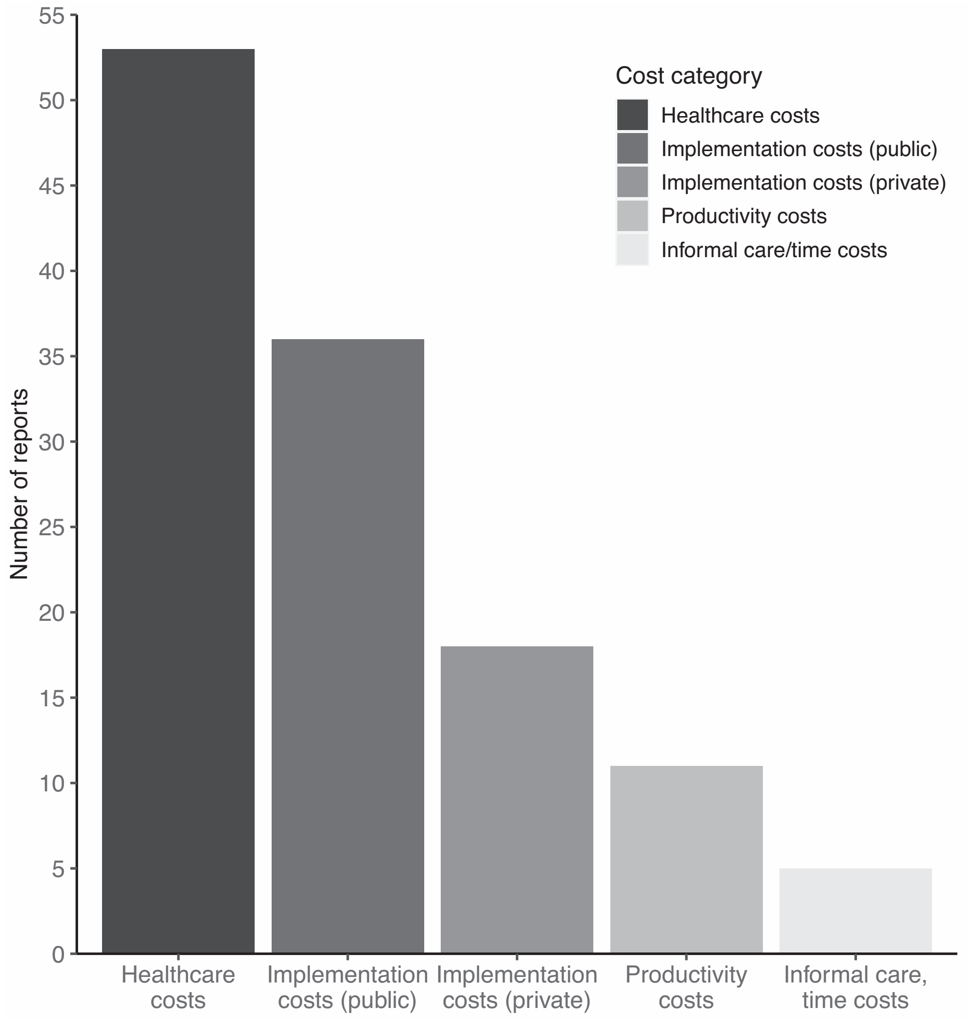

FIGURE 5 Bar plot of number of studies assessing different cost categories. Reported and included cost categories based on 56 modeling studies. Categories are aggregated from subcategories in Table 1.

subsidy) that targeted more diverse food groups (e.g., healthy and unhealthy foods).

Model risk factors and health outcomes

The range of implementations across all model types and modeling studies covered the main diet-related cardiometabolic outcomes, cancer, osteoarthritis, cirrhosis of the liver, and dental caries. Sorted by frequency, the health outcomes modeled most often were CVD [e.g., angina, heart failure, coronary heart disease (CHD)] ($n = 46$ studies), stroke ($n = 37$), type 2 diabetes ($n = 24$), different cancers (e.g., endometrial cancer, colon cancer) ($n = 17$), osteoarthritis ($n = 10$), obesity ($n = 4$), dental caries ($n = 3$), and cirrhosis of the liver ($n = 1$) (Supplemental Table 1).

The mean number of health outcomes included in a given modeling study varied widely depending on model type: Markov multistate life table models incorporated, on average, 4.8 health outcomes; microsimulations, 2.9; standard Markov models, 2.3; and CRA models, 1.6. Two studies modeled only a single health outcome, although evaluating policies with extensive health effects, thus potentially underestimating cost-effectiveness (51, 52).

Few studies (11/56) modeled only the direct relation between nutritional targets and health outcomes (e.g., TFA intake → CHD). Beyond direct pathways, 7 intermediate risk factors (e.g., salt/sodium intake → blood pressure → CHD) were included in modeling studies: BMI ($n = 30$ studies), blood pressure ($n = 26$), cholesterol (i.e., HDL, LDL, or total cholesterol) ($n = 14$), smoking behavior ($n = 12$), type 2 diabetes (risk factor for CVD) ($n = 11$), the Alternative Healthy Eating Index ($n = 1$), and triglycerides ($n = 1$).

Figure 3 shows how often nutritional target → risk factor → outcome pathways were explicitly considered in the studies included in this review. This means, for example, that, although 26 of 56 studies included blood pressure as a risk factor, blood pressure presents a small share of all pathways modeled because it is mainly relevant for salt/sodium and CVD or stroke. BMI, on the other hand, is not only often included as a risk factor in dietary policy evaluations but also serves as the main intermediate risk factor for many nutrition–health outcome pathways in these studies.

Model validation and uncertainty

Validation information was reported in less than half (19/56) of the modeling studies. The remainder only referred to other studies for methodological documentation without justifying the deduced validity of the respective model or did not report on this aspect. Although most studies included a paragraph briefly describing modeling methods, comprehensive supplementary material transparently presenting the model structure and underlying equations was often lacking (Supplemental Table 3).

Uncertainty in outcomes was assessed in all but 1 study (66). Most (36/56) studies addressed parameter uncertainty (second-order uncertainty) (13) using probabilistic sensitivity analysis with sampling from parameter distributions (i.e., Monte Carlo sampling). Deterministic sensitivity analysis with variation of parameters across predefined ranges was performed in 8 studies. All 11 microsimulation models assessed overall uncertainty of estimates by incorporating individual-level stochastic uncertainty (first-order uncertainty) and parameter uncertainty (second-order uncertainty) simultaneously (Supplemental Table 1).

Population health measures and equity

Reported population health measures were categorized into epidemiological metrics (i.e., incidence, prevalence, and mortality), health-adjusted or unadjusted life-years [i.e., QALYs, DALYs, health-adjusted life-years (HALYs), life-years (LYs), and life-years gained (LYG)], and life expectancy and other measures (i.e., person-years, total cases, health care utilization). Incidence and mortality were the most commonly reported metrics (59 and 44 reports, respectively) (Figure 4A and Table 1). QALYs were reported in 21 of 56 studies, and 19 of 56 studies reported DALYs. Six and 12 of 56 studies reported HALYs and LYs or LYG, respectively. A single study estimated a change in life expectancy (Figure 4B and Table 1).

