



Presentations of the cost effectiveness simulation model and related simulation tools: WP6

Dr Abbygail Jaccard

#EConDAconf
www.econdaproject.eu

This presentation is part of the project EConDA which has received funding from the European Union in the framework of the Health Programme

WP6: Development of the cost-effectiveness model

OBJECTIVES

- Develop a **demonstration model** of cost-effectiveness
- Develop a **tool** to evaluate the cost-effectiveness of an **intervention** applied to a **cohort** of interest.

ACTIVITIES

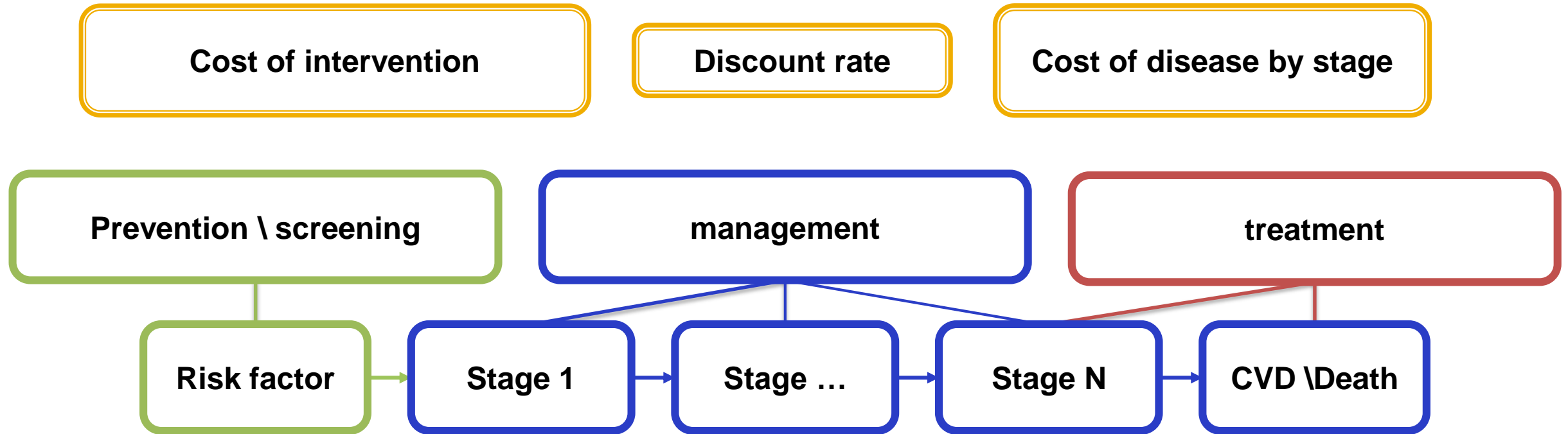
- **Collection** of cost-effectiveness and intervention **data**
- **Implement** and **simulate** various interventions
- Implement the model in **7 EU countries**

DELIVERABLES

- Develop a cost-effectiveness simulation model and tool.



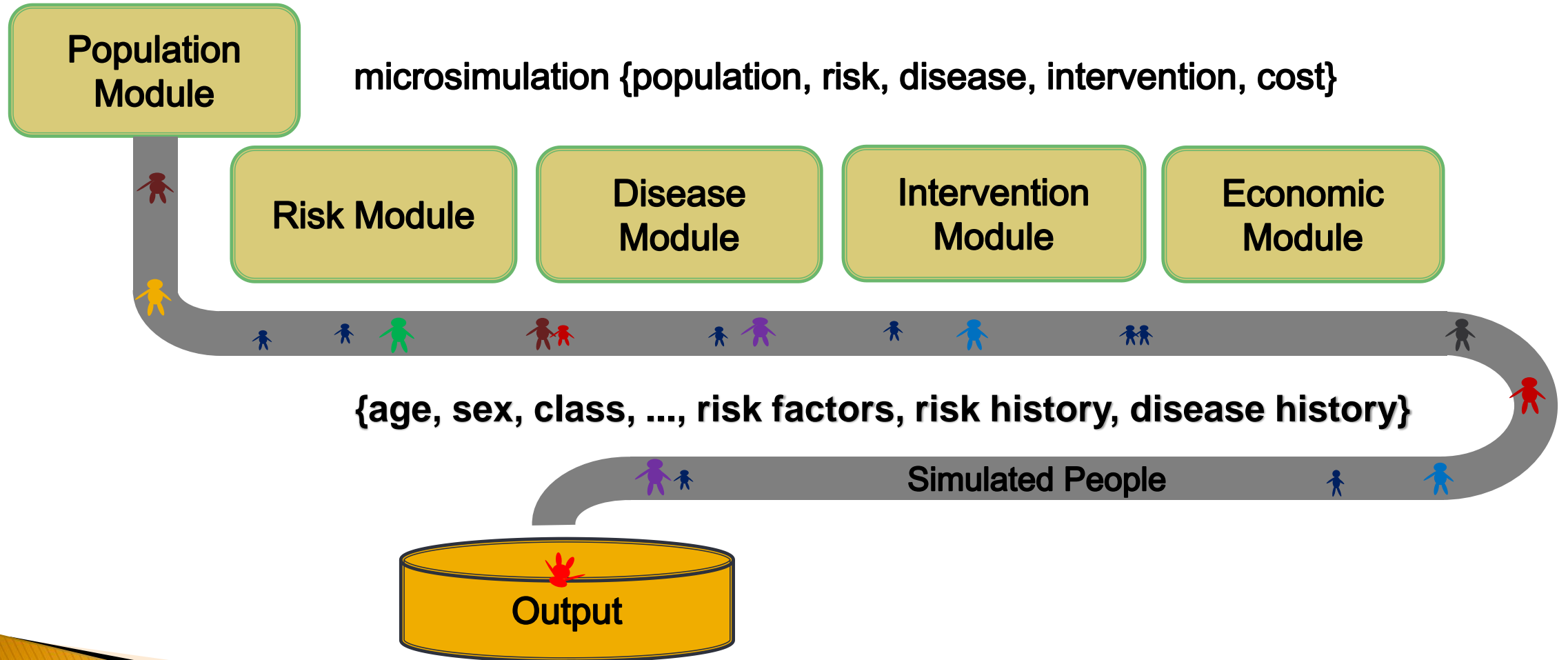
Cost-effectiveness of interventions



Outputs: prevalence, incidence, QALY, DALY, total health care cost, indirect cost, ICER

Proxy data (NL, UK) general cost-of-illness study, as the RIVM has performed for The Netherlands since 2003

Diagram of the microsimulation model



Interventions

- ▶ Hypothetical e.g. 1% or 5% reduction in BMI
- ▶ Policy interventions
- ▶ Prevention, screening and treatment



Quit Smoking



Disease data and stages

Epidemiological data

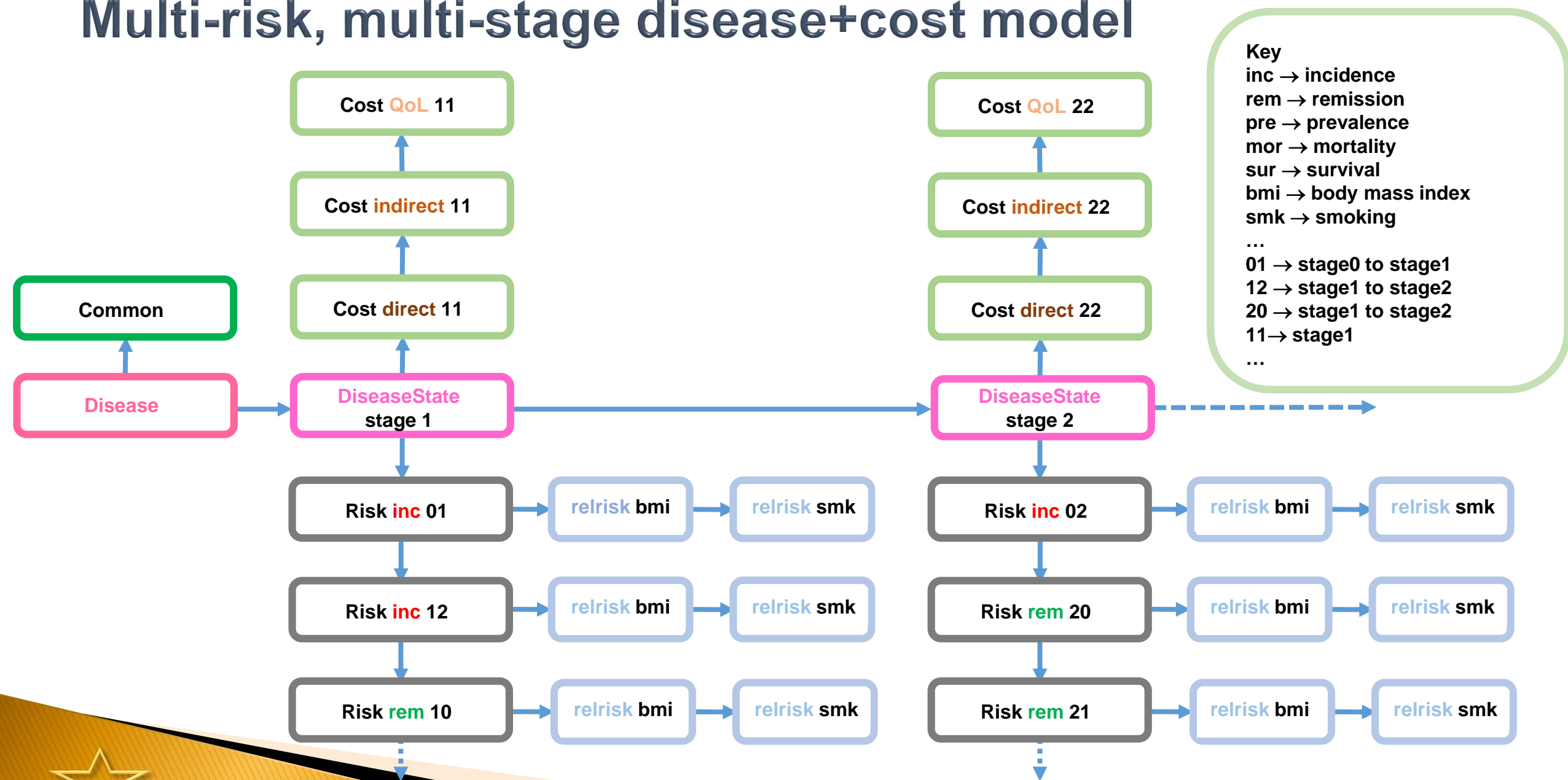
inc → incidence
rem → remission
pre → prevalence
mor → mortality
sur → survival
bmi → body mass index
smk → smoking
...
...

