The Swedish RHS-model (Risk factors, health and societal costs)

Technical report

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Abstract

This technical report describes the methods, data employed and assumptions required for the simulation model RHS (Risk factors, health and societal costs). The population-based model employs epidemiological methods and data in conjunction with population risk factor prevalence to estimate future disease and related societal costs and health. The model simulations are performed as scenarios, which compare the outcomes between the current risk factor prevalence and another specified prevalence, called the desired situation.

The simulations are based on the adult population prevalence of four lifestyle risk factors: obesity (i.e. BMI>30), daily tobacco smoking, physical inactivity (<2 hours per week) and risky consumption of alcohol (40-60 grams alcohol per day for men and 20-40 grams for women), with the population divided into six age- and gender-specific groups: 18-44 years, 45-64 years and 65-84 years, men and women. The disease risks are taken from international scientific studies and Swedish registers. A total of 15 diseases, among them six types of cancers, are modelled.

The societal costs, reported in Swedish krona year 2012 ((1 Euro=8.70 SEK; 1 USD=6.78 SEK) include medical care costs, municipal (local authority) costs for care, and sickness insurance costs, taken from Swedish scientific articles or registers. The costs thus reflect costs for three Swedish sectors; the national social benefit system, the regional healthcare, and the local authorities. To reflect health effects, morbidity is expressed in QALYs and DALYs, based on international scientific reports.

The report includes a scenario, comprised of data from Stockholm county council, to illustrate the model data demands and results. The scenario consists of two time horizons, 5 years and 10 years from the current year, in this case year 2012. In the scenario, the desired risk factor levels are one percentage point lower than the current level for the year 5 and two percentage points lower for the year 10.

The model is constructed to supply information on potential gains of a successful public health policy for three important stakeholders in Sweden; the national social benefits system, the regional healthcare sector and the local municipal sector Sickness insurance payments are included instead of productivity costs as we believe national-level decision-makers are more interested in costs for the social benefit system. For the same reasons the model contains two different measures of health effects; QALYs and DALYs, as the preferences of decision-makers on health measures differ. We thus believe that the model estimates can supply relevant and valid arguments for decision-makers in the three sectors of Swedish society that have the largest potential to influence the Swedish public health.

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Introduction

The population lifestyle is an important determinant for many common diseases as well as for the future public health. For very prevalent disease groups cancer, cardiovascular disease and diabetes type 2, data on the population lifestyles coupled with epidemiological methods can give relatively certain estimates of future ill-health.

The lifestyle risk factors that are estimated to contribute the most the Swedish ill-health, measured in DALYs (disability-adjusted life-years), according to the latest Global Burden of Disease report (GBD 2010; Lim et al, 2012), are shown in figure 1. Dietary risk, mainly a low consumption of fruits, nuts and seeds, and a high consumption of salt, are estimated to contribute to around 13 per cent of the disease burden, followed by high blood pressure, high body mass index, (BMI, a measure of obesity), smoking and physical inactivity (GBD 2010 Visualizations). Healthier lifestyles in Sweden are reported to be able to prevent up to 80 per cent of the cardiovascular disease and 30 per cent of the cancers, and to prevent or delay the onset of diabetes type 2 (Socialstyrelsen, 2011a). Furthermore, the societal costs of the Swedish disease burden are considerable; around a quarter of the annual total Swedish production measured as GDP (Ramsberg & Ekelund, 2011). These costs are distributed over a wide range of Swedish sectors, e.g. the contribution of the healthcare system only amounts to 23 per cent of the total societal costs.

There are some Swedish studies on the health economic effects of preventive work within the Swedish primary care. In particular, several studies have reported that lifestyle interventions to increase healthy dietary habits and physical activity implemented in primary care in order to prevent cardiovascular disease and diabetes are cost-effective (Lindholm et al, 1996; Engman et al, 2008; Feldman et al, 2013; Saha et al, 2013). Brief interventions for tobacco cessation by GPs are

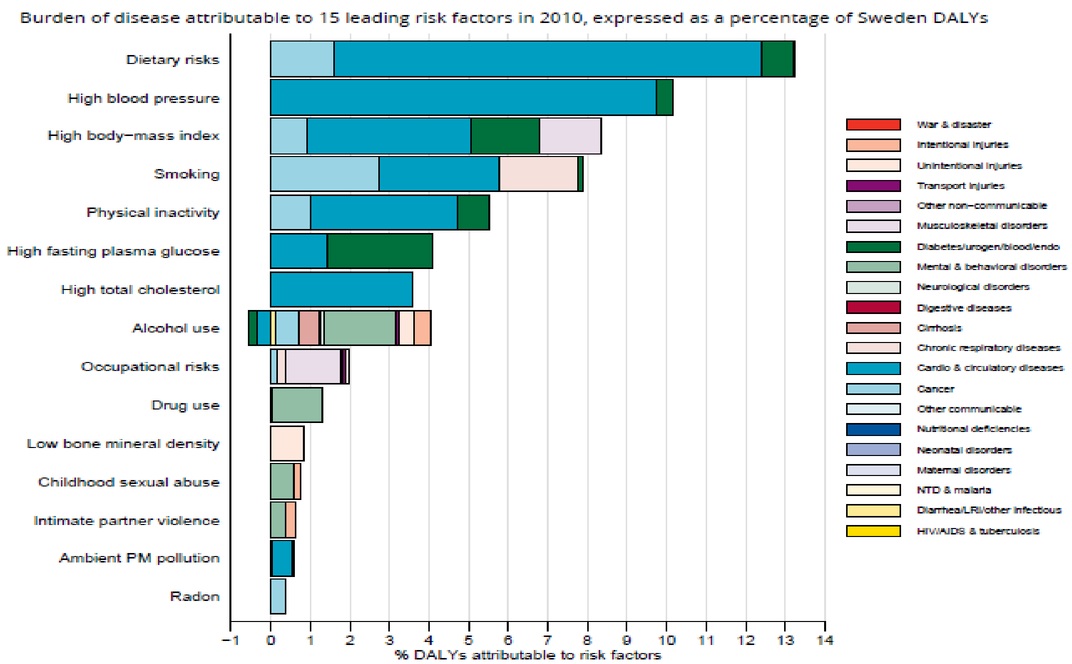

Figure 1. The contribution of risk factors to the Swedish burden of disease, in percent of total DALYs. Source: GBD 2010 Visualizations

considered very cost-effective, (SBU, 1998), while primary care brief interventions on excessive alcohol consumption are reported cost-effective in international studies (Mortimer & Segal, 2005; Tariq et al, 2009) and potentially cost-effective in a Swedish study (Lindholm, 1998).