Only a few studies (13/56) conducted a quantitative equity analysis and assessed the potentially heterogeneous impact of dietary policies on health and economic outcomes according to age (32, 57, 58, 60, 61, 70, 78), sex (32, 57, 58, 61, 70, 78), ethnicity (32, 57, 58, 61, 78), area-based deprivation (26, 46, 47, 60), or income (55, 68–70). One study qualitatively examined the equity aspects of an SSB tax (49) (Table 1).

Beyond these, some studies (22/56) reported health or cost outcomes stratified by sociodemographic variables without specifically aiming to analyze the impact on health inequalities, from which equity considerations may nonetheless be derived (Table 1).

Cost components and evaluation perspective

Almost all studies (52/56) included formal health sector costs in their economic analysis, although not all these studies included disease cost offsets (i.e., potential future treatment cost savings) (Figure 5 and Table 1). Informal health sector costs (i.e., informal care and time costs) were only included in 3 studies.

Regarding costs outside the health sector, implementation costs (e.g., legislation) in the public sector were considered by 35 studies, whereas 18 studies included implementation costs in the private sector (e.g., product reformulation, package design).

Only 11 studies included costs resulting from lost productivity (e.g., unemployment, absenteeism, presenteeism) (Table 1), of which the majority (9/11) used a partial or full human capital [lost productivity is calculated based on all potential earnings lost due to illness (employee perspective)] as opposed to a friction costing approach [lost productivity is calculated based on potential earnings lost during a friction period until replacement by another employee (employer perspective)].

After redefining costing perspectives, we found that 17 studies used an extended health sector perspective, 12 studies a societal perspective, 10 studies used a limited societal perspective, 9 studies used a health sector perspective, 4 studies applied the generalized cost-effectiveness analysis (GCEA) framework from the WHO (85), and 2 studies evaluated costs from a government perspective. For 10 studies the choice of perspective was not reported and derived by the author team based on the included cost categories (health sector: $n = 3$; limited societal: $n = 5$; societal: $n = 1$; UK National Health Service: $n = 1$). A comparison between multiple costing perspectives was only performed by 6 studies (Table 1).

Population health measures in relation to cost

Of 56 studies, 32 reported an ICER, and 3 additionally reported the net monetary benefit of policies (Table 1). The net monetary benefit combines the ICER with the willingness of a society to pay for a certain gain in health utility, thus placing a monetary value on health, and enables direct national comparisons across diseases and policies. One caveat is that some authors might have chosen not to report ICERs because the evaluated policy was cost-saving, making interpretation infeasible (79).

As we did not adjust reported cost values for purchasing power parity, we were not able to directly compare cost-effectiveness, cost-utility, or cost-benefit between policies and countries. Instead, we indicated whether studies considered the policy under evaluation to be cost-saving.

Independent of the perspective chosen, a majority of applications (103/136) considered the dietary policy under evaluation to be cost-saving (Table 1). For 3 model applications, a comparison of costing perspectives led to the policy being cost-saving from the more extensive perspective (45, 56).

Limitations reported by authors

We used limitations reported by the authors of the included modeling studies to synthesize considerations for

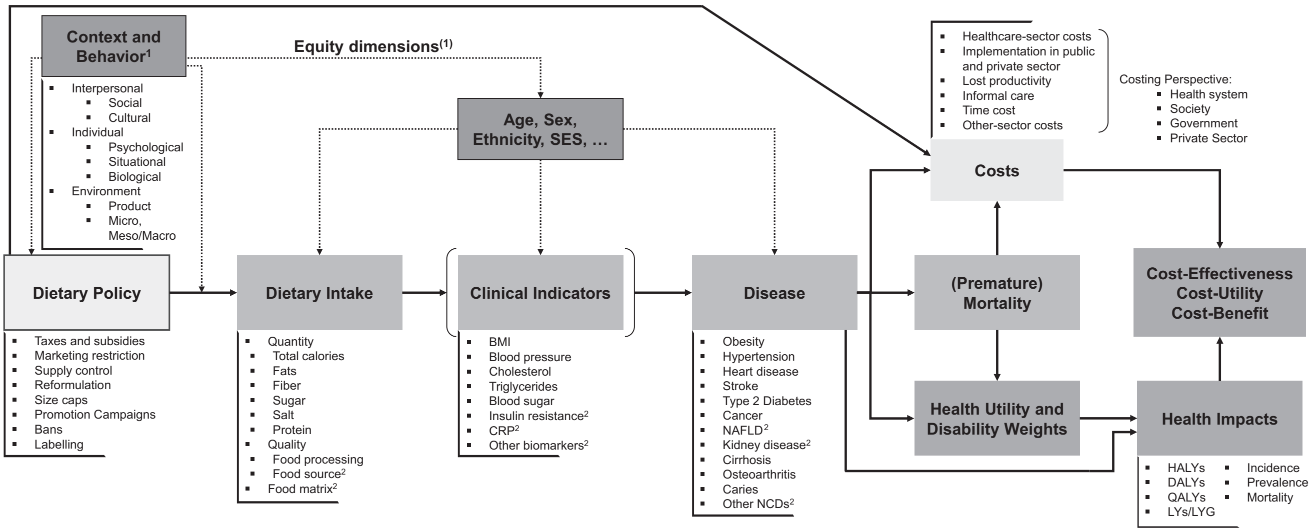

FIGURE 6 Logic model of the prototypical operationalization of economic dietary policy evaluations including context factors and equity dimensions. All elements deduced from the included modeling studies unless indicated otherwise. [1]Contextual and behavioral factors and some potential equity dimensions based on Symmank et al. (86). [2]Based on Mozaffarian et al. (87). CRP, C-reactive protein; DALY, disability-adjusted life-year; HALY, health-adjusted life-year; LY, life-year; LYG, life-year gained; NAFLD, nonalcoholic fatty liver disease; NCD, noncommunicable disease; QALY, quality-adjusted life-year; SES, socioeconomic status.

dietary policy evaluations that use public health economic simulation models. The following 6 major themes were identified (see Table 1 for details per study): *1*) validity and uncertainty of effect estimates (e.g., relative risk of disease per 5 g nuts and seeds intake/d) from observational studies, which might lead to overestimation of health gains due to false positives; *2*) nonconstant intervention effectiveness and limited long-term real-world impact through unpredictable behavioral changes and secular trends; *3*) information biases in underlying epidemiological population data, which may distort conclusions (e.g., underreporting of food intake); *4*) disregard of lost productivity and potential tax revenue re-investment (i.e., earmarking), which leads to underestimation of health and economic impacts; *5*) disregard of equity dimensions of policies; and *6*) lacking assessment of structural model uncertainty.

Discussion

Main findings

In this systematic scoping review, we mapped economic evaluations of population-based dietary policies using public health economic simulation models. We identified a large body of literature with 56 modeling studies consisting of 136 applications covering 21 different countries or regions. The policies under evaluation addressed a wide variety of population-based approaches to diet-related NCD prevention with different levels of granularity. Various types of public health economic simulation models such as Markov cohort models and individual-level microsimulation were applied with distinct patterns emerging (Figure 2). Overall, the most important NCDs and risk factors with dietary relevance were covered, albeit only 1 study included a summary measure of diet quality (i.e., the Alternative Healthy Eating Index) as an intermediate risk factor (Figure 3). Uncertainty was assessed in most studies, but only a few documented internal or external validation procedures. Our analysis of authors' limitations identified substantial challenges, particularly regarding validity of effect estimates and long-term dietary policy effects.