Disease data stage transition

01 → stage0 to stage1
12 → stage1 to stage2
20 → stage1 to stage2
11 → stage1



Multi-risk, multi-stage disease+cost model



Interventions modelled in EConDA

Upstream

- ▶ Sugar-sweetened beverage tax (SSB tax)

Community-based prevention

- ▶ Multi-component lifestyle interventions
- ▶ Smoking cessation services

Screening

- ▶ Albumin screening for chronic kidney disease

Treatment

- ▶ Romiflast for COPD

Hypothetical

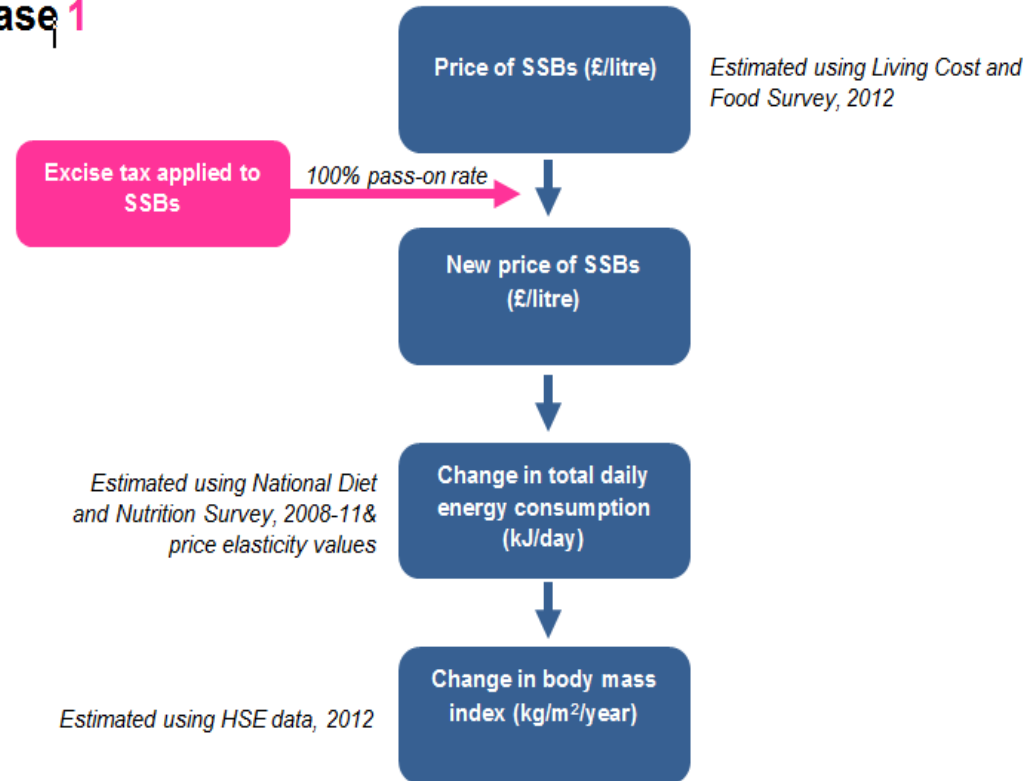
- ▶ 'What if' scenarios



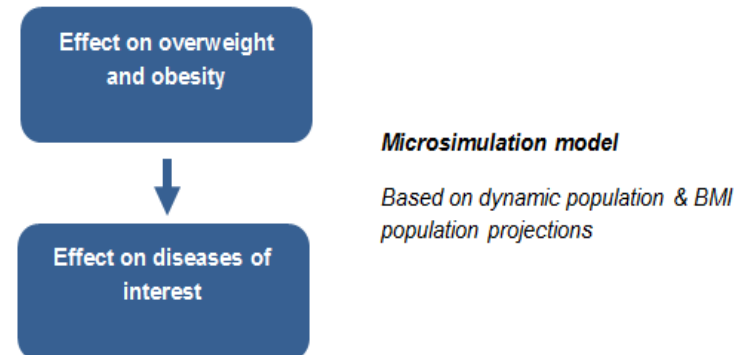
SSB Tax

Flow Diagram of the impact fiscal policy measures applied to SSBs has on health outcomes.
Source: Adapted from Briggs et al, 2012

Phase 1



Phase 2



SSB Tax

Country	Mean reduction in BMI (kg/m ²)
Bulgaria	-0.01
Finland	-0.01
Greece	-0.01
Lithuania	0
Netherlands	-0.02
Poland	-0.01
Portugal	-0.01
UK	-0.05



Multi-component lifestyle interventions (MCLI)

- ▶ Definition:

A programme that aims to **reduce a person's energy intake** and help them to be more physically active by **changing their behaviour** (NICE, 2013).

A MCLI must include the following components:

- ▶ Diet
- ▶ Physical activity
- ▶ Behavioural therapy (for example, counselling, goal setting, action planning, barrier identification and problem solving, self-monitoring of behaviour, feedback)