The Swedish National Board of Health and Welfare (Socialstyrelsen, 2011a) have issued guidelines on methods to be implemented within the Swedish healthcare to support the population to change four lifestyles: tobacco smoking, risky consumption of alcohol, insufficient physical activity and unhealthy dietary habits. The evidence base for the guidelines included some economic aspects and cost-effectiveness estimates of the methods proposed. The guidelines however indicated that even though the recommended methods are likely to lead to decreases in healthcare costs in the longer term (10-30 years), these cost savings cannot be expected to contribute to the financing of the preventive work during coming years (Socialstyrelsen, 2011a).

We however believe that there is a decision-maker interest in estimates of potential changes in societal costs when population lifestyles change. Epidemiological methods and data in conjunction with population risk factor prevalence can supply prognoses on future disease and ill-health, and related societal costs and health effects can be calculated. These methods, in combination with scenarios on assumed risk factor prevalences, can be used to calculate the probable implications of hypothetical situations. Similar population risk factor models have been reported previously: the Dutch RIVM model (Feenstra et al, 2011), for Australia (Cadilhac et al, 2011) as well as the OECD & WHO Chronic Disease Prevention (CDP) Model (Cecchini et al, 2010).

This report describes the methods and the data of the further developed RHS-model (Risk factors, health and societal costs) supported by the Swedish HPH-network. A previous, more restricted, model has been supplied in digital form (under the name of “Hälsokalkylator”) to many Swedish regional healthcare authorities, supported by the same network. This technical report describes in detail the enhanced model, with two scenarios based on Stockholm county council data.

Method and Material

Epidemiological studies report relationships between certain risk factors and certain diseases. Furthermore, there is an epidemiological method that enables calculation of the proportion of a certain disease that would be prevented if the population prevalence of a certain contributing risk factor is decreased (Morgenstern & Bursic, 1982). Based on the prevented cases of disease, changes in future health related societal costs as well as quality of life can be estimated. The epidemiological method thus enables calculations of changes in societal costs and health following from changes in population risk factor prevalence. This section describes the risk factors and related diseases included in the RHS-model, all data and assumptions included in the model, and the epidemiological method (called potential impact fraction). The chapter is concluded with a summary of the model input and output data.

The risk factors

Obesity, BMI>30

Unhealthy dietary habits are one of the most significant modifiable risk factors for several chronic diseases. Based on an ever increasing number of scientific reports, the GBD 2010 describes 14 deficient food habits and reports their contribution to mortality and morbidity. For Sweden three of these (low dietary intake of fruits, of nuts and seeds, and high intake of salt) ranked among the ten most important risk factors for losses of DALYs (GBD 2010 Visualizations; Lim et al, 2012). For the Swedish guidelines for methods to prevent disease a new index on food habits was developed, based on Swedish nutritional recommendations. Unhealthy food habits were defined as low points on the index; 0-4 out of maximum 12 points (Swedish National Board of Health and Welfare, 2011b). However, no epidemiological studies report, yet, disease risks based on the new Swedish dietary

Table 1. The risk factors and the diseases, and ICD-10 disease codes.

	Obesity, BMI>30	Daily smoking	Physical inactivity	Risky consumption of alcohol	ICD-10 code
Diabetes type 2	x	x	x		E11
Ischaemic heart disease	x	x	x		I20, I24, I25
Stroke	x	x	x		I61, I63, I64
COPD		x	x		J40-J44
Depression	x	x	x	x	F32-F33
Hip fracture		x	x	x	S72.0-S72.2
Liver cirrhosis				x	K70, K74
Epilepsy				x	G40- G41
Mental and behavioural disorders due to use of alcohol				x	F 10
Cancers:					
Colon	x	x	x	x	C18
Lung		x			C34
Breast	x	x	x	x	C50
Prostate	x	x			C61
Oesophageal				x	C15

Liver	x	C22

COPD = chronic obstructive pulmonary disease

Table 2. Relative risks in the model for obesity, BMI>30.

	Men			Women			Sources
	18-44	45-64	65-84	18-44	45-64	65-84	
Diabetes type 2	8.5	3.0	1.8	9.4	3.6	2.0	van Baal et al, 2008
Ischaemic heart disease	1.7	1.4	1.2	1.9	1.4	1.2	van Baal et al, 2008
Stroke	1.3	1.3	1.1	1.4	1.3	1.1	van Baal et al, 2008
Depression	1.3	1.3	1.3	1.3	1.3	1.3	Herva et al, 2006
Cancers:							
Colon	1.5	1.5	1.5	1.5	1.5	1.5	van Baal et al, 2008
Breast	-	-	-	1.7	1.4	1.0	Key et al, 2003
Prostate	1.2	1.1	1.1	-	-	-	Rodriguez et al, 2007

index. As the dietary index is not yet used in Swedish population surveys, and nor is most of the GBD 2010 dietary deficiencies, no comprehensive Swedish data exists on the population prevalence of the risk factor. We are thus forced to use the measure BMI (body mass index), which is commonly used in epidemiological studies as a composite measure of food habits in combination with physical activity. Therefore, the model uses obesity, defined as BMI over 30, as an indicator of unhealthy food habits. See table 1 for the model diseases that are related to a BMI>30, and table 2 for the relative risks for disease.