A logic model of economic evaluations in dietary policy

Based on our mapping process, we developed a logic model that describes how dietary policy evaluation is operationalized in public health economic simulation models (**Figure 6**). It visualizes the implicitly causal structure that studies assume to model dietary policy impacts.

We enhanced the logic model with aspects discussed in the literature on dietary behavior and policy evaluation that were not covered by the included studies. For this, we used the results of a systematic interdisciplinary mapping on the determinants of food behavior from the Knowledge Hub on the DEterminants of DIet and Physical Activity and a recent review of dietary policy as guidance (86, 87). We aimed to highlight factors that go beyond what was modeled in the reviewed studies.

The logic model provides a visual reference throughout the next sections to help discuss our results compared with a prototypical model. It thereby provides a connection to broader implications of dietary policy evaluation.

Population-based dietary policies and nutritional targets

In this review, 4 major policy types were covered with different mechanisms to improve population diets and economic aspects of implementation:

First, population education policies such as health-promotion campaigns that aim to educate individuals to change their behavior but can be very costly to maintain on a larger scale (88).

Second, policies modifying point-of-purchase information such as nutrient-specific labels, which seek to passively increase public awareness of healthy dietary choices and rely more on structural elements of consumer choice. The implementation of voluntary or mandatory labels can be politically challenging, with the majority of implementation costs typically borne by the private sector (89).

Third, reformulation policies, which set quality standards for food processing and limit additives such as sugar, salt, and TFAs. Such policies can be more effective than consumer information with minimal public and private sector costs once they are established (88).

Finally, fiscal policies including taxes, subsidies, and other financial incentives, which rely on individual sensitivity to price changes and generate revenue that can be earmarked for other health policies (90).

Although a large variation in food groups and nutrients relevant to NCD prevention was evaluated in this review, 71 of 136 applications evaluated reformulation or fiscal policies in relation to salt/sodium or SSBs (Table 1 and Figure 2). While these are responsible for a large share of the burden of NCDs, the corresponding etiologic pathways are well established, and many countries consider or have already implemented such policies, they represent only part of the broader picture on population-based dietary policy (91) (Figure 6).

From a nutritional point of view, this represents a degree of undercomplexity in the structure of public health economic simulation models considering newer findings on the relevance of the overall nutrient composition of foods, interaction of those nutrients, and dietary quality beyond macronutrients (87) (Figure 6). Only 1 study in this review (16) uses a summary measure of diet quality (i.e., the Alternative Healthy Eating Index) as a risk factor, and 2 studies evaluate policies targeting a distinct set of healthy and unhealthy foods as defined by recent evidence (48, 56) (Table 1).

Similarly, only 14 policy applications focus on foods that were processed in some form (Table 1). Although the evidence of the direct effect of food processing on human health is not fully understood, ultra-processed foods typically have high energy density and contain high amounts of unhealthy fats, sugars, and sodium (92–94). Policies addressing food processing and processed-food consumption may play an important role in NCD prevention (95) and should be supported by economic evaluations to assess their compatibility with other strategies (Figure 6). A caveat is that studies evaluating dietary policy in children (which were excluded in this review) are likely to focus on more processed foods (96).

From a policy perspective, there is a scarcity of evaluations of multicomponent policies combining structural and agentic elements, the cost-effectiveness of which is of great relevance for effective large-scale NCD prevention (10, 88, 97). Yet, only 11 of 136 applications evaluated such combinations of policies. A comprehensive strategy could, for example, use different taxes, subsidies, and accompanying information campaigns together with advertisement restrictions (87, 88).

Only a few studies included in this review evaluated dietary policies in low- and middle-income countries [as defined by the Development Assistance Committee of the Organization for Economic Co-operation and Development (98)]. Although likely the result of our search strategy restriction to articles published in English, this might be also related to the high data requirements and resources needed to conduct economic evaluations of dietary policies using simulation modeling (14). This is important as obesity rates and the double burden of malnutrition are rising across the globe, increasing the need for evidence of cost-effective preventive policy options in all settings (99).

Key economic aspects for the evaluation of population-based dietary policies

Adherence to guidelines for health economic evaluation regarding the definition of costing perspectives and inclusion of cost categories was inconsistent across the reviewed studies. Because costing perspective is a key information for decision makers, consequent adherence to research and reporting standards including a discussion of deviations from them is important (82).

In the economic evaluation of population-based policies for the prevention of NCDs, costs beyond the health care sector (i.e., beyond future treatment savings) make up a substantial share of total costs and should be considered (100, 101). Yet, only a few studies include consequences for labor market outcomes or workplace productivity (e.g., early retirement, absenteeism, presenteeism).

Studies that compare different costing perspectives [e.g., Kim et al. (45)] show that the adoption of a societal perspective can substantially increase projected net savings from dietary policies (Table 1). One caveat to this is that lost productivity can be calculated in 2 ways, human capital versus friction cost, yielding different results, the respective superiority of which is a subject of ongoing debate in health economics.

The choice of a health sector perspective itself—and thus the exclusion of costs from lost productivity—does not constitute a limitation from a health economics viewpoint.

But, because of the population-based character and corresponding large-scale impact of many dietary policies, a societal perspective seems most appropriate, and comparison of multiple perspectives is recommended (25). Because inertia in knowledge exchange between policy sectors often leads to an underestimation of the economic benefits of health-promotion efforts, quantifying costs beyond the health care sector is crucial for dietary policy implementation (102) (Figure 6).

The 2 most important cost categories accruing during the implementation of population-based dietary policies are private and public sector policy costs. These are distinct from intervention costs in community or clinical settings.

Private sector costs are mainly relevant for policies where businesses must adjust production procedures, recipes, or package design, such as reformulation and packaging regulations (including labeling). Valid estimation of private sector implementation costs is complicated by conflicts of interest and nondisclosure on the part of the food industry. Although some studies use government tools to approximate private sector costs (15, 61), most evaluations do not consider them or use very rough calculations linked to public sector implementation costs (e.g., setting them equal).

Depending on the type of policy, public sector implementation costs are the only cost driver of population-based policy and thus should be considered carefully. Yet, implementation costs of, for example, a tax, although implicitly appraisable by assuming hypothetical legislation costs, can only be calculated very roughly.

Public health economic simulation model types and dietary policy evaluation

Types of public health economic simulation models in this review cover a wide range of cohort- and individual-level approaches from generic single-use Markov models [e.g., Dalziel and Segal (39)] to established and continuously developed microsimulation models [e.g., Huang et al. (15)]. Although there is no one-size-fits-all solution, relatively simple approaches, such as CRAs, may give similar results, compared with, for example, a complex microsimulation, for a given policy evaluation depending on the granularity of the policy itself (12). Comparative modeling studies can support the assessment of this structural uncertainty and strengthen the trust for model-based evidence (see "Transparency and open science in dietary policy evaluation" below). However, for the modeling of very specific dietary policies, which, for example, target subfood groups or rely on mechanisms that require time- and event-dependent interaction (e.g., substitution), individual-level models are generally more suitable. Additionally, the availability of data and requirements for the timely, transparent communication of results with stakeholders all influence the choice of model type beyond purely methodological considerations (103).