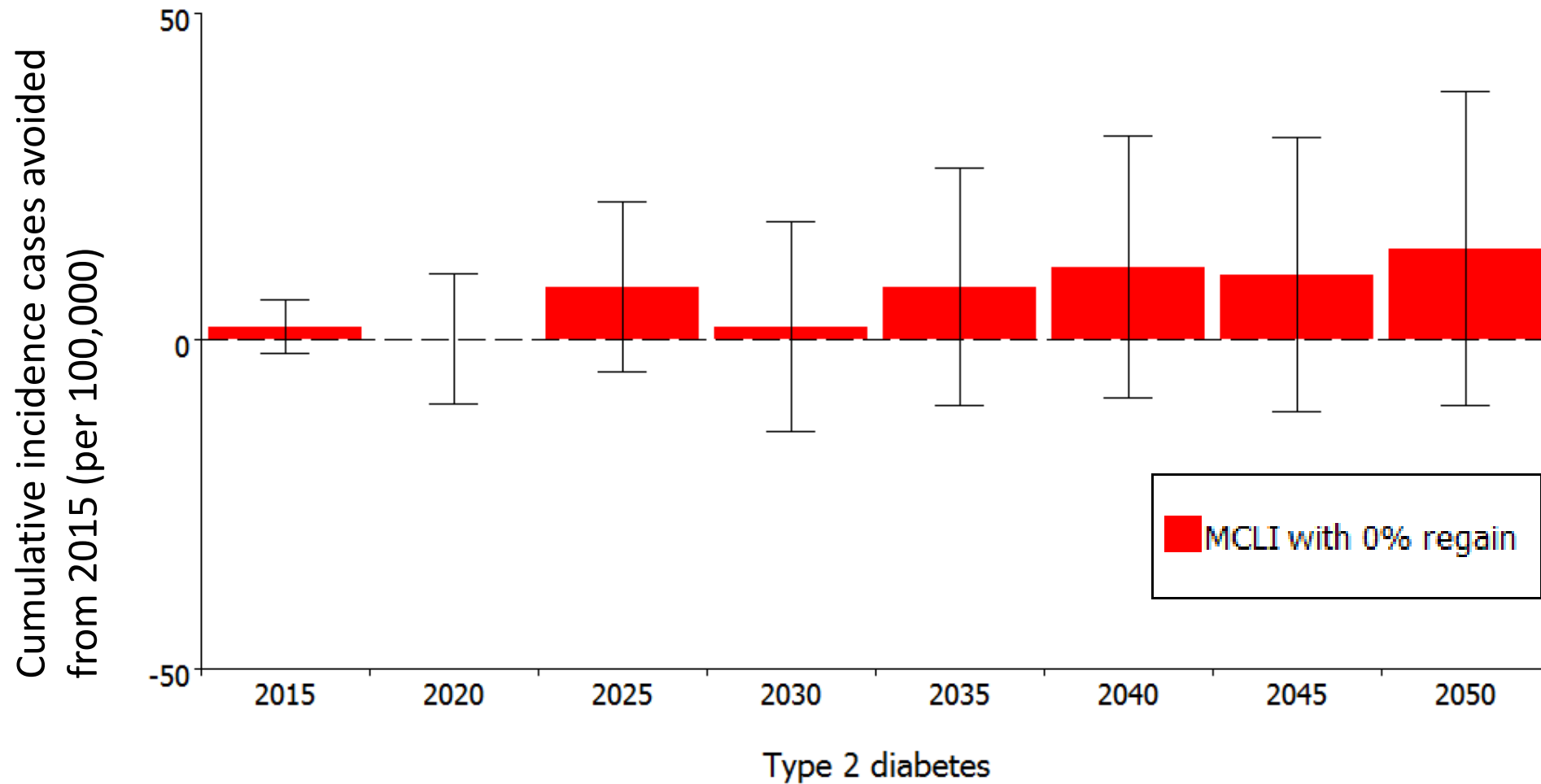
MCLI - assumptions

Country	Reduction in BMI*	% BMI lost regained after 5 years	Cost of intervention per patient
Greece	0.6	100	175 Euros
UK	0.7	100	£91.87
Finland	1.6	100	110 Euros (Proxy)
Netherlands	1.1	100	110 Euros (Proxy)
Portugal	2.2	100	110 Euros
Lithuania	Greece Proxy	Greece Proxy	Greece Proxy
Poland	Greece Proxy	Greece Proxy	Greece Proxy
Bulgaria	Greece Proxy	Greece Proxy	Greece Proxy

* Absolute units of BMI; reduction in intervention group at 12 moths for UK, Finland, Netherlands and Portugal and at 3 months for Greece



UK Results – cumulative incidence cases avoided

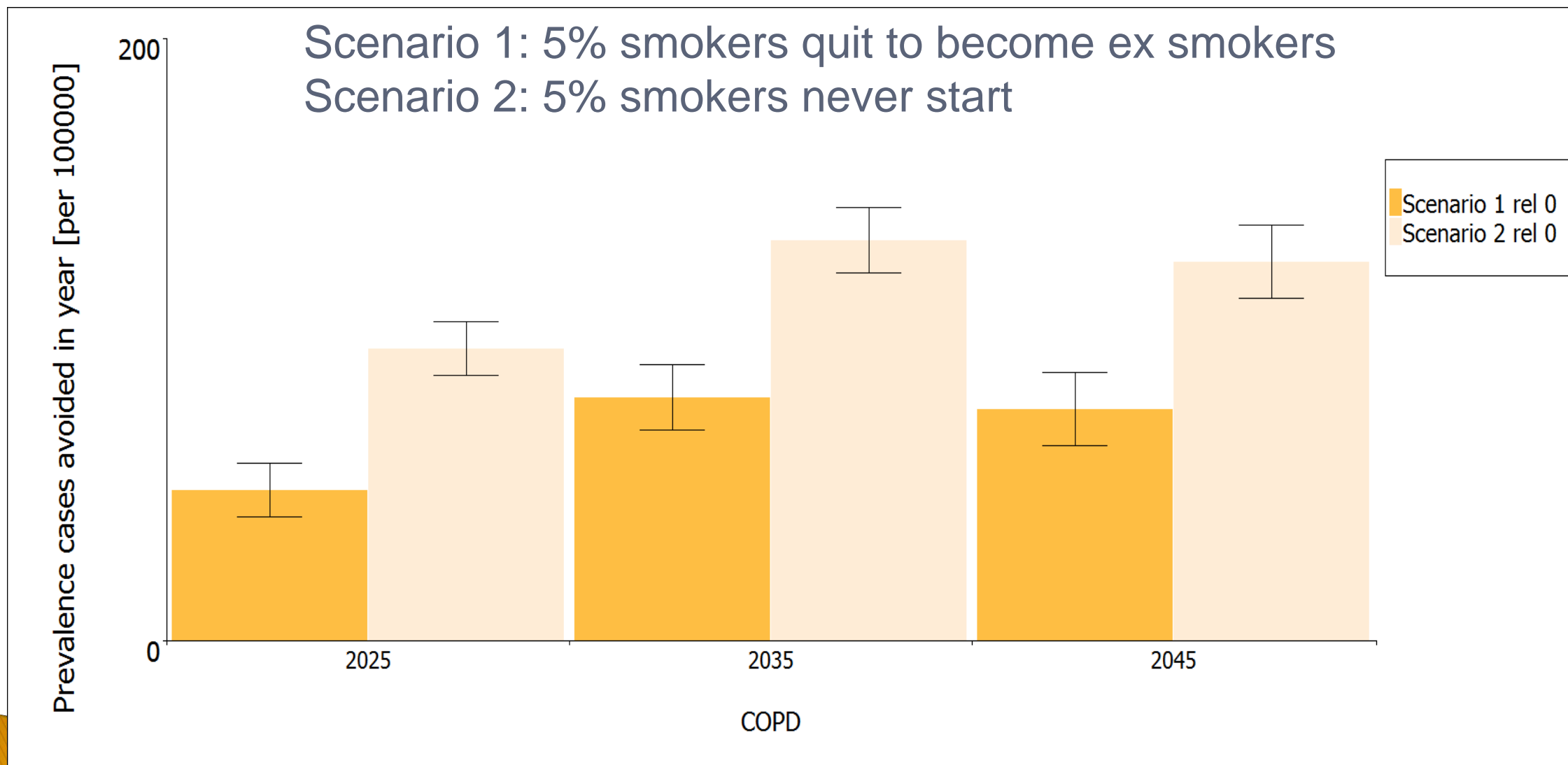


Smoking cessation scenario (hypothetical)

- ▶ What if 5% smokers became ex-smokers (smoking cessation)
- ▶ What if 5% smokers had never started
- ▶ Poland as an example



Poland COPD prevalence: cases avoided



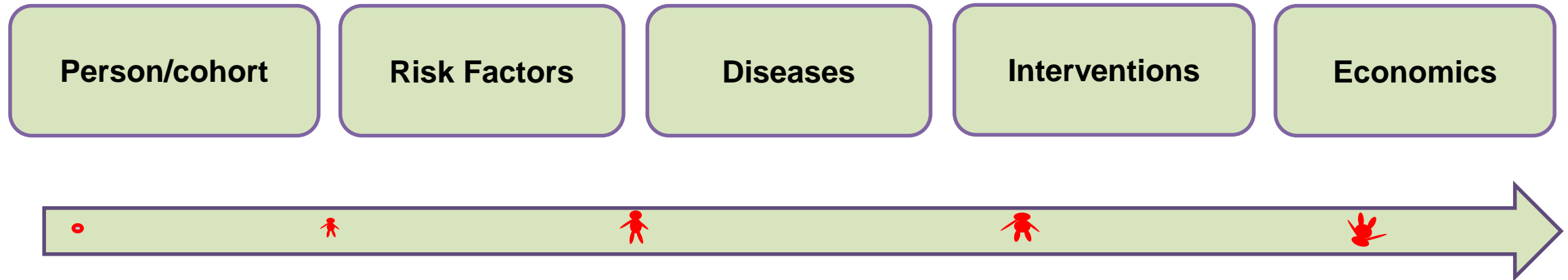
The downloadable tool (WP6)

- ▶ Downloadable tool
- ▶ Deterministic model
- ▶ Download here: econdaproject.eu
- ▶ Survey monkey: <https://www.surveymonkey.com/r/EConDATool>