Daily tobacco smoking

Smoking tobacco daily increases the risk for premature death and multiply the risks for many diseases; see table 1 for the ones included in the model and table 3 for the relative risks. Tobacco smoking also increases the disease risks for persons that are affected by secondhand smoke, but these risks are not included in the model. Daily tobacco smoking is the definition used in the Swedish guidelines (National Board of Health and Welfare, 2011b).

Table 3. Relative risks in the model for daily tobacco smoking.

	Men			Women			Sources
	20-44	45-64	65-84	20-44	45-64	65-84	
Diabetes type 2	1.2	1.2	1.2	1.2	1.2	1.2	Willi et al, 2007
Ischaemic heart disease	3.1	1.8	1.4	3.6	2.1	1.5	Prochaska & Hilton, 2012
Stroke	2.8	1.9	1.5	3.2	2.1	1.3	Colditz et al, 1998; Robbins et al, 1994
COPD	10.6	12.3	11.8	9.3	10.8	7.5	Lindberg et al, 2006
Depression	1.1	1.1	1.1	1.1	1.1	1.1	Buden et al, 2010
Hip fracture	1.8	1.8	1.8	1.8	1.8	1.8	Marks, 2010
Cancers:							
Colon	1.2	1.2	1.2	1.2	1.2	1.2	Giovannucci, 2001; Parkin, 2011
Lung	26.4	28.0	21.6	16.1	14.1	10.6	Parkin, 2011

Breast	-	-	-	1.1	1.1	1.1	Terry et al, 2002
Prostate	1.1	1.1	1.1	-	-	-	Huncharek et al, 2010

Table 4. Relative risks in the model for physical inactivity, <2 hour/week.

	Men			Women			Sources
	18-44	45-64	65-84	18-44	45-64	65-84	
Diabetes type 2	2.0	2.0	2.0	2.0	2.0	2.0	van Baal et al, 2008; Hu et al, 1999
Ischaemic heart disease	1.3	1.3	1.3	1.3	1.3	1.3	Wannamethee & Shaper, 2002
Stroke	1.2	1.2	1.2	1.2	1.2	1.2	Lee, 2003
COPD	1.1	1.1	1.1	1.1	1.1	1.1	Watz et al, 2008
Depression	1.8	1.8	1.8	1.8	1.8	1.8	Camacho et al, 1991
Hip fracture	2.0	2.0	2.0	2.0	2.0	2.0	Marks, 2010
Cancers:							
Colon	1.6	1.6	1.6	1.6	1.6	1.6	Howard et al, 2008
Breast	-	-	-	1.2	1.2	1.2	Rockhill et al, 1999

Physical inactivity, < 2 hours/week

Lack of adequate physical activity ranks as the fourth important risk factor for DALY losses in western Europe, as well as in Sweden, in the GBD 2010 (Lim et al, 2012), and most population groups in Sweden would benefit from an increased physical activity. In the model physical inactivity is defined as less than 2 hours physical activity per week. That definition is somewhat different from the definition in the Swedish guidelines: less than 150 minutes per week at a moderate level or less than 75 minutes per week at a high intensity level (Swedish National Board of Health and Welfare, 2011b). Table 1 reports the diseases related to physical inactivity and table 4 the relative risks.

Risky consumption of alcohol

High consumption of alcohol increases the risks for premature death 3-7 times (Andreasson et al, 1988) and it ranks as the eights risk factor for DALY losses in Western Europe in the GBD 2010 (Lim et al, 2012). Excessive alcohol consumption is related to a large number of diseases (Rehm et al, 2003),

Table 5. Relative risks in the model for risky consumption of alcohol.

	Men			Women			Sources
	18-44	45-64	65-84	18-44	45-64	65-84	
Depression	2.0	2.0	2.0	2.0	2.0	2.0	Davidson, 1995
Hip fracture	1.2	1.2	1.2	1.2	1.2	1.2	Marks, 2010
Liver cirrhosis	9.5	9.5	9.5	9.5	9.5	9.5	Johansson et al, 2006
Epilepsy	7.2	7.2	7.2	7.5	7.5	7.5	Johansson et al, 2006
Mental and behavioural disorders due to use of alcohol	wholly attributable to alcohol						Johansson et al, 2006
Cancers:							
Colon	1.8	1.8	1.8	1.8	1.8	1.8	Giovannucci et al, 1995

Breast	-	-	-	1.4	1.4	1.4	Johansson et al, 2006
Oesophageal	2.4	2.4	2.4	2.4	2.4	2.4	Johansson et al, 2006
Liver	3.0	3.0	3.0	3.0	3.0	3.0	Johansson et al, 2006

of which the model includes nine, see table 1. Note that moderate alcohol consumption is considered protective against certain diseases, in particular ischaemic heart disease and stroke (WHO, 2011), which is not considered in the model.

Unfortunately, there exist several definitions of excessive alcohol consumption. Hazardous consumption of alcohol in Swedish population surveys is normally defined based on the so-called AUDIT index (8 and more points for men and 6 and more for women) (Wennberg et al, 2006). In the Swedish guidelines, the term risky consumption of alcohol is used, defined as a weekly consumption exceeding 14 standard units for men and 9 for women (one standard unit contains 12 grams of pure alcohol; thus equivalent to 24 grams per day for men and 15 grams for women, respectively) or binge drinking at least once a month (5 or more standard units for men and 4 or more for women on the same one occasion) (Swedish National Board of Health and Welfare, 2011b). The Swedish Costs of Alcohol study (i.e. Johansson et al, 2006 in table 5), from which many of the relative risks are taken, define hazardous alcohol consumption as 40-60 grams alcohol per day for men and 20-40 grams for women (Johansson et al, 2006).

Mental and behavioural disorders due to use of alcohol is an exception in comparison with other diagnoses as the disease is wholly attributable to excessive consumption of alcohol. It means that if the prevalence of excessive consumption of alcohol decreases to zero the incidence of mental and behavioural disorders due to use of alcohol also increases to zero.