An important observation is that, in recent years, there has been a tendency toward increased model complexity with the detailed simulation of individual risk factor and disease trajectories accounting for diverse socioeconomic features. The primary reason for this may be increasing availability of computational resources and granular input data required to conduct such sophisticated simulations.

We did not identify studies using model types that enable individual environment interaction (e.g., agent-based simulation) or resource constraints (e.g., system dynamics models). For some dietary policies, agent-based models might be preferred, as they allow the integration of a more valid representation of consumer environment behavior, thus producing important insights into policy impacts (12). Although increasingly sophisticated simulation models require even more granular input data and very specific, but nonetheless valid, parameters, these methods could be better suited for the evaluation of some policy types.

Validity considerations for dietary policy evaluation

Apart from the choice of model type, key considerations for dietary policy modeling are, first, the quality of dietary data, and second, the reliance on effect estimates from observational studies.

Individual dietary data on the consumption of foods and intake of nutrients within a predefined time period are one of the most important inputs for the reviewed models. However, reliable and valid collection of these data, which are typically collected using food-frequency questionnaires, 24-h dietary recalls, food diaries, or food-purchasing information is complicated and susceptible to information biases such as social desirability bias (104). In the case of purchasing data, food waste may need to be considered (105, 106). Although considerable efforts are made to mitigate these biases and intake data can be adjusted for (e.g., underreporting), this remains an important limitation (107).

Further, nonrandomized studies can produce biased results, especially in the field of nutritional epidemiology (108) and thus have to be interpreted with caution. Although some pathways, as discussed above, can be seen as causal, a better understanding of the health effects of dietary patterns and overall diet quality is needed (87). On the other hand, randomized controlled trials of dietary interventions have particular challenges, sometimes resulting in questionable external validity for real-world policy (109).

A central limitation with all modeling studies in this review remains (long-term) external validity, which is usually performed by comparing model projections with observed data that were not part of the model fitting process (110). As most of the dietary policies evaluated are not actually implemented, outcomes are projected far into the future, and factors beyond dietary policy influence disease incidence, statements about substantial health gains need to be interpreted with caution. Therefore, future studies need to quantify the health and economic effects that are attributable to implemented dietary policies once sufficient time has passed for the corresponding health outcomes to potentially be prevented (111).

Translation from experimental evidence of potential policy mechanisms to real-world policy impacts is not always easy to establish. For many types of dietary policies, these mechanisms, such as consumer reactions to changes in price, are well researched (112). Yet, policymakers may draw only preliminary conclusions from these studies which, in the absence of alternatives, are also often the foundation for effect estimates used in simulation studies. It is therefore crucial for stakeholders and researchers to evaluate every step of the logic pathway (Figure 6) from policy to health and economic outcomes in a real-world setting.

Early international evidence suggests that some policies indeed work as intended (e.g., taxes on SSBs increase prices and decrease SSB consumption) but a translation to measurable real-world health outcomes is yet to be observed (113–115). Complementary ex post evaluations using econometric causal inference methods such as difference-in-difference or synthetic control approaches on observational data can help improve the evidence base in this regard (116).

One issue particularly compromising long-term validity may be that authors sometimes assume stable long-term effects over unrealistic time horizons (e.g., lifetime of the population) without including rebound effects. For some policies, such as health-promotion campaigns, which might be implemented iteratively, diminishing re-intervention effects need to be considered as well.

Transparency and open science in dietary policy evaluation

To mitigate some of the above-mentioned issues, transparency and adherence to quality standards in the conduct and reporting of studies using public health economic simulation modeling are important. Published models need to be explicit about all their assumptions and limitations pertaining to policy effects, input data, and validation. The provision of comprehensive supplementary material and the public sharing of code on online repositories such as GitHub or the Open Science Framework are key components of this transparency.

Although some frameworks for the quality assessment of simulation models and economic evaluations using such models exist, these are primarily aimed at application in health technology assessment (25, 117).

For this reason, we extended and adapted the established CHEERS checklist for the quality appraisal of economic evaluations as described in the Methods section. Even though this revised checklist is not validated by experts, it can serve as a preliminary baseline to judge and compare the overall quality of economic evaluations of dietary policies using public health economic simulation models. Through the inclusion of key considerations for simulation modeling and dietary policy evaluation such as validation, calibration, and transparency and making explicit the dietary target and policy under consideration, it enables the identification of high-quality studies in this review.

Nonetheless, work toward a consistent set of guidelines specifically for public health economic simulation modeling of NCDs with clear recommendations for relevant behavioral and proximal risk factors, diseases, and health outcomes, including complementing guidelines for economic evaluations, should be considered. For this purpose, the Mt. Hood Diabetes Challenge Network could serve as an example (118). This might imply a considerable effort among the research community but will support authors, peer-reviewers, and decision makers to benchmark the quality of modeling studies, increase comparability, and ultimately strengthen trust in model-based projections by policymakers.

In contrast to other areas, such as infectious diseases or cancer progression modeling, in dietary policy evaluation no comparative modeling studies have been published so far. Such studies compare 2 or more model types (e.g., microsimulation vs. Markov cohort models) or implementations of the same type (e.g., 2 independently developed Markov cohort models with different features) using the same input data to assess differences in outcome projections (119). The influence of effect estimates sourced from various meta-analyses on outcomes could also be compared.

These techniques may give important insights into structural model uncertainty, such as the choice of included risk factors, and foster a more thorough discussion of model assumptions and outcomes. As all "models are wrong, but some are useful" (120), comparing different independently developed models, using different modeling techniques, can increase the credibility of the results in a similar way to meta-analyses (119).

Equity and context in dietary policy evaluation

From an economic perspective, population-based preventive policy can be a means to address an undesirable distribution of social welfare, including health (102).

Socioeconomic factors are important in the economic evaluation of population-based dietary policies because dietary, health, and economic disparities are correlated across population subgroups (Figure 6) (86). Yet, only a few studies recognize the heterogeneous effects of dietary policies on health outcomes across different equity dimensions, although this was identified by some authors as a limitation to their modeling (Table 1).

The mechanism of a policy can moderate differential health effects according to dimensions such as age, gender, race, and income (80). As an example, because low-income groups have a higher baseline consumption of taxed unhealthy products and a higher price elasticity of demand, taxation strategies can be regressive—having a larger impact on those with low incomes—depending on their design (112).

Acknowledging this can not only reduce health disparities through dietary policy by, for example, earmarking part of a tax revenue generated for nutrition programs supporting communities with low dietary literacy, but also lead to more cost-effective dietary policy by reducing the health burden in highly-affected groups (121).

Future studies should use the flexibility of individual-level approaches more often to explicitly model effects across heterogeneous subpopulations and assess to what degree dietary policies increase or decrease health inequalities. This can help with finding the optimal design and combination of policies by comparing health, equity, and cost implications.

Limitations

Our review has some important limitations. First, we post hoc excluded subsets of studies in accordance with our protocol (Figure 1). We also excluded studies evaluating policies addressing children and adolescents, although they are an important target of NCD prevention efforts including dietary policies such as healthy meals and vending machine bans in schools. In line with this decision, we also excluded economic evaluations of dietary policies in specific settings such as primarily addressing individuals in high-risk groups through dietary counseling in primary care and studies only including other subgroups such as indigenous people. Second, the number of epidemiological modeling studies evaluating only the effectiveness of policies is much higher than the number of economic modeling studies, most of which essentially build on the same model types but also include aspects of health-related quality of life and costs. We might therefore have missed some potentially viable model implementations, which could be supplemented with an economic module. Third, we restricted our search to studies published in English, thus potentially overlooking eligible modeling studies published in other languages.