Tool: Deterministic person(s) simulation

**Deterministic simulation of individual person
& groups of individuals**



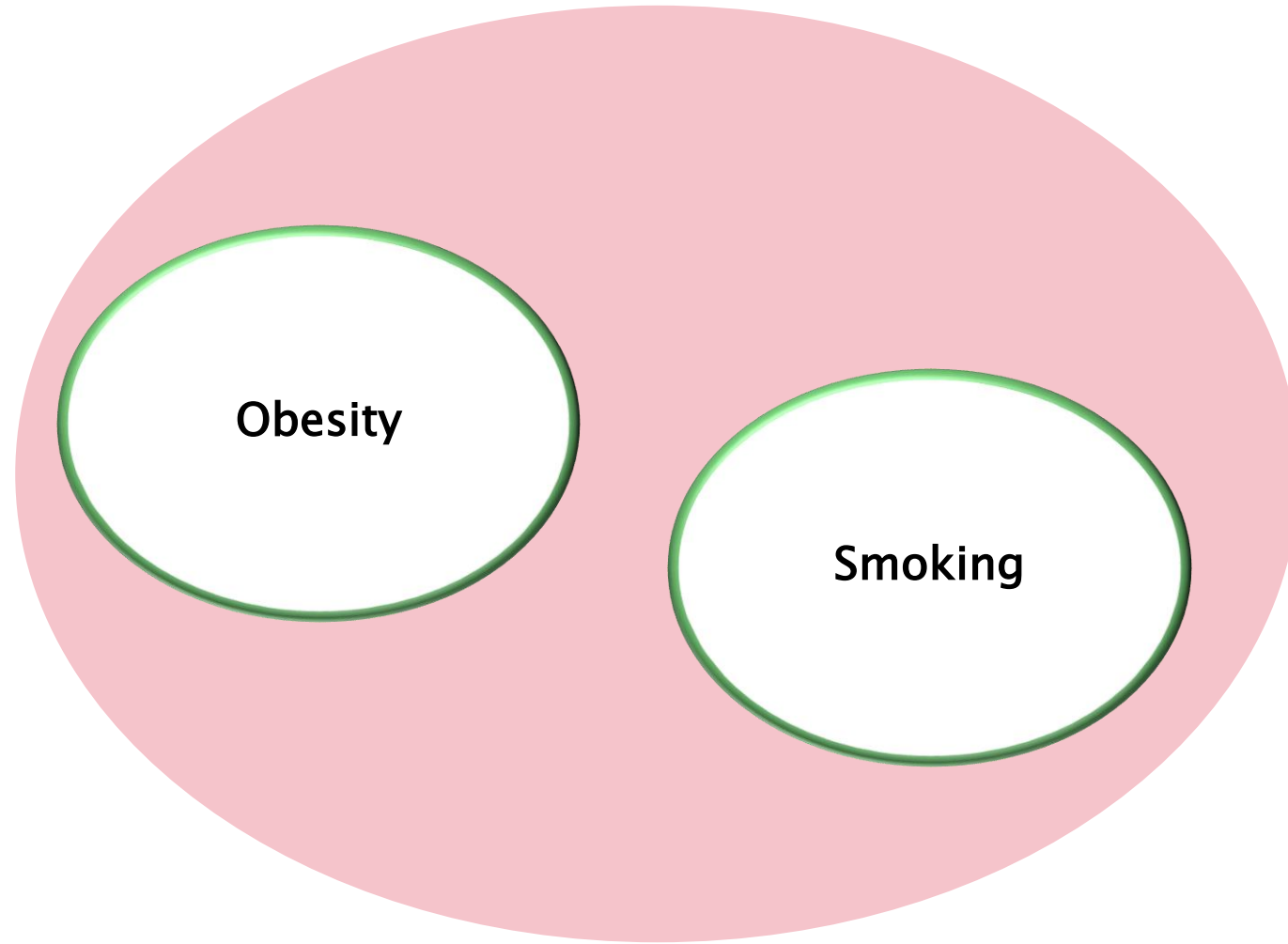
Person=person(age, sex, class, education, ..., risk factors, risk history, disease history}

Crucially –identical distributional data and methods as in the micro simulation

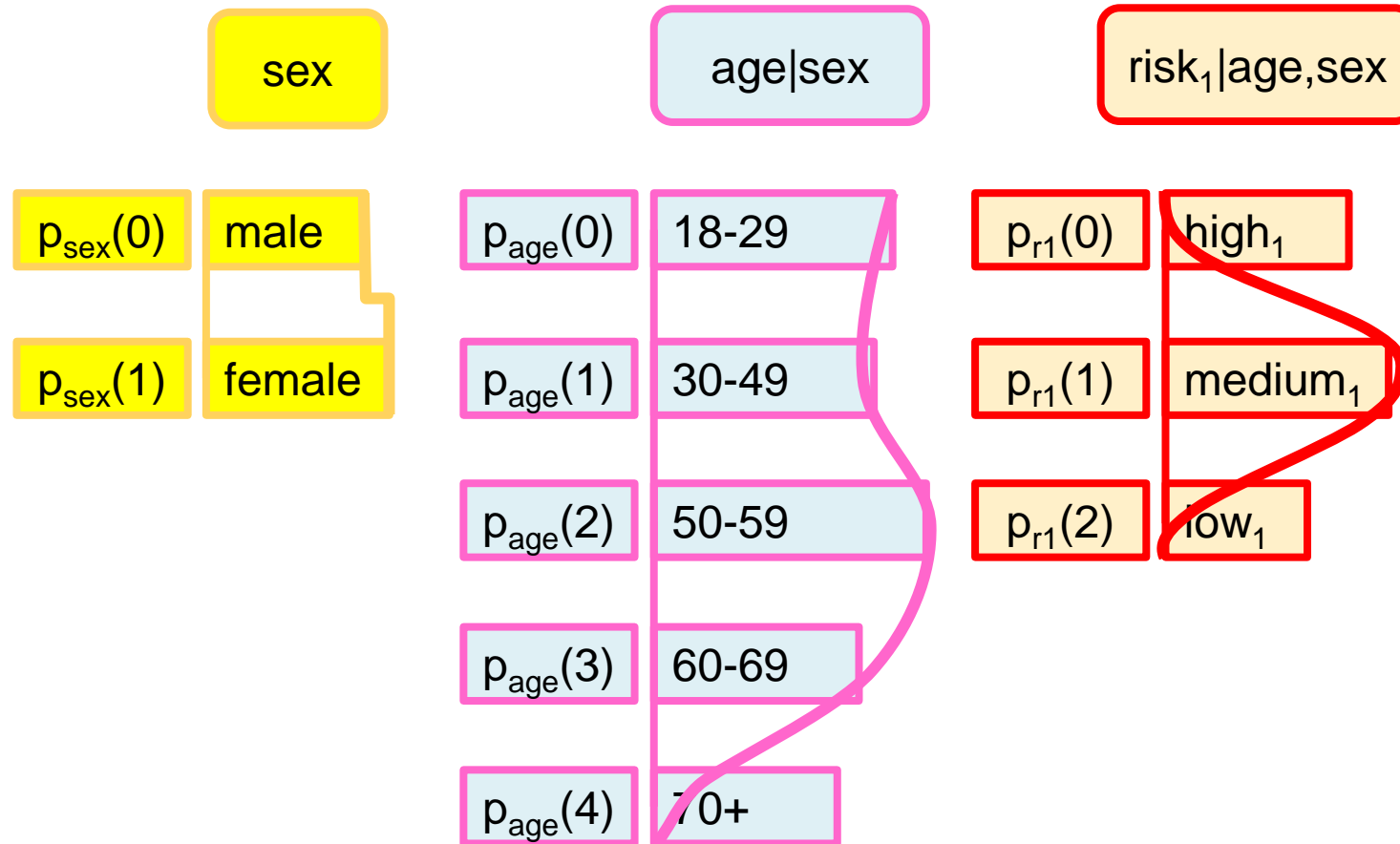
Groups (possibly weighted) of persons can be made into cohorts