The model diseases

The model includes 15 disease groups, among them six types of cancer, which epidemiological studies have related to the four lifestyle risk factors. The metabolic diseases, i.e. diabetes, ischaemic heart disease, and stroke, are very prevalent in Sweden, with a combined annual incidence of around 0.5 million people (NDR 2011; SoS, Hospital Register; Riks-Stroke, 2011). The six types of cancer

Table 6. Annual incidence in the model diseases in Sweden, per 10 000.

	Men			Women			Sources
	18-44	45-64	64-84	18-44	45-64	64-84	
Diabetes type 2	12.523	67.799	114.991	9.043	54.160	98.682	NDR, 2011
Ischaemic heart disease	15.843	107.908	201.538	8.564	56.004	124.706	Allebeck et al, 2006
Stroke	0.904	7.192	21.251	0.747	4.104	13.069	Riks-Stroke, 2011
COPD	8.072	50.002	109.507	9.981	32.790	43.278	Lindberg. 2004
Depression	7.140	7.140	7.140	9.800	9.800	9.800	Sundquist et al, 2004
Hip fracture	1.519	6.813	23.448	0.590	7.620	36.075	SoS, Hospital Register
Liver cirrhosis	2.670	3.008	2.074	1.203	1.579	1.095	SoS, Hospital Register
Epilepsy	2.000	5.000	4.000	1.500	3.000	3.000	KFA, 2010
Mental and behavioural	0.060	6.930	30.403	0.070	1.664	10.048	SoS, Hospital Register

disorders due to use of alcohol							
Cancers:							
Colon	0.446	2.824	21.098	0.431	2.705	18.009	SoS, Cancer Register
Lung	0.130	3.142	19.506	0.162	3.278	14.723	SoS, Cancer Register
Breast	-	-	-	4.649	23.440	42.832	SoS, Cancer Register
Prostata	0.085	19.451	88.168	-	-	-	SoS, Cancer Register
Oesophageal	0.060	6.930	30.400	0.070	1.660	10.050	SoS, Cancer Register
Liver	0.510	8.980	34.818	0.666	3.272	15.075	SoS, Cancer Register

constitute around 45% of the Swedish cancer incidence (SoS, Cancer Register). Depression is a very common Swedish disorder, affecting around 30% of the Swedish population during their life (Sobocki et al, 2007). COPD is very common among tobacco smokers (Lindberg, 2004) while liver cirrhosis and epilepsy may be attributed to excessive alcohol consumption and mental and behavior disorders are alcohol related (Johansson et al, 2006). Hip fractures are common and serious events particularly in the elderly population (Marks, 2010). Table 6 reports the annual incidence in the diseases in the Swedish population.

The disease costs

To each of the 15 model diseases, societal costs are assigned. The costs include medical care costs, municipal (local authority) costs for care, and sickness insurance costs. The costs thus reflect costs for three Swedish sectors; the national social insurance, the regional healthcare, and the local authorities. The costs should be interpreted as annual costs per person, reported in Swedish SEK year 2012 (1 Euro=8.70 SEK; 1 USD=6.78 SEK). All costs have been converted into the 2012 price level by the Swedish consumer price index. The costs are undiscounted, to facilitate comparisons between the years.

Medical care costs

The medical care costs are taken from Swedish national and regional registers on healthcare consumption, except for depression, that is based on a Swedish published study (Sobocki et al, 2007). All costs are average annual disease-specific costs for hospital inpatient, specialist outpatient, and primary health care per person over the genders and age-groups. Some of the costs have been estimated for previous purposes, either for costs-effectiveness models (Feldman et al, 2011; Johansson, 2008) or for a cost-of-illness study on alcohol (Johansson et al, 2006), see table 7. Other medical care costs, referenced solely as Stockholm county council register, have been estimated for the present model in the same manner as the data for the cost-effectiveness models, described in

Table 7. Medical care costs, annual per person, in SEK year 2012.

	Annual cost	Source
Diabetes type 2	37 600	Stockholm county council register, from Feldman et al, 2011
Ischaemic heart disease	42 900	Stockholm county council register; from Feldman et al, 2011
Stroke	51 200	Stockholm county council register; from Feldman et al, 2011
COPD	74 000	Stockholm county council register
Depression	34 800	Sobocki et al, 2007
Hip fracture	123 600	Stockholm county council register; from Johansson, 2008
Liver cirrhosis	46 400	Swedish national and regional registers, from Johansson et al, 2006

Epilepsy	31 300	Swedish national and regional registers, from Johansson et al, 2006
Mental and behavioural disorders due to use of alcohol	22 300	Swedish national and regional registers, from Johansson et al, 2006
Cancers:		
Colon	46 600	Stockholm county council register
Lung	61 400	Stockholm county council register
Breast	26 900	Stockholm county council register
Prostata	29 800	Stockholm county council register
Oesophageal	72 500	Swedish national and regional registers, from Johansson et al, 2006
Liver	60 500	Swedish national and regional registers, from Johansson et al, 2006

detail in the model technical reports (Feldman et al, 2011; Johansson, 2008). The costs for hip fracture are estimated for the first year after a fracture, while the depression costs are estimated from the reported 6 months costs.

The Stockholm county council medical consumption register, set up to enable internal market transactions within the county council, covers all medical care for all Stockholm county inhabitants (2.1 million in 2012) since the year 1997. Each healthcare episode of each inhabitant is recorded, with up to 10 diagnoses, under a personal identification number. The register thus enables the calculation of disease-specific medical costs per individual during a series of years. The inpatient and outpatient consumption are priced according to the Stockholm county council NordDRG-based pricelist, while primary care is valued by Swedish standard costs.

The medical care costs for five alcohol-related diseases (Liver cirrhosis , Liver and Oesophageal cancer, Mental and behavioural disorders due to use of alcohol and Epilepsy) are based on several Swedish national and regional medical care registers, described in detail in the Swedish Cost of Alcohol report (Johansson et al, 2006). The costs for the present study were calculated by dividing the disease-specific alcohol-attributable cost by the number of alcohol-related cases. Note that this does not imply costs per individual but costs per case. To the extent that the same individual might constitute several cases during a certain year, the costs are underestimated.