Conclusions

In conclusion, different types of public health economic simulation models exist and are widely applied for evaluations of population-based dietary policies. The reviewed studies address most policy types, nutrients/food groups, risk factors, and health outcomes relevant for diet-related NCD prevention. A substantial number of applications evaluate labeling, reformulation, and taxation policies that target salt/sodium and sugar (including SSBs and snacks/sweets). Few studies estimate lost productivity as part of their economic evaluation, which is key information for stakeholders outside the health sector. In recent years, advanced microsimulations have been used to evaluate more complex policies and nutritional targets, yet only partially incorporating dietary complexity beyond a single-nutrient/food-group focus. These models are also better suited to incorporate population heterogeneity and analyze correlated social, health, economic, and equity impacts, which only a minority of studies examine. The choice of modeling method is dependent on policy type, and extensive data requirements for individual-level models may limit application in some contexts where good dietary and epidemiological data are not available. Lack of knowledge about long-term intervention effects, potential unintended policy consequences on dietary behavior, and secular disease trends represent key limitations of current economic evaluations of population-based dietary policies. There is still considerable uncertainty about real-world health economic policy impacts, and the external validity of public health economic simulation models needs to be carefully assessed based on the available data and future studies. Transparency in model application and dissemination based on open-science guidelines can increase the trust of stakeholders in the results of modeling exercises and ultimately strengthen NCD prevention efforts.

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References

1. Roth GA, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, Abdela J, Abdelalim A, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet North Am Ed 2018;392(10159):1736–88.
2. Kyu HH, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, Abdela J, Abdelalim A, et al. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet North Am Ed 2018;392(10159):1859–922.
3. Bloom DE, Cafiero E, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S, Feigl AB, Gaziano T, Hamandi A, Mowafi M. The global economic burden of noncommunicable diseases. Geneva (Switzerland): World Economic Forum; 2011.
4. Muka T, Imo D, Jaspers L, Colpani V, Chaker L, van der Lee SJ, Mendis S, Chowdhury R, Bramer WM, Falla A, et al. The global impact of non-communicable diseases on healthcare spending and national income: a systematic review. Eur J Epidemiol 2015;30(4):251–77.
5. Ezzati M, Riboli E. Behavioral and dietary risk factors for noncommunicable diseases. N Engl J Med 2013;369(10):954–64.
6. Beaglehole R, Bonita R, Horton R, Adams C, Alleyne G, Asaria P, Baugh V, Bekedam H, Billo N, Casswell S, et al. Priority actions for the non-communicable disease crisis. Lancet North Am Ed 2011;377(9775):1438–47.
7. Nugent R, Bertram MY, Jan S, Niessen LW, Sassi F, Jamison DT, Pier EG, Beaglehole R. Investing in non-communicable disease prevention and management to advance the Sustainable Development Goals. Lancet North Am Ed 2018;391(10134):2029–35.
8. Capewell S, Capewell A. An effectiveness hierarchy of preventive interventions: neglected paradigm or self-evident truth? J Public Health (Oxf) 2018;40(2):350–8.
9. Breeze PR, Thomas C, Squires H, Brennan A, Greaves C, Diggle P, Brunner E, Tabak A, Preston L, Chilcott J. Cost-effectiveness of population-based, community, workplace and individual policies for diabetes prevention in the UK. Diabet Med 2017;34(8):1136–44.
10. Hyseni L, Atkinson M, Bromley H, Orton L, Lloyd-Williams F, McGill R, Capewell S. The effects of policy actions to improve population dietary patterns and prevent diet-related non-communicable diseases: scoping review. Eur J Clin Nutr 2017;71(6):694–711.
11. Hawkes C, Jewell J, Allen K. A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the NOURISHING framework. Obes Rev 2013;14(Suppl 2):159–68.
12. Briggs AD, Wolstenholme J, Blakely T, Scarborough P. Choosing an epidemiological model structure for the economic evaluation of

non-communicable disease public health interventions. Popul Health Metrics 2016;14:17.