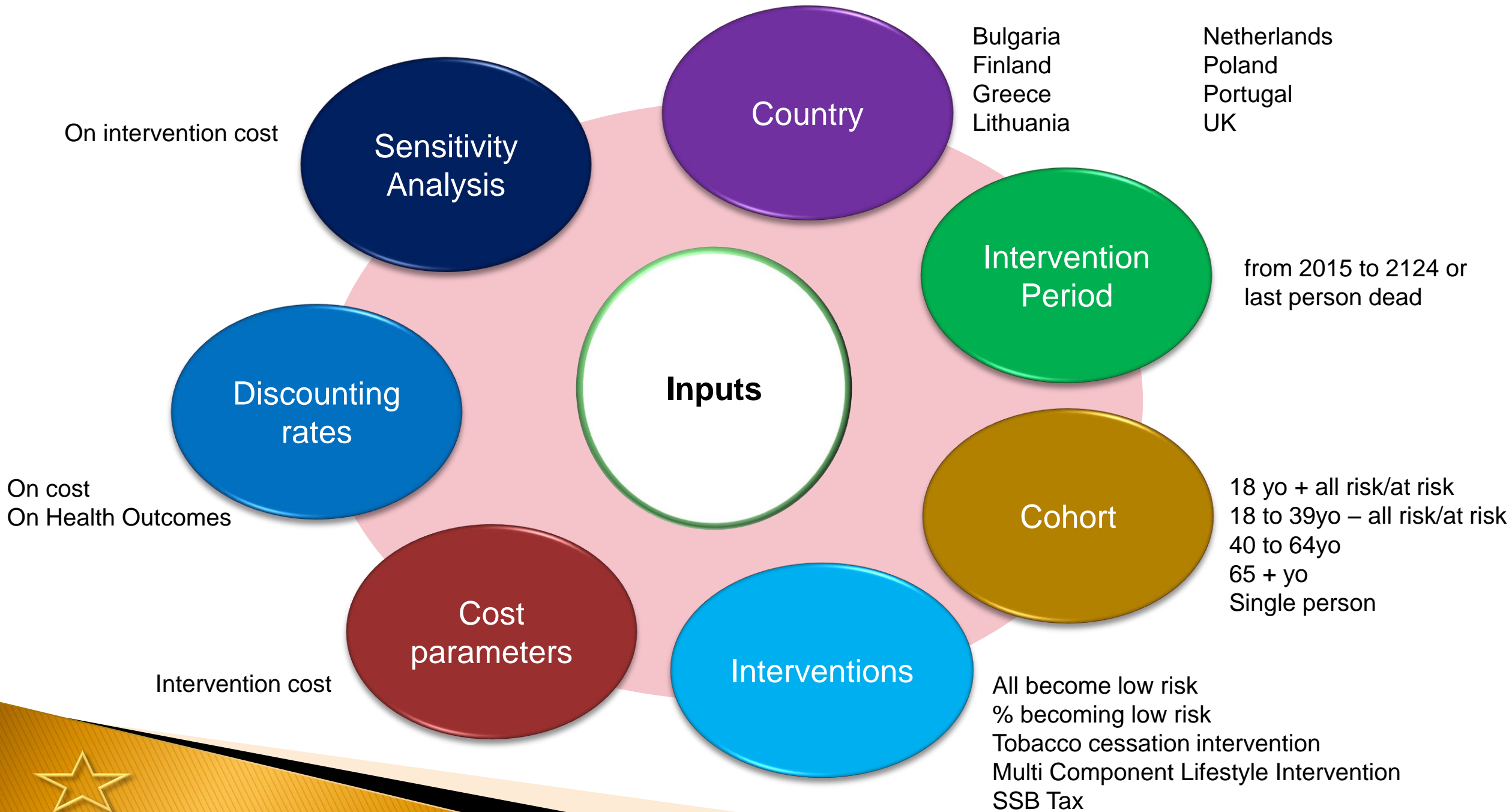
Tool



MIDRiFs System Architecture (ECONDA Tool) \ cohort structure [eg 2x5x3=90 people]



cohort member[i, j, k, l] weight = $p_{\text{sex}}(i) \times p_{\text{age}}(j|i) \times p_{r1}(k|i,j) \times p_{r2}(l|i,j)$
where $i \in [0,1]$, $j \in [0,4]$, $k \in [0,2]$, $l \in [0,2]$



Prevalence of a disease per 100,000

☆ EConDA: [BMI risks] UK

File Edit Run View Help

Baseline [B]: numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
coronary heart disease.0	3228	2919	2687	2547	2425	2337	2285	2293	2277	2288	2309
colo-rectal cancer.0	0	84	139	176	202	218	233	245	255	258	265
diabetes.0	0	2995	5438	7195	8418	9243	9997	10443	10651	10694	10818
diabetes.1	0	377	1085	2062	3206	4444	5716	7041	8357	9636	10847
stroke.0	2669	2673	2673	2686	2680	2707	2724	2757	2760	2798	2819

Intervention [I]: numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
coronary heart disease.0	3228	2897	2641	2470	2321	2202	2121	2093	2052	2034	2029
colo-rectal cancer.0	0	81	133	169	195	210	225	237	247	250	257
diabetes.0	0	2520	4621	6176	7301	8098	8840	9328	9608	9741	9940
diabetes.1	0	297	843	1594	2476	3435	4426	5472	6520	7546	8526
stroke.0	2669	2664	2653	2653	2634	2646	2649	2666	2655	2676	2684

Changes (Baseline relative to Intervention [B-I]) in the numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
[B-I] coronary heart disease	0	22	46	77	104	135	164	200	225	254	280
[B-I] colo-rectal cancer	0	3	6	7	7	8	8	8	8	8	8
[B-I] diabetes	0	475	817	1019	1117	1145	1157	1115	1043	953	878
[B-I] stroke	0	80	242	468	730	1009	1290	1569	1837	2090	2321

Probability of having a disease and being dead

Setup Costs: Input and Output Run specification Graphics Output: Summary and Cost Effectiveness Analysis Output: Disease Prevalence by State



Probability of having a disease

☆ EConDA: [BMI risks] UK

File Edit Run View Help

cohort baseline: annual mean probabilities of [being alive and having a disease] and the annual mean probability of being dead

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
coronary heart disease	3.23E-02	2.92E-02	2.69E-02	2.55E-02	2.43E-02	2.34E-02	2.28E-02	2.29E-02	2.28E-02	2.29E-02	2.31E-02
colo-rectal cancer	0.00E+00	8.40E-04	1.39E-03	1.76E-03	2.02E-03	2.18E-03	2.33E-03	2.45E-03	2.55E-03	2.58E-03	2.65E-03
diabetes	0.00E+00	3.77E-03	1.09E-02	2.06E-02	3.21E-02	4.44E-02	5.72E-02	7.04E-02	8.36E-02	9.64E-02	1.08E-01
stroke	2.67E-02	2.67E-02	2.67E-02	2.69E-02	2.68E-02	2.71E-02	2.72E-02	2.76E-02	2.76E-02	2.80E-02	2.82E-02
dead	0.00E+00	1.32E-02	2.61E-02	3.88E-02	5.21E-02	6.51E-02	7.80E-02	9.09E-02	1.04E-01	1.18E-01	1.31E-01

cohort post intervention: annual mean probabilities of [being alive and having a disease] and the annual mean probability of being dead

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
coronary heart disease	3.23E-02	2.90E-02	2.64E-02	2.47E-02	2.32E-02	2.20E-02	2.12E-02	2.09E-02	2.05E-02	2.03E-02	2.03E-02
colo-rectal cancer	0.00E+00	8.09E-04	1.33E-03	1.69E-03	1.95E-03	2.10E-03	2.25E-03	2.37E-03	2.47E-03	2.50E-03	2.57E-03
diabetes	0.00E+00	2.97E-03	8.43E-03	1.59E-02	2.48E-02	3.44E-02	4.43E-02	5.47E-02	6.52E-02	7.55E-02	8.53E-02
stroke	2.67E-02	2.66E-02	2.65E-02	2.65E-02	2.63E-02	2.65E-02	2.65E-02	2.67E-02	2.65E-02	2.68E-02	2.68E-02
dead	0.00E+00	1.32E-02	2.61E-02	3.87E-02	5.19E-02	6.47E-02	7.75E-02	9.01E-02	1.03E-01	1.17E-01	1.30E-01

Setup Costs: Input and Output Run specification Graphics **Output: Disease** Output: Summary and Cost Effectiveness Analysis Output: Disease Prevalence by State



Life expectancy, DALY and Health Economic Analysis

☆ EConDA: [BMI risks] UK

File Edit Run View Help

Health Economy Analyses

Cost type		Qaly type [years]		
Baseline disease cost (€/pers)	100	Baseline Qaly [years]	8.75	
Intervention disease cost (€/pers)	96	Intervention Qaly [years]	8.76	
Intervention cost (€/pers)	850.00	Qaly Difference [years]	0.01	
Cost difference (€/pers)	846.00			
life expectancy [baseline]	57.32			
life expectancy [intervention]	57.33			
life expectancy [gain]	0.01			
DALYs [gain per person]	0.21			
Cost effectiveness Analyses				

QoL

disease	Male qol	Female qol
coronary heart disease	0.61	0.61
colo-rectal cancer	0.68	0.68
diabetes	1.00	1.00
stroke	0.63	0.63