Municipal costs for care

Data on disease-specific costs accrued by the municipals (local authorities) for community services in Sweden are very sparse, even though the reported costs for some specific diseases are considerable (Jacobsson et al, 2007; Persson et al, 2012). In the model we thus use a novel approach, relating the model diseases to certain levels of need of community services, enabled by a publication that reports

Table 8. Municipal care costs, annual per person, in SEK year 2012, and assumed IADL class.

	Annual cost	IADL dependencies
Diabetes type 2	0	0
Ischaemic heart disease	21 000	1
Stroke	52 000	na
COPD	21 000	1
Depression	26 000	na
Hip fracture	95 000	2-4

Liver cirrhosis	21 000	1
Epilepsy	175 000	na
Mental and behavioural disorders due to use of alcohol	95 000	2-4
Cancers:	95 000	2-4
Colon		
Lung		
Breast		
Prostata		
Oesophageal		
Liver		

Source: Lindholm et al, 2013. Estimated from figures 1 and 2.
na=not applicable

costs based on functional levels (Lindholm et al, 2013). Municipal community services are approved based on needs for support in daily activities, not because of specific diseases. We thus propose that municipal care costs described from functional level can be used to estimate expected costs of services for certain diseases, if the typical need of community services because of these diseases also is described by functional level.

The model diseases were classified into number of IADL dependencies (Instrumental Activities of Daily Living; seven possible dependencies including shopping for groceries, cooking, cleaning, doing laundry, taking care of one's finances, using the telephone, and using public transportation) based on the lay descriptions of disease used for the GBD 2010 (Salomon et al, 2012, supplemental material). The municipal care costs, including accommodation, home help, and home health care, for the IADL classes were then approximated from Lindholm et al (2013). The costs for the diseases stroke, depression and epilepsy were reported separately in the publication, and were thus approximated without the IADL classification, see table 8. Note that the costs could be somewhat overestimated, as they were calculated for an elderly (aged 65+) cohort, even though age *per se* does not constitute a reason for approved community services in Sweden.

Sickness insurance costs

The sickness insurance costs included in the model are costs to the national social security system because of disease, constituting a transfer to substitute lost income because of sickness. Note that the costs are not the so-called productivity costs, recommended to be included in Swedish health economic evaluations (Drummond et al, 2005; LFN, 2003), but reflects the costs of disease for the national level sector in Sweden.

Table 9. Sickness insurance costs, annual per person, in SEK year 2012, and assumed sickness absence.

	Annual cost	Proportion sickness absence
Diabetes type 2	0	0%

Ischaemic heart disease	72 000	25%
Stroke	144 000	50%
COPD	72 000	25%
Depression	72 000	25%
Hip fracture	288 000	100%
Liver cirrhosis	72 000	25%
Epilepsy	288 000	100%
Mental and behavioural disorders due to use of alcohol	288 000	100%
Cancers:	288 000	100%
Colon		
Lung		
Breast		
Prostata		
Oesophageal		
Liver		

Table 10. QALY and DALY weights, for a year spent in disease.

	QALY weight	DALY weight
Diabetes type 2	0.66	0.03
Ischaemic heart disease	0.60	0.06
Stroke	0.52	0.08
COPD	0.73	0.19
Depression	0.68	0.41
Hip fracture	0.67	0.31
Liver cirrhosis	0.62	0.19
Epilepsy	0.64	0.32
Mental and behavioural disorders due to use of alcohol	0.70	0.39
Cancers:		0.29
Colon	0.67	
Lung	0.56	
Breast	0.76	
Prostata	0.69	
Oesophageal	0.82	
Liver	0.82	

Source: Sullivan et al, 2011, web table 3; Salomon et al, 2012, table 2.

The costs are calculated based on estimated level of sickness absence, see table 9, derived from the lay descriptions of the diseases in GBD 2010 (Salomon et al, 2012, supplemental material), and thus corresponding to the IADL dependencies in table 8. More than 1 IADL dependencies were assumed to lead to a 100% sickness absence, while 1 IADL dependency was assumed to correspond to a 25% absence. Stroke was assumed to lead to a 50% absence, depression to 25% and epilepsy to 100%.

The social security benefit level was assumed to 80% of lost income, where the lost income is based on the average salary in Sweden in year 2012; 24 000 SEK per month.

Disease health effects

The health effects because of disease are described in the model as the decreased number of incident cases of disease and as two separate measures of health; increased health-related quality of life (QALYs) and decreases in disability (DALYs).

Quality-adjusted life-years (QALYs)

The QALY weights are used to describe the losses in health-related quality of life due to the model diseases, see table 10. The weights are community-based, derived via the EQ-5D classification system with the UK time-trade-off valuations (Sullivan et al, 2011). The weights are applied to a year lived with disease for all ages and genders, thus not taking into account the decreased average quality of life in older ages and the differences in average quality of life between the genders (Burström et al, 2001). The QALYs are calculated as increases in health, i.e. as the difference to full health (with a weight of 1).

Disability-adjusted life-years (DALYs)

The DALY weights are used to describe the disability due to the model diseases, see table 10. The weights are taken from the new Global Burden of Disease reports, the GBD 2010 (Salomon et al, 2012). The weights are applied to a year lived with disease for all ages. The DALYs are calculated as losses of full health (with a weight of 1).

Epidemiological data and methods

The RHS-model is population-based, linking the population prevalence of risk factors to future disease incidence via the risks for disease and the current disease incidence, for each modeled disease. Changes in population risk factor prevalence is assumed to lead to changes in future incidence, calculated by the epidemiological method called potential impact fraction, that estimates the fraction of the current disease incidence that could be prevented in the future. This section describes the model epidemiological data and assumptions; the population groups considered, the choices and format of the risk equation, and the methods of adjusting for the two time horizons 5 and 10 years.