13. Briggs AH, Weinstein MC, Fenwick EA, Karnon J, Sculpher MJ, Paltiel AD, ISPOR-SMDM Modeling Good Research Practices Task Force. Model parameter estimation and uncertainty analysis: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force Working Group-6. Med Decis Making 2012;32(5):722–32.
14. Cecchini M, Sassi F, Lauer JA, Lee YY, Guajardo-Barron V, Chisholm D. Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. Lancet 2010;376(9754):1775–84.
15. Huang Y, Kypridemos C, Liu J, Lee Y, Pearson-Stuttard J, Collins B, Bandosz P, Capewell S, Whitsel L, Wilde P, et al. Cost-effectiveness of the US Food and Drug Administration added sugar labeling policy for improving diet and health. Circulation 2019;139(23):2613–24.
16. Basu S, Seligman H, Bhattacharya J. Nutritional policy changes in the supplemental nutrition assistance program: a microsimulation and cost-effectiveness analysis. Med Decis Making 2013;33(7):937–48.
17. Kent S, Becker F, Feenstra T, Tran-Duy A, Schlackow I, Tew M, Zhang P, Ye W, Lizheng S, Herman W, et al. The challenge of transparency and validation in health economic decision modelling: a view from Mount Hood. Pharmacoeconomics. Published online 28 July 2019. doi: 10.1007/s40273-019-00825-1.
18. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MDJ, Horsley T, Weeks L, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. The PRISMA-ScR statement. Ann Intern Med 2018;169(7):467–73.
19. Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc 2015;13(3):141–6.
20. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci 2010;5(1):69.
21. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol 2005;8(1):19–32.
22. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. 4th ed. Oxford (UK): Oxford University Press; 2015.
23. Mazarello Paes V, Ong KK, Lakshman R. Factors influencing obesogenic dietary intake in young children (0-6 years): systematic review of qualitative evidence. BMJ Open 2015;5(9):e007396.
24. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev 2016;5(1):210.
25. Neumann PJ, Ganiats TG, Russell LB, Sanders GD, Siegel JE. Cost-effectiveness in health and medicine. 2nd ed. New York: Oxford University Press; 2016.
26. Allen K, Pearson-Stuttard J, Hooton W, Diggle P, Capewell S, O'Flaherty M. Potential of trans fats policies to reduce socioeconomic inequalities in mortality from coronary heart disease in England: cost effectiveness modelling study. BMJ 2015;351:h4583.
27. Amies-Cull B, Briggs ADM, Scarborough P. Estimating the potential impact of the UK government's sugar reduction programme on child and adult health: modelling study. BMJ 2019;365:l1417.
28. An R. Nationwide expansion of a financial incentive program on fruit and vegetable purchases among Supplemental Nutrition Assistance Program participants: a cost-effectiveness analysis. Soc Sci Med 2015;147:80–8.
29. Basto-Abreu A, Barrientos-Gutierrez T, Vidana-Perez D, Colchero MA, Hernandez FM, Hernandez-Avila M, Ward ZJ, Long MW, Gortmaker SL. Cost-effectiveness of the sugar-sweetened beverage excise tax in Mexico. Health Aff 2019;38(11):1824–31.
30. Carter HE, Schofield DJ, Shrestha R, Veerman L. The productivity gains associated with a junk food tax and their impact on cost-effectiveness. PLoS One 2019;14(7):e0220209.
31. Choi SE, Seligman H, Basu S. Cost effectiveness of subsidizing fruit and vegetable purchases through the Supplemental Nutrition Assistance Program. Am J Prev Med 2017;52(5):e147–e55.
32. Cleghorn C, Blakely T, Mhurchu CN, Wilson N, Neal B, Eyles H. Estimating the health benefits and cost-savings of a cap on the size of single serve sugar-sweetened beverages. Prev Med 2019;120:150–6.
33. Cobiac LJ, Vos T, Veerman JL. Cost-effectiveness of interventions to reduce dietary salt intake. Heart 2010;96(23):1920–5.
34. Cobiac LJ, Vos T, Veerman JL. Cost-effectiveness of interventions to promote fruit and vegetable consumption. PLoS One 2010;5(11):e14148.
35. Cobiac LJ, Magnus A, Lim S, Barendregt JJ, Carter R, Vos T. Which interventions offer best value for money in primary prevention of cardiovascular disease? PLoS One 2012;7(7):e41842.
36. Cobiac LJ, Tam K, Veerman L, Blakely T. Taxes and subsidies for improving diet and population health in Australia: a cost-effectiveness modelling study. PLoS Med 2017;14(2):e1002232.
37. Collins M, Mason H, O'Flaherty M, Guzman-Castillo M, Critchley J, Capewell S. An economic evaluation of salt reduction policies to reduce coronary heart disease in England: a policy modeling study. Value Health 2014;17(5):517–24.
38. Crino M, Herrera AMM, Ananthapavan J, Wu JHY, Neal B, Lee YY, Zheng M, Lal A, Sacks G. Modelled cost-effectiveness of a package size cap and a kilojoule reduction intervention to reduce energy intake from sugar-sweetened beverages in Australia. Nutrients 2017;9(9): 983.
39. Dalziel K, Segal L. Time to give nutrition interventions a higher profile: cost-effectiveness of 10 nutrition interventions. Health Promot Int 2007;22(4):271–83.
40. Dodhia H, Phillips K, Zannou MI, Airoldi M, Bevan G. Modelling the impact on avoidable cardiovascular disease burden and costs of interventions to lower SBP in the England population. J Hypertens 2012;30(1):217–26.
41. Ha DA, Chisholm D. Cost-effectiveness analysis of interventions to prevent cardiovascular disease in Vietnam. Health Policy Plan 2011;26(3):210–22.
42. Mantilla Herrera AM, Crino M, Erskine HE, Sacks G, Ananthapavan J, Mhurchu CN, Lee YY. Cost-effectiveness of product reformulation in response to the Health Star rating food labelling system in Australia. Nutrients 2018;10(5):614.
43. Huse O, Ananthapavan J, Sacks G, Cameron AJ, Zorbas C, Peeters A, Moodie M, Martin J, Backholer K. The potential cost-effectiveness of mandatory restrictions on price promotions for sugar-sweetened beverages in Australia. Int J Obes 2020;44(5): 1011–20.
44. Jevdjevic M, Trescher AL, Rovers M, Listl S. The caries-related cost and effects of a tax on sugar-sweetened beverages. Public Health 2019;169:125–32.
45. Kim DD, Wilde PE, Michaud DS, Liu J, Lizewski L, Onopa J, Mozaffarian D, Zhang FF, Wong JB. Cost effectiveness of nutrition policies on processed meat: implications for cancer burden in the U.S. Am J Prev Med 2019;57(5):e143–52.
46. Lal A, Mantilla-Herrera AM, Veerman L, Backholer K, Sacks G, Moodie M, Siahpush M, Carter R, Peeters A. Modelled health benefits of a sugar-sweetened beverage tax across different socioeconomic groups in Australia: a cost-effectiveness and equity analysis. PLoS Med 2017;14(6):e1002326.
47. Laverty AA, Kypridemos C, Seferidi P, Vamos EP, Pearson-Stuttard J, Collins B, Capewell S, Mwatsama M, Cairney P, Fleming K, et al. Quantifying the impact of the Public Health Responsibility Deal on salt intake, cardiovascular disease and gastric cancer burdens: interrupted time series and microsimulation study. J Epidemiol Community Health 2019;73(9):881–7.
48. Lee Y, Mozaffarian D, Sy S, Huang Y, Liu J, Wilde PE, Abrahams-Gessel S, Jardim TSV, Gaziano TA, Micha R. Cost-effectiveness of financial incentives for improving diet and health through Medicare and Medicaid: a microsimulation study. PLoS Med 2019;16(3):e1002761.
49. Long MW, Gortmaker SL, Ward ZJ, Resch SC, Moodie ML, Sacks G, Swinburn BA, Carter RC, Claire Wang Y. Cost effectiveness of a sugar-sweetened beverage excise tax in the U.S. Am J Prev Med 2015;49(1):112–23.
50. Long MW, Polacsek M, Bruno P, Giles CM, Ward ZJ, Cradock AL, Gortmaker SL. Cost-effectiveness analysis and stakeholder evaluation

of 2 obesity prevention policies in Maine, US. J Nutr Educ Behav 2019;51(10):1177–87.