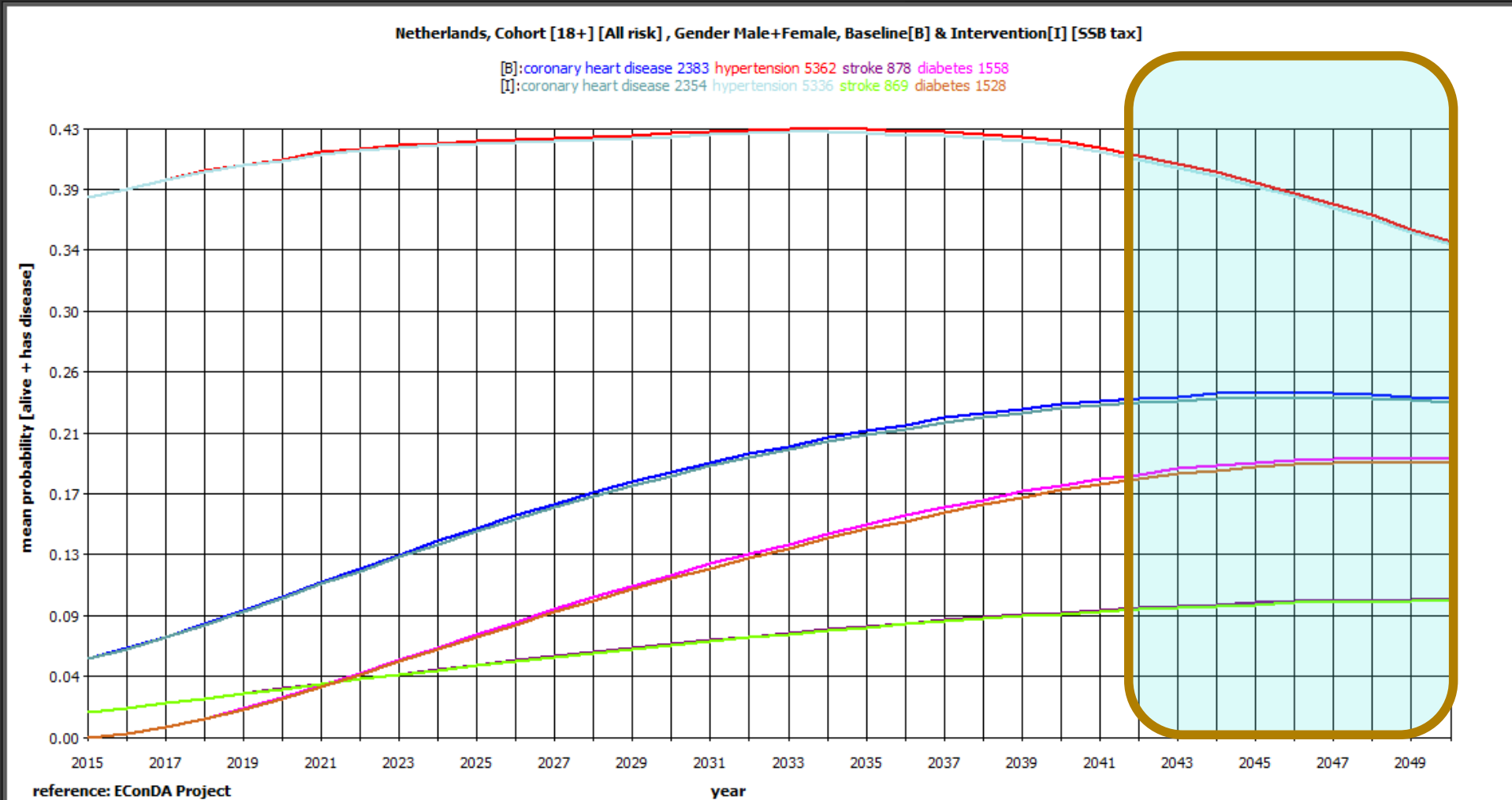
Setup Costs: Input and Output Run specification Graphics Output: Disease Output: Summary and Cost Effectiveness Analysis Output: Disease Prevalence by State



Netherlands: 20% SSB Tax

- ▶ Assuming a **0.03% reduction** in the prevalence of **obesity**.
- ▶ SSB tax applied to **adults** (≥ 18 year olds).
- ▶ **Cohort** of individuals who are healthy weight, overweight and obese.