Population groups

The model covers the adult population, divided into six age- and gender-specific groups; age groups 18-44 years, 45-64 years and 65-84 years, and men and women. The age groups are chosen to correspond to common age groups in Swedish population surveys, to reflect differing disease risks and disease patterns, and to take account of the Swedish institutional setting.

Only the adult population is included, with 18 years being the age of legal adulthood in Sweden, as the risk factors affect disease mainly in adult years. Disease is however comparatively rare at the younger ages, see table 6, but as the model time horizon spans 10 years, the risk factor prevalence among the younger adults will lead to future disease incidence. The middle age group 45-64 years is chosen mainly to be able to correctly model the sickness insurance costs, as the Swedish customary age of retirement from work is around 65 years. The oldest included age is 84 years, as the very high disease prevalence among the elderly makes it more difficult to establish causality between risk factors and disease incidence, leading to a lack of epidemiological data. The gender division is necessary as there are marked differences in risk factor prevalence as well as in disease risks between men and women.

The risk factor prevalence in the model population groups can be found in customary Swedish population surveys, that periodically study the lifestyles of the Swedish population, at national as well as regional level.

The disease incidence

The future disease incidence in the model results is based on the current disease incidence rate, age group- and gender-specific, see table 6. The data is taken from Swedish national registers and Swedish scientific reports. For the register data, average incidence rates for 2012 for the population groups included in the model were calculated.

The model takes advantage of the unique breadth and width of Swedish national and local registers, foremost the databases from Swedish National Board of Health and Welfare (SoS, Socialstyrelsen).

Incidence data for all cancer diagnoses were taken from the Cancer register, where yearly incidence is regularly updated and presented separately for genders and age. That is the reason why it is possible to calculate average incidence rates for the population groups included in the model. The incidence for hip fracture, lever cirrhosis as well as alcohol psychosis were derived from the Hospital Register, where the number of patients per 100,000 inhabitants are reported annually for all diagnoses. These prevalence numbers could be slightly overestimated and they were thus adjusted according to expert opinion (*pers com. Tobias Eriksson, Chief medical officer, Section of Dependency and Neuropsychiatrics, Akademiska Hospital, Uppsala, Sweden*) for the proportion of new cases among all hospital admission cases for these diagnoses.

The incidence for diabetes and stroke were derived from Swedish national so-called Quality Registers; the National Diabetes Register (NDR, 2011) and the National Stroke register (Riks-Stroke, 2011). These data sources cover almost 80% of the cases in Sweden, are updated yearly and present the data separately for gender and age.

The incidence for ischemic heart disease, depression, COPD and epilepsy were taken from Swedish scientific reports. This means that the data is of more uncertain quality, as the data were mainly presented for a given year.

Studies report differential disease patterns in Swedish regions (Wennerholm et al, 2011), but as this might be due to differential risk factor patterns, the model uses the Swedish national average disease rates. The incidence rate is reported as incident cases of disease per 10,000 person-years. Together with the number of inhabitants in the population groups, the incidence rate is employed to calculate the number of incident cases in the population studied.

The risk equation

The starting points of the simulations are the increased risk for disease for a person with a certain risk factor, compared to the risk of a person without the risk factor. This risk is often called the relative risk (Morgenstern & Bursic, 1982; Kleinbaum et al, 1982) which is defined formally as: the risk of disease in relation to exposure of a risk factor. The relative risk is calculated, for each disease, as the risk of an outcome (i.e. an incident case of disease in our model) in the exposed group (i.e.

among people with the risk factor) divided by the risk in the unexposed group (i.e. among people without the risk factor). The relative risk is thus the extra risk that is related to a certain risk factor.

The relative risks in the model are reported in tables 2 to 5, for each respective risk factor, for the six population groups. To obtain the risks for the risk factors obesity, daily tobacco smoking and physical inactivity, searches of scientific literature databases were done for each risk factor separately using key words combined with every disease (diagnoses); e.g. "daily tobacco smoking" AND "stroke". We selected those studies which presented relations between the risk factor and the probability to contract a disease in terms of a relative risk. If relative risks were not available, they were calculated based on the reported data from long-term epidemiological studies. One of the important factors in choosing the specific study was the possibility to obtain data distributed according to gender and age. If no retrieved study reported such data, we assumed that the relative risks reported were the same for men and women independent of age.

The relative risks for risky consumption of alcohol are taken from on studies presented in the Swedish Costs of Alcohol study (i.e. Johansson et al, 2006).

The age group- and gender-specific relative risks together with the risk factor prevalence in the population group are used to calculate the potential impact fraction, often called IF. The IF is the proportion of the current disease incidence that could be prevented in the future if the risk factor prevalence is changed, see equation below.

Potential impact fraction

$$IF = \frac{[(p2 - p1) + RR(p1 - p2)]}{[(1 - p1) + RR * p1]}$$

p1 is the prevalence of the risk factor in the population group at present
p2 is the changed prevalence of the risk factor in the population group
RR is the relative risk

Adjusting for time horizon

Changes in risk factors cannot be expected to affect morbidity immediately, but with a time lag. This time lag is often called time horizon, and specify when the changes are likely to have become reflected in a reduction in morbidity. In the model, the time horizon is from 5 to 10 years, and it is incorporated into the calculations by an adjusted relative risk (RR adjusted). The chosen time horizon in this version of the model is a simplification; the model diseases are affected differently over time by changes in risk factors.

The two main assumptions are:

- Relative risks (RR) change linearly, from 1 (no excess risk) to RR (the risk factor-specific excess risk) during 10 years:

  RRi = (RR/10)* i
  i is the year, i= 5 to 10

This is a simplification. The epidemiological studies used in this model report different time intervals when the risk factor-specific excess risk for a disease decreases to 1, from 5 to 20 years. We have decided to assume the 10 years' time horizon for all relative risks in the model.