51. Manyema M, Veerman JL, Chola L, Tugendhaft A, Labadarios D, Hofman K. Decreasing the burden of type 2 diabetes in South Africa: the impact of taxing sugar-sweetened beverages. PLoS One 2015;10(11):e0143050.
52. Manyema M, Veerman LJ, Tugendhaft A, Labadarios D, Hofman KJ. Modelling the potential impact of a sugar-sweetened beverage tax on stroke mortality, costs and health-adjusted life years in South Africa. BMC Public Health 2016;16:405.
53. Martin-Saborido C, Mouratidou T, Livaniou A, Caldeira S, Wollgast J. Public health economic evaluation of different European Union-level policy options aimed at reducing population dietary trans fat intake. Am J Clin Nutr 2016;104(5):1218–26.
54. Mason H, Shoaibi A, Ghandour R, O'Flaherty M, Capewell S, Khatib R, Jabr S, Unal B, Sozmen K, Arfa C, et al. A cost effectiveness analysis of salt reduction policies to reduce coronary heart disease in four Eastern Mediterranean countries. PLoS One 2014;9(1):e84445.
55. Mekonnen TA, Odden MC, Coxson PG, Guzman D, Lightwood J, Wang YC, Bibbins-Domingo K. Health benefits of reducing sugar-sweetened beverage intake in high risk populations of California: results from the cardiovascular disease (CVD) policy model. PLoS One 2013;8(12):e81723.
56. Mozaffarian D, Liu J, Sy S, Huang Y, Rehm C, Lee Y, Wilde P, Abrahams-Gessel S, de Souza Veiga Jardim T, Gaziano T, et al. Cost-effectiveness of financial incentives and disincentives for improving food purchases and health through the US Supplemental Nutrition Assistance Program (SNAP): a microsimulation study. PLoS Med 2018;15(10):e1002661.
57. Nghiem N, Blakely T, Cobiac LJ, Pearson AL, Wilson N. Health and economic impacts of eight different dietary salt reduction interventions. PLoS One 2015;10(4):e0123915.
58. Nghiem N, Blakely T, Cobiac LJ, Cleghorn CL, Wilson N. The health gains and cost savings of dietary salt reduction interventions, with equity and age distributional aspects. BMC Public Health 2016;16:423.
59. Nomaguchi T, Cunich M, Zapata-Diomedi B, Veerman JL. The impact on productivity of a hypothetical tax on sugar-sweetened beverages. Health Policy 2017;121(6):715–25.
60. Pearson-Stuttard J, Hooton W, Critchley J, Capewell S, Collins M, Mason H, Guzman-Castillo M, O'Flaherty M. Cost-effectiveness analysis of eliminating industrial and all trans fats in England and Wales: modelling study. J Public Health (Oxf) 2017;39(3):574–82.
61. Pearson-Stuttard J, Kypridemos C, Collins B, Mozaffarian D, Huang Y, Bandosz P, Capewell S, Whitsel L, Wilde P, O'Flaherty M, et al. Estimating the health and economic effects of the proposed US Food and Drug Administration voluntary sodium reformulation: microsimulation cost-effectiveness analysis. PLoS Med 2018;15(4):e1002551.
62. Rubinstein A, Garcia Marti S, Souto A, Ferrante D, Augustovski F. Generalized cost-effectiveness analysis of a package of interventions to reduce cardiovascular disease in Buenos Aires, Argentina. Cost Eff Resour Alloc 2009;7:10.
63. Rubinstein A, Colantonio L, Bardach A, Caporale J, Martí SG, Kopitowski K, Alcaraz A, Gibbons L, Augustovski F, Pichón-Rivière A. Estimation of the burden of cardiovascular disease attributable to modifiable risk factors and cost-effectiveness analysis of preventative interventions to reduce this burden in Argentina. BMC Public Health 2010;10(1):627.
64. Rubinstein A, Elorriaga N, Garay OU, Poggio R, Caporale J, Matta MG, Augustovski F, Pichon-Riviere A, Mozaffarian D. Eliminating artificial trans fatty acids in Argentina: estimated effects on the burden of coronary heart disease and costs. Bull World Health Organ 2015;93(9):614–22.
65. Sacks G, Veerman JL, Moodie M, Swinburn B. "Traffic-light" nutrition labelling and "junk-food" tax: a modelled comparison of cost-effectiveness for obesity prevention. Int J Obes 2011;35(7):1001–9.
66. Salomon JA, Carvalho N, Gutierrez-Delgado C, Orozco R, Mancuso A, Hogan DR, Lee D, Murakami Y, Sridharan L, Medina-Mora ME, et al. Intervention strategies to reduce the burden of non-communicable diseases in Mexico: cost effectiveness analysis. BMJ 2012;344: e355.
67. Sánchez-Romero LM, Penko J, Coxson PG, Fernández A, Mason A, Moran AE, Ávila-Burgos L, Odden M, Barquera S, Bibbins-Domingo K. Projected impact of Mexico's sugar-sweetened beverage tax policy on diabetes and cardiovascular disease: a modeling study. PLoS Med. 2016;13(11):e1002158.
68. Saxena A, Stacey N, Puech PDR, Mudara C, Hofman K, Verguet S. The distributional impact of taxing sugar-sweetened beverages: findings from an extended cost-effectiveness analysis in South Africa. BMJ Glob Health 2019;4(4):e001317.
69. Saxena A, Koon AD, Lagrada-Rombaua L, Angeles-Agdeppa I, Johns B, Capanzana M. Modelling the impact of a tax on sweetened beverages in the Philippines: an extended cost-effectiveness analysis. Bull World Health Organ 2019;97(2):97–107.
70. Schwendicke F, Thomson WM, Broadbent JM, Stolpe M. Effects of taxing sugar-sweetened beverages on caries and treatment costs. J Dent Res 2016;95(12):1327–32
71. Smith-Spangler CM, Juusola JL, Enns EA, Owens DK, Garber AM. Population strategies to decrease sodium intake and the burden of cardiovascular disease: a cost-effectiveness analysis. Ann Intern Med 2010;152(8):481.
72. Sowa PM, Keller E, Stormon N, Lalloo R, Ford PJ. The impact of a sugar-sweetened beverages tax on oral health and costs of dental care in Australia. Eur J Public Health 2019;29(1):173–7.
73. Veerman JL, Sacks G, Antonopoulos N, Martin J. The impact of a tax on sugar-sweetened beverages on health and health care costs: a modelling study. PLoS One 2016;11(4):e0151460.
74. Wang YC, Coxson P, Shen YM, Goldman L, Bibbins-Domingo K. A penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burdens of diabetes. Health Aff 2012;31(1):199–207.
75. Wang M, Moran AE, Liu J, Coxson PG, Penko J, Goldman L, Bibbins-Domingo K, Zhao D. Projected impact of salt restriction on prevention of cardiovascular disease in China: a modeling study. PLoS One 2016;11(2):e0146820.
76. Wilcox ML, Mason H, Fouad FM, Rastam S, al Ali R, Page TF, Capewell S, O'Flaherty M, Maziak W. Cost-effectiveness analysis of salt reduction policies to reduce coronary heart disease in Syria, 2010–2020. Int J Public Health 2015;60(Suppl 1):23.
77. Wilde P, Huang Y, Sy S, Abrahams-Gessel S, Jardim TV, Paarlberg R, Mozaffarian D, Micha R, Gaziano T. Cost-effectiveness of a US national sugar-sweetened beverage tax with a multistakeholder approach: who pays and who benefits. Am J Public Health 2019;109(2):276–84.
78. Wilson N, Nghiem N, Eyles H, Mhurchu CN, Shields E, Cobiac LJ, Cleghorn CL, Blakely T. Modeling health gains and cost savings for ten dietary salt reduction targets. Nutr J 2015;15:44.
79. O'Mahony JF. Does cost-effectiveness analysis really need to abandon the incremental cost-effectiveness ratio to embrace net benefit? Pharmacoeconomics 2020;38(8):777–9.
80. McLaren L, McIntyre L, Kirkpatrick S. Rose's population strategy of prevention need not increase social inequalities in health. Int J Epidemiol 2010;39(2):372–7.
81. Vemer P, Corro Ramos I, van Voorn GA, Al MJ, Feenstra TL. AdViSHE: a validation-assessment tool of health-economic models for decision makers and model users. Pharmacoeconomics 2016;34(4):349–61.
82. Husereau D, Drummond M, Petrou S, Carswell C, Moher D, Greenberg D, Augustovski F, Briggs AH, Mauskopf J, Loder E. Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement. BMJ 2013;346:f1049.
83. Sanders GD, Neumann PJ, Basu A, Brock DW, Feeny D, Krahn M, Kuntz KM, Meltzer DO, Owens DK, Prosser LA, et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: Second Panel on Cost-Effectiveness in Health and Medicine. JAMA 2016;316(10): 1093–103.