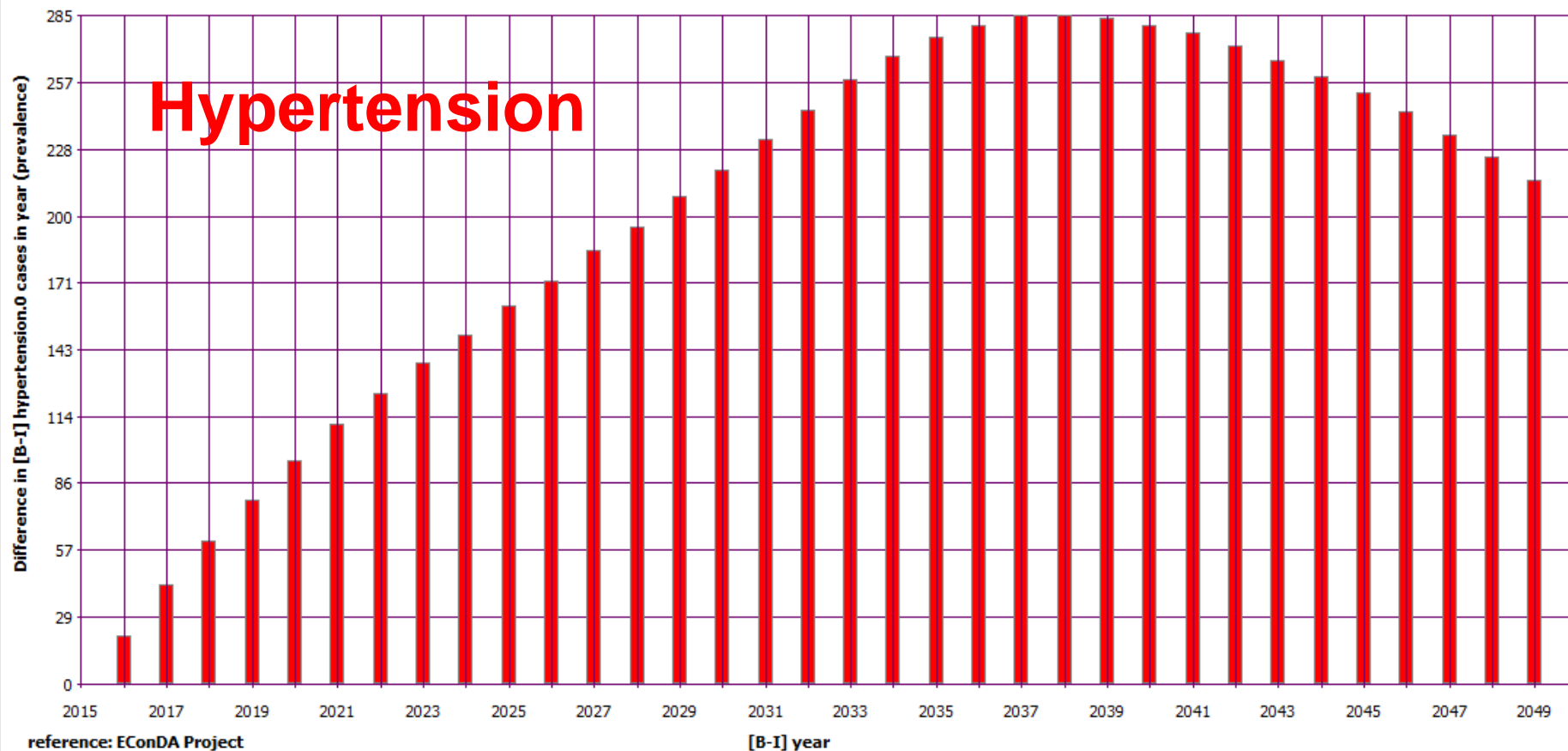


☐ Draw last line in legend



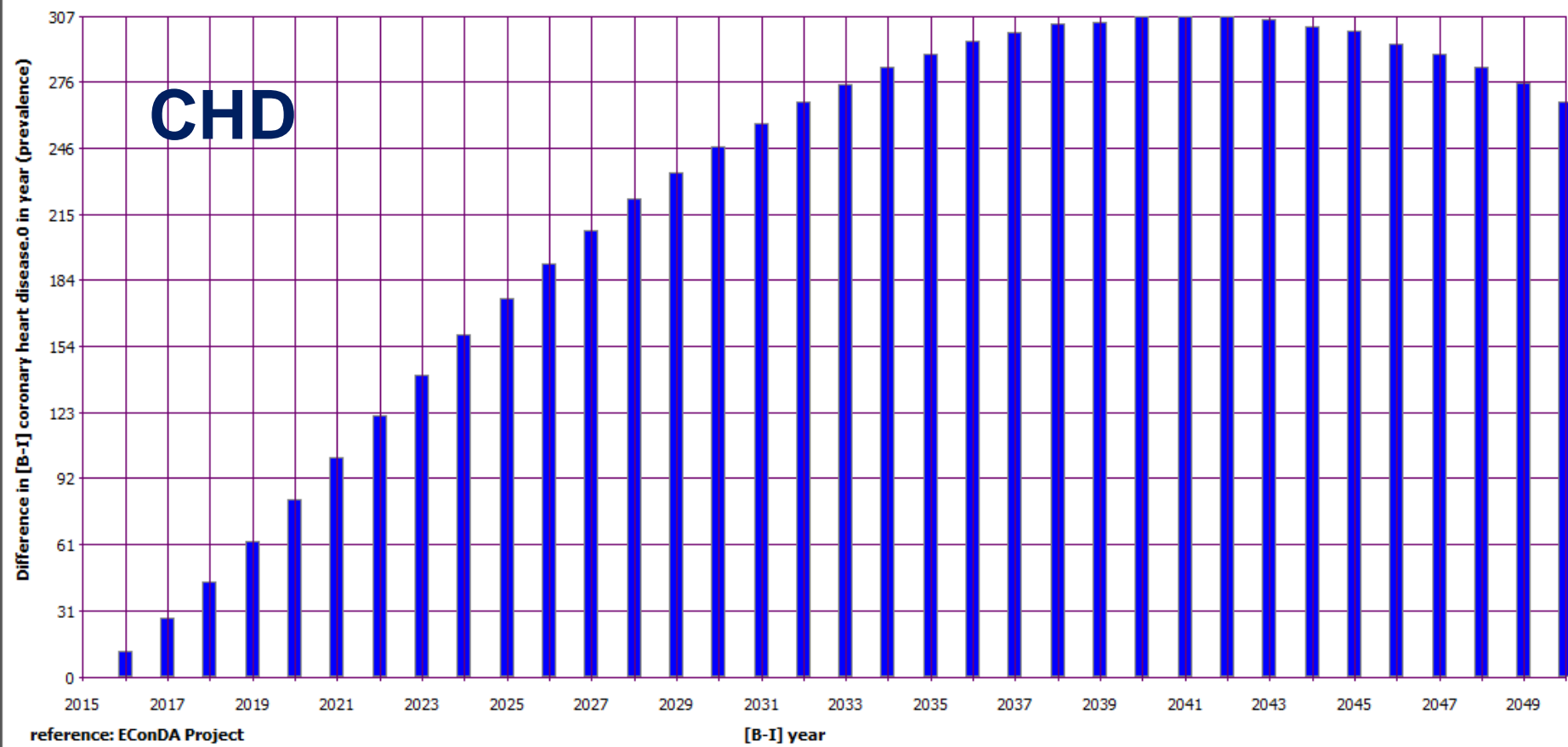
Netherlands, Cohort [18+] [All risk] , Gender Male+Female, Baseline[B] & Intervention[I] [SSB tax]

☐ Draw last line in legend



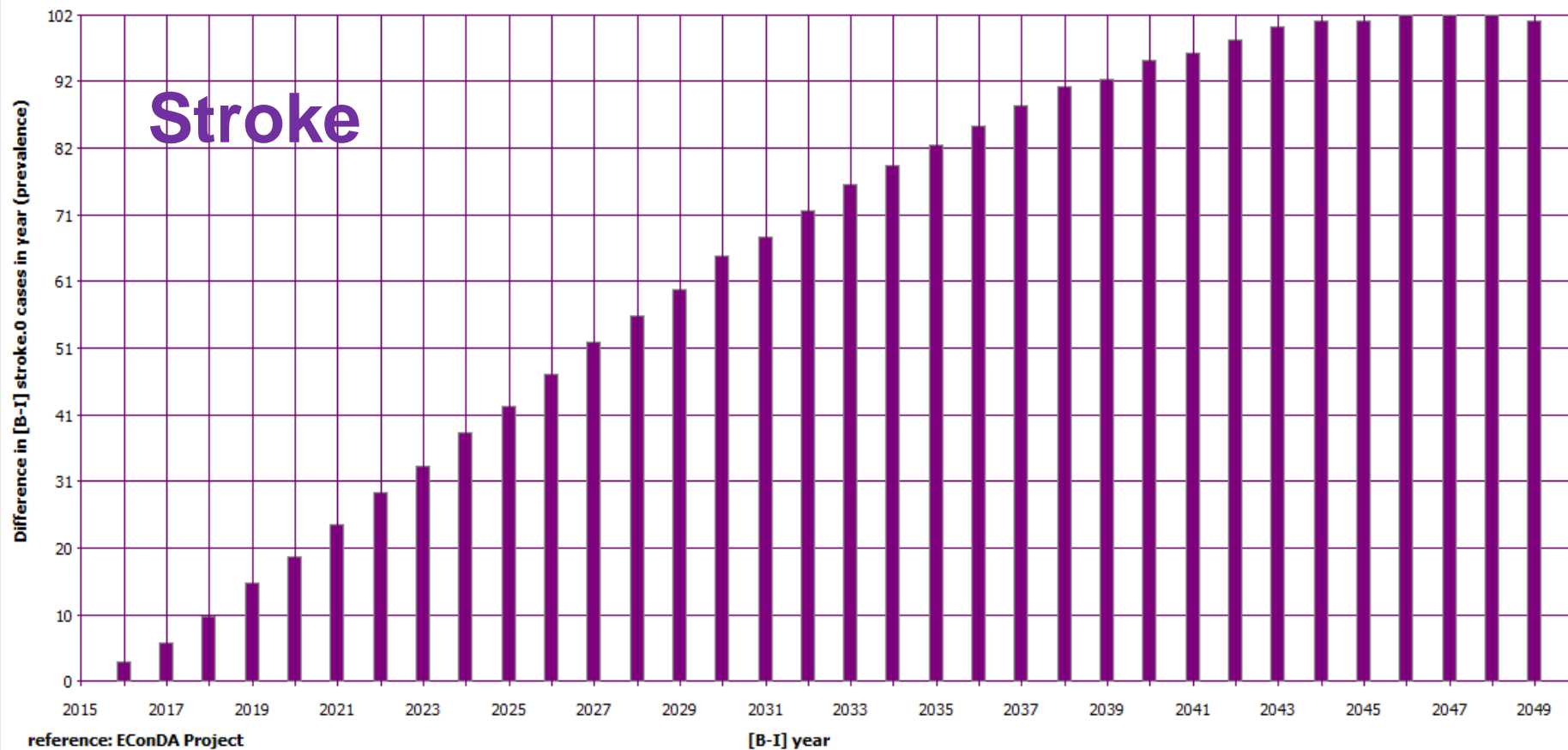
Netherlands, Cohort [18+] [All risk] , Gender Male+Female, Baseline[B] & Intervention[I] [SSB tax]

☐ Draw last line in legend



Netherlands, Cohort [18+] [All risk] , Gender Male+Female, Baseline[B] & Intervention[I] [SSB tax]