- The risk factor prevalence changes linearly, from the year five:

  $p2_i$ =(p2/10)* i, (i=5 to 10)

Adjusted potential impact fraction

$$IF_i(p1, p2_i) = \frac{[(p2_i - p1) + RR_i(p1 - p2i)]}{[(1 - p1) + RR_i * p1]}$$

i is the year (i=5 to 10)

and thus the change in incidence $f(i)$ can be calculated for each year.

The adjusted impact fractions for every year i are calculated separately, so the total change in incidence during n years, n=5 to 10, $F(n)$ is then the sum of the changes in incidence during the n years:

$$F(n) = \sum_{i=5}^{n} f(i)$$

Summary of model input and output data

The model thus contains several types of data, often called parameters in modelling. These can be divided into fixed parameters and input parameters. The fixed parameters are derived from scientific studies or registers and should in most cases be kept unchanged when running the model. The input parameters describe the scenarios that are to be modelled.

The fixed parameters are:

- Relative risks for the 15 diseases, subject to the risk factor prevalence, for the six gender-specific age groups (tables 2- 5)
- Incidence in the 15 diseases, for the six gender-specific age groups (table 1)
- Annual societal costs for a person with a certain disease (tables 7-9)
- Annual health effects, in QALYs or DALYs, for a person with a certain disease (table 10)

The input parameters are:

- Number of population , for the four gender-specific age groups
- Current prevalence of the four risk factors in the six gender-specific age groups, expressed in decimals (i.e. 0.12 instead of 12%)
- Desired prevalence of the four risk factors in the six gender-specific age groups, expressed in decimals (i.e. 0.1 instead of 10%)

Based on the fixed parameters and the chosen input parameters, the model calculates a result, i.e. an output. The output in the current version can be calculated from two different time horizons; 5 or 10 years posterior to the chosen simulation year.

The model outputs for the 5 year horizon:

- Changes in number of incident cases, in year 5
- Changes in societal costs, total as well as per sector, in year 5
- Changes in health effects, in QALYs and DALYs, in year 5

The model outputs for the n-year horizon (n=6 to 10):

- Changes in number of incident cases, accumulated from year 5 to year n
- Changes in societal costs, total as well as per sector, accumulated from year 5 to year n
- Changes in health effects, in QALYs and DALYs, accumulated from year 5 to year n

A scenario

To illustrate the data requirements and the model results a scenario from the Swedish healthcare region Stockholm, the capital, is used. The scenario has been reported previously in Swedish (Johansson & Feldman, 2013), but this section also reports the detailed model results, in terms of risk factor-specific disease-related societal costs and health effects. The scenario consists of two time horizons, 5 years and 10 years from the current year, which in this case is year 2012.

Input parameters

The starting point of the scenario simulations is the current prevalence of the risk factor in the population groups, along with the desired prevalence 5 years and 10 years later. In this scenario, the desired prevalence is one percentage point lower than the current level for the year 5 and two percentage points lower for the year 10, see table 11 . The scenario does not specify how this desired level would be achieved, and no costs are calculated for the measures that are required to reach the desired level.

The calculation of the population disease incidence requires the number of people in the six population groups, see table 12, in this case a total of 1.6 million adults in the ages 18-85 years in Stockholm county. In conjunction with the model fixed parameters, i.e. the relative risks, the average disease incidence as well as the annual disease-related societal costs and health effects, an estimate of the effects of the scenario assumptions can be performed for a 5 and 10 year time horizon.

Tabell 11. Prevalence of the risk factors in Stockholm county, current situation year 2012 and desired situation year 2017 (5 years) and year 2022 (10 years)

	Obesity						Daily smoking					
	current		desired				current		desired			
Age			year 5, 2017		year 10, 2022				year 5, 2017		year 10, 2022	
group	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
20-44	8%	7%	7%	6%	6%	5%	11%	13%	10%	12%	9%	11%
45-64	15%	15%	14%	14%	13%	13%	15%	15%	14%	14%	13%	13%
65-84	12%	15%	11%	14%	10%	13%	9%	9%	8%	8%	7%	7%

	Physical inactivity						Risky consumption of alcohol					
	current		desired				current		desired			
Age			year 5, 2017		year 10, 2022				year 5, 2017		year 10, 2022	
group	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
20-44	20%	20%	19%	19%	18%	18%	18%	11%	17%	10%	16%	9%
45-64	26%	21%	25%	20%	24%	19%	16%	10%	15%	9%	14%	8%
65-84	28%	31%	27%	30%	26%	29%	15%	10%	14%	9%	13%	8%

Source: Stockholm county council, Public Health Report 2011.

Tabell 12. Population in Stockholm county, year 2012.

Age group	Men	Women
18-44	416 682	409 560
45-64	258 662	256 946
65-84	130 127	152 035

Source: Statistics Sweden Database

Model results

The model results are reported as changes in incident cases and related costs and health effects in 5 and 10 years if the desired risk factor prevalence is achieved, in comparison with the situation if the current risk factor prevalence from year 2012 prevails.

As the year 10 changes are accumulated for 5 years, i.e. since year 5, while the year 5 changes are the changes occurring during year 5 only, there is a dramatic difference between the estimates, see table 13. Another factor is the assumed higher decrease, of 2 percentage points, of risk factor levels for the year 10 estimate.

The largest reduction in the number of incident cases is found for COPD (chronic obstructive pulmonary disease), as the disease is so frequent among smokers. This makes the decrease in daily smoking the risk factor change that is estimated to lead to the largest number of prevented cases, 360 during year 5 and to over 3 000 during the following 5 years until year 10. A decreased

Table 13. Estimated changes in incident cases at year 5 and year 10.