84. Grieger JA, Johnson BJ, Wycherley TP, Golley RK. Evaluation of simulation models that estimate the effect of dietary strategies on nutritional intake: a systematic review. J Nutr 2017;147(5):908–31.
85. Tan-Torres Edejer T, Baltussen R, Adam T, Hutubessy R, Acharya A, Evans DB, Murray CJL,editors. Making choices in health: WHO guide to cost-effectiveness analysis. Geneva (Switzerland): World Health Organization; 2003.
86. Symmank C, Mai R, Hoffmann S, Stok FM, Renner B, Lien N, Rohm H. Predictors of food decision making: a systematic interdisciplinary mapping (SIM) review. Appetite 2017;110:25–35.
87. Mozaffarian D. Dietary and policy priorities to reduce the global crises of obesity and diabetes. Nat Food 2020;1(1):38–50.
88. Mozaffarian D, Angell SY, Lang T, Rivera JA. Role of government policy in nutrition-barriers to and opportunities for healthier eating. BMJ 2018;361:k2426.
89. Chaloupka FJ, Warner KE, Acemoğlu D, Gruber J, Laux F, Max W, Newhouse J, Schelling T, Sindelar J. An evaluation of the FDA's analysis of the costs and benefits of the graphic warning label regulation. Tob Control 2015;24(2):112–19.
90. Mozaffarian D. Dietary and policy priorities for cardiovascular disease, diabetes, and obesity: a comprehensive review. Circulation 2016;133(2):187–225.
91. Grillo A, Salvi L, Coruzzi P, Salvi P, Parati G. Sodium intake and hypertension. Nutrients 2019;11(9):1970.
92. Moodie R, Stuckler D, Monteiro C, Sheron N, Neal B, Thamarangsi T, Lincoln P, Casswell S. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. Lancet North Am Ed 2013;381(9867):670–9.
93. Poti JM, Braga B, Qin B. Ultra-processed food intake and obesity: what really matters for health-processing or nutrient content? Curr Obes Rep 2017;6(4):420–31.
94. Juul F, Martinez-Steele E, Parekh N, Monteiro CA, Chang VW. Ultra-processed food consumption and excess weight among US adults. Br J Nutr 2018;120(1):90–100.
95. Moubarac JC, Parra DC, Cannon G, Monteiro CA. Food classification systems based on food processing: significance and implications for policies and actions: a systematic literature review and assessment. Curr Obes Rep 2014;3(2):256–72.
96. Costa CS, Del-Ponte B, Assuncao MCF, Santos IS. Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. Public Health Nutr 2018;21(1):148–59.
97. Cobiac LJ, Veerman L, Vos T. The role of cost-effectiveness analysis in developing nutrition policy. Annu Rev Nutr 2013;33(1):373–93.
98. Organisation for Economic Co-operation and Development. DAC list of ODA recipients [Internet]. Paris: Organisation for Economic Co-operation and Development; 2021 [cited 2021 Jan 04]. Available from: http://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/daclist.htm.
99. Nugent R, Levin C, Hale J, Hutchinson B. Economic effects of the double burden of malnutrition. Lancet 2019;396(10218):156–64..
100. Wilkins E, Wilson L, Wickramasinghe K, Bhatnagar P, Leal J, Luengo-Fernandez R, Burns R, Rayner M, Townsend N. European cardiovascular disease statistics 2017. Brussels (Belgium): European Heart Network; 2017.
101. Bommer C, Sagalova V, Heesemann E, Manne-Goehler J, Atun R, Barnighausen T, Davies J, Vollmer S. Global economic burden of diabetes in adults: projections from 2015 to 2030. Diabetes Care 2018;41(5):963–70.
102. McDaid D, Sassi F, Merkur S,editors. Promoting health, preventing disease the economic case: the economic case. Paris: OECD Publishing; 2015.
103. Whitty CJ. What makes an academic paper useful for health policy? BMC Med 2015;13:301.
104. Ravelli MN, Schoeller DA. Traditional self-reported dietary instruments are prone to inaccuracies and new approaches are needed. Front Nutr 2020;7:90.
105. Bandy L, Adhikari V, Jebb S, Rayner M. The use of commercial food purchase data for public health nutrition research: a systematic review. PLoS One 2019;14(1):e0210192.
106. Whybrow S, Horgan GW, Macdiarmid JI. Buying less and wasting less food: changes in household food energy purchases, energy intakes and energy density between 2007 and 2012 with and without adjustment for food waste. Public Health Nutr 2017;20(7):1248–56.
107. Illner AK, Freisling H, Boeing H, Huybrechts I, Crispim SP, Slimani N. Review and evaluation of innovative technologies for measuring diet in nutritional epidemiology. Int J Epidemiol 2012;41(4): 1187–203.
108. Ioannidis JPA. The challenge of reforming nutritional epidemiologic research. JAMA 2018;320(10):969–70.
109. Staudacher HM, Irving PM, Lomer MCE, Whelan K. The challenges of control groups, placebos and blinding in clinical trials of dietary interventions. Proc Nutr Soc 2017;76(3):203–12.
110. Eddy DM, Hollingworth W, Caro JJ, Tsevat J, McDonald KM, Wong JB, ISPOR-SMDM Modeling Good Research Practices Task Force. Model transparency and validation: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force-7. Med Decis Making 2012;32(5):733–43.
111. Falbe J. Sugar-sweetened beverage taxation: evidence-based policy and industry preemption. Am J Public Health 2019;109(2): 191–2.
112. Cawley J, Thow AM, Wen K, Frisvold D. The economics of taxes on sugar-sweetened beverages: a review of the effects on prices, sales, cross-border shopping, and consumption. Annu Rev Nutr 2019;39:317–38.
113. Harrington RA, Adhikari V, Rayner M, Scarborough P. Nutrient composition databases in the age of big data: FoodDB, a comprehensive, real-time database infrastructure. BMJ Open 2019;9(6):e026652.
114. Bleich SN, Lawman HG, LeVasseur MT, Yan J, Mitra N, Lowery CM, Peterhans A, Hua S, Gibson LA, Roberto CA. The association of a sweetened beverage tax with changes in beverage prices and purchases at independent stores. Health Aff 2020;39(7):1130–9.
115. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. Health Aff 2017;36(3):564–71.
116. Basu S, Meghani A, Siddiqi A. Evaluating the health impact of large-scale public policy changes: classical and novel approaches. Annu Rev Public Health 2017;38:351–70.
117. Philips Z, Ginnelly L, Sculpher M, Claxton K, Golder S, Riemsma R, Woolacott N, Glanville J. Review of guidelines for good practice in decision-analytic modelling in health technology assessment. Health Technol Assess 2004;8(36):iii–iv, ix-xi, 1-158.
118. Palmer AJ, Si L, Tew M, Hua X, Willis MS, Asseburg C, McEwan P, Leal J, Gray A, Foos V, et al. Computer modeling of diabetes and its transparency: a report on the eighth Mount Hood challenge. Value in Health 2018;21(6):724–31.
119. Kim DD, Neumann PJ. Comparative modeling to inform health policy decisions: a step forward. Ann Intern Med 2019;171(11):851–2.
120. Box GE. Robustness in the strategy of scientific model building. In: Launer RL, Wilkinson GN,editors. Robustness in statistics. New York: Academic Press; 1979. p. 201–36.
121. Sassi F, Belloni A, Mirelman AJ, Suhrcke M, Thomas A, Salti N, Vellakkal S, Visaruthvong C, Popkin BM, Nugent R. Equity impacts of price policies to promote healthy behaviours. Lancet North Am Ed 2018;391(10134):2059–70.