☐ Draw last line in legend



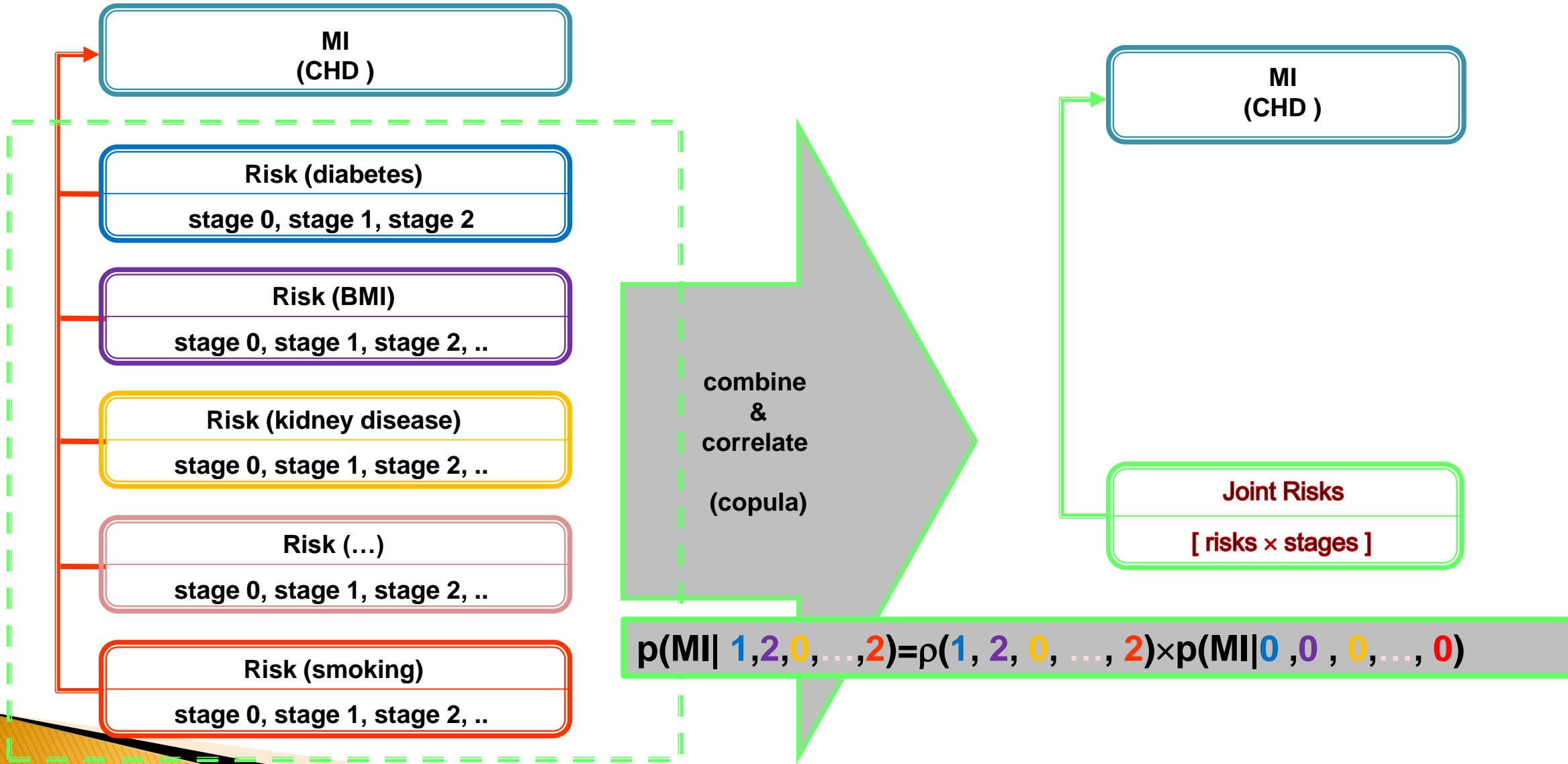
SSB tax in the Netherlands

Key	Value
ICER	-34,800 Euro/qol → DOMINANT
DALY gain per person	0.08 year
Life Expectancy gain per person	0.01 year (from 74.84 year)

Key	Value
Disease Expectancy reduction for CHD	29 days
Disease Expectancy reduction for diabetes	30 days
Disease Expectancy reduction for hypertension	26 days
Disease Expectancy reduction for stroke	9 days



Future work - Multi Risk Diseases (eg MI – EConDA & UKHF Heart Disease & Stroke model)



Acknowledgements

- ▶ This presentation arises from the project EConDA which has received funding from the European Union in the framework of the Health Programme
- ▶ EConDA Team
- ▶ Ron Gansevoort
- ▶ UK Health Forum Modelling Team
 - Laura Webber
 - Lise Retat
 - Martin Brown
 - Arti Bhimjiyani
 - Andre Knuchel-Takano
 - Carolina Pérez Ferrer
 - John Murray



SSB Tax

Country	Baseline consumption of SSB (g/day)	Price elasticities for SSBs	Reduction in consumption of SSBs (%)	Reduction in consumption of SSBs (g/day)	Reduction in energy intake from SSBs (kJ/day)	Reduction in total energy intake accounting for substitutions (kJ/day)	Reduction in body weight (kg)	Reduction in BMI (kg/m ²)
Bulgaria	19.92	-0.798	-15.96	-3.18	-4.77	-2.86	-0.03	-0.01
Finland	19.74	-0.798	-15.96	-3.15	-4.73	-2.84	-0.03	-0.01
Greece	13.1	-0.798	-15.96	-2.09	-3.14	-1.88	-0.02	-0.01
Lithuania	5.2	-0.798	-15.96	-0.83	-1.25	-0.75	-0.01	0
Netherlands	37.38	-0.798	-15.96	-5.97	-8.95	-5.37	-0.05	-0.02
Poland	19.8	-0.798	-15.96	-3.16	-4.74	-2.84	-0.03	-0.01
Portugal	21.42	-0.798	-15.96	-3.42	-5.13	-3.08	-0.03	-0.01



Key	Value	Comment
country	Netherlands	- the name of the country
start year	2015	- the simulation start year
stop year	2050	- simulation stop year
----	----	----
cohort	[18+] [All risk]	Cohorts are identified by their ages and their risk group in the start year
cohort gender	Male+Female	- the cohort gender
single person risk[rf_bmi]	Not required	- the initial risk level of the single person (Low: BMI<25, Medium: 25<=BMI<30, High: BMI>=30)
single person age	Not required	- the initial age of the single person
----	----	----
intervention[rf_bmi]	[SSB tax]	Interventions are identified by their impact on the risk factor
[% become healthy weight]	31	- the percentage of people moving from the at risk category
----	----	----
options		
allow input cost editing	false	- must be set to true if the input costs are to be edited
risk factor	rf_bmi	- risk factor [single option] consumption
----	----	----
Intervention cost per person (€)	1	- the cost of the intervention
Baseline cost per person (€)	0	- the cost of the baseline intervention
Discounting rate [% per year]	3.5	- cost discounting rate
Health discounting rate [% per year]	3.5	- health discounting rate

Run Cohort

Close

File Edit Run View Help

Health Economy Analyses

Cost type		Qaly type [years]	
life expectancy [intervention]	74.84		
life expectancy [gain]	0.01		
DALYs [gain per person]	0.08		
Cost effectiveness Analyses			
ICER (€/qaly/pers)	-34799.20	Intervention less costly and more effective (dominant)	
Average cost effectiveness ratio (€/qaly)	1237.93		
Sensitivity Analyses			

QoL

disease	Male qol	Female qol
coronary heart disease	0.71	0.71
hypertension	0.72	0.72
stroke	0.54	0.54
diabetes	1.00	1.00

Setup Costs: Input and Output Run specification Graphics Output: Summary and Cost Effectiveness Analysis Output: Disease Prevalence by State

Health Economy Analyses

Cost type		Qaly type [years]	
Baseline disease cost (€/pers)	34255	Baseline Qaly [years]	27.38
Intervention disease cost (€/pers)	33906	Intervention Qaly [years]	27.39
Intervention cost (€/pers)	1.00	Qaly Difference [years]	0.01
Cost difference (€/pers)	-348.00		
life expectancy [baseline]	74.83		
life expectancy [intervention]	74.84		
life expectancy [gain]	0.01		

QoL

disease	Male qol	Female qol
coronary heart disease	0.71	0.71
hypertension	0.72	0.72
stroke	0.54	0.54
diabetes	1.00	1.00

Baseline [B]: numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
coronary heart disease.0	5544	6237	7043	7943	8888	9883	10868	11858	12822	13793	14702	15583	16411	17221	17963	18667
hypertension.0	37978	38627	39335	39858	40344	40743	41181	41441	41673	41819	41973	42101	42219	42261	42446	42556
stroke.0	1735	2052	2380	2738	3077	3415	3751	4104	4427	4749	5066	5394	5684	5977	6264	6562
diabetes.0	0	2978	5662	7810	9488	10812	12056	12993	13631	14091	14553	14832	14914	14929	15134	15312
diabetes.1	0	274	725	1205	2022	2704	3630	4407	5435	6224	7224	8110	9015	9827	10634	11411

Intervention [I]: numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
coronary heart disease.0	5544	6225	7016	7899	8825	9801	10766	11737	12682	13634	14526	15391	16204	16999	17729	18421
hypertension.0	37978	38607	39293	39797	40266	40648	41070	41317	41536	41670	41812	41929	42034	42066	42238	42337
stroke.0	1735	2049	2374	2728	3062	3396	3727	4075	4394	4711	5024	5347	5632	5921	6204	6497
diabetes.0	0	2932	5577	7697	9355	10666	11899	12831	13467	13929	14393	14676	14766	14788	14997	15178
diabetes.1	0	267	707	1272	1982	2727	3542	4301	5207	6178	7058	7926	8812	9607	10300	11162

Changes (Baseline relative to Intervention [B-I]) in the numbers surviving in the cohort and the numbers of disease cases by state by year per 100,000 (prevalence)

[B-I] year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
[B-I] hypertension.0	0	20	42	61	78	95	111	124	137	149	161	172	185	195	208	219
[B-I] stroke.0	0	3	6	10	15	19	24	29	33	38	42	47	52	56	60	65
[B-I] diabetes.0	0	46	85	113	133	146	157	162	164	162	160	156	148	141	137	134
[B-I] diabetes.1	0	7	18	32	50	67	87	106	128	146	166	184	202	220	235	249
[B-I] dead	0	0	0	0	0	1	1	2	2	4	6	6	8	0	10	12

Right-click on the disease row in order to plot the prevalence gain of interest over time

Prevalence for single state disease

Probability of having a disease and being dead

SSB Tax Results – UK BMI reduction

Baseline	Male				Female				Both		
	NW	OW	OB		NW	OW	OB		NW	OW	OB
2025	23.50%	41.15%	35.35%		33.31%	33.39%	33.30%		28.50%	37.19%	34.30%
2050	17.06%	31.65%	51.30%		25.12%	29.99%	44.89%		21.18%	30.80%	48.02%
SSB	Male				Female				Both		
	NW	OW	OB		NW	OW	OB		NW	OW	OB
2025	23.09%	41.94%	34.97%		33.50%	33.46%	33.04%		28.40%	37.61%	33.99%
2050	12.42%	36.46%	51.12%		19.25%	36.00%	44.76%		15.91%	36.22%	47.86%