	Obesity		Daily smoking		Physical inactivity		Risky cons. of alcohol	
	5 years	10 years	5 years	10 years	5 years	10 years	5 years	10 years
Diabetes type 2	-121	-1 091	-2	-120	-56	-504	0	0
Ischaemic heart disease	-31	-283	-72	-651	-27	-244	0	0
Stroke	-1	-12	-5	-49	-2	-14	0	0
COPD	0	0	-225	-2 024	-4	-39	0	0
Depression	-4	-36	-1	-12	-9	-84	-12	-110
Hip fracture	0	0	-10	-91	-10	-93	-3	-28
Liver cirrhosis	0	0	0	0	0	0	-12	-111
Epilepsy	0	0	0	0	0	0	-15	-138
Mental and behavioural disorders due to use of alcohol	0	0	0	0	0	0	-57	-517
Cancers:								
Colon	-4	-31	-1	-13	-4	-34	-5	-48
Lung	0	0	-39	-348	0	0	0	0
Breast	-4	-32	-1	-13	-3	-25	-6	-50
Prostata	-2	-14	-2	-21	0	0	0	0
Oesophageal	0	0	0	0	0	0	-9	-81

Liver	0	0	0	0	0	0	-11	-103
Total	-167	-1 499	-360	-3 341	-115	-1 038	-130	-1 185

Table 14. Estimated changes in societal costs at year 5, in SEK year 2012.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	-4 344 428	-476 873	-2 006 317	0
Ischaemic heart disease	-4 208 233	-9 686 045	-3 633 459	0
Stroke	-338 125	-1 338 550	-388 061	0
COPD	0	-36 765 412	-714 040	0
Depression	-524 788	-178 428	-1 223 815	-1 597 768
Hip fracture	0	-5 062 651	-5 165 267	-1 532 454
Liver cirrhosis	0	0	0	-2 633 661
Epilepsy	0	0	0	-7 563 323
Mental and behavioural disorders due to use of alcohol	0	0	0	-23 298 860
Cancers:				
Colon	-1 454 683	-609 001	-1 620 903	-2 257 497
Lung	0	-1 7047 048	0	0
Breast	-1 448 206	-582 996	-1 123 117	-2 268 105
Prostata	-626 997	-941 600	0	0
Oesophageal	0	0	0	-4 090 953
Liver	0	0	0	-5 086 933
Total	-12 945 459	-72 688 604	-15 874 978	-50 329 554

prevalence of obesity is estimated to affect diabetes type 2 to a large extent, while ischaemic heart disease is affected by three risk factors; obesity, daily smoking and physical inactivity. The assumed reduction of risk factor prevalence of 1 percentage point at year 5 is estimated to reduce the number of incident cases by at least 100 for all the risk factors. The assumed change of 2 percentage points for the year 10 horizon might lead to decreases of at least 1 000 cases between year 5 and 10 for all the four risk factors, and the largest number for daily smoking followed by risky consumption of alcohol.

Model estimates for year 5

The estimated changes in societal costs, i.e. for medical care, municipal care and sickness insurance costs, at year 5 are shown in table 14. A decrease in daily smoking of 1 percent point is expected to lead to decreases in costs of over 70 million SEK, half of that due to a decrease in COPD cases. A similar reduction in risky consumption of alcohol will lead to cost savings of around 50 million, while obesity and physical activity is estimated to lead to smaller cost decreases; 13 and 16 million, respectively.

The following tables, tables 15 to 17, show the detailed cost decreases estimated at year 5. The savings in sickness insurance costs are the largest; estimated at over 30 million SEK for daily smoking and risky consumption of alcohol, and 5-8 million for obesity and physical inactivity. The medical care cost decreases are by far the largest for daily smoking, 23 million, while at 4-6 million for the other three risk factors, again due to the high incidence of COPD among smokers. The municipal care cost savings are estimated at around 12 million for daily smoking and risky alcohol consumption, and only 2 million for obesity and physical inactivity.

Table 15. Estimated changes in medical care costs at year 5, in SEK year 2012.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	-4 344 428	-476 873	-2 006 317	0
Ischaemic heart disease	-1 283 676	-2 954 624	-1 108 347	0
Stroke	-67 395	-266 800	-77 348	0
COPD	0	-15 851 901	-307 868	0
Depression	-132 707	-45 120	-309 476	-404 040
Hip fracture	0	-1 190 082	-1 214 204	-360 235
Liver cirrhosis	0	0	0	-572 642
Epilepsy	0	0	0	-478 924
Mental and behavioural disorders due to use of alcohol	0	0	0	-1 281 926
Cancers:				
Colon	-151 147	-63 277	-168 417	-234 562
Lung	0	-2 257 137	0	0
Breast	-90 815	-36 559	-70 429	-142 230
Prostata	-45 263	-67 974	0	0
Oesophageal	0	0	0	-651 140
Liver	0	0	0	-693 933
Total	-6 115 431	-23 210 348	-5 262 407	-4 819 632

Table 16. Estimated changes in municipal care costs at year 5, in SEK year 2012.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	0	0	0	0
Ischaemic heart disease	-660 384	-1 519 998	-570 186	0
Stroke	-71 826	-284 342	-82 434	0
COPD	0	-4 722 406	-91 716	0
Depression	-104 021	-35 367	-242 580	-31 6703
Hip fracture	0	-960 559	-980 029	-29 0759
Liver cirrhosis	0	0	0	-1 172 436
Epilepsy	0	0	0	-2 677 689
Mental and behavioural disorders due to use of alcohol	0	0	0	-5 461 119
Cancers:				
Colon	-323 332	-135 362	-360 277	-501 772

Lung	0	-3 668 516	0	0
Breast	-336 690	-135 539	-261 110	-527 306
Prostata	-144 294	-216 696	0	0
Oesophageal	0	0	0	-853 218
Liver	0	0	0	-1 089 647
Total	-1 640 547	-11 678 785	-2 588 333	-12 890 650

Table 17. Estimated changes in sickness insurance costs at year 5, in SEK year 2012.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	0	0	0	0
Ischaemic heart disease	-2 264 173	-5 211 423	-1 954 925	0
Stroke	-198 903	-787 408	-228 279	0
COPD	0	-16 191 105	-314 456	0
Depression	-288 059	-97 940	-671 760	-877 024
Hip fracture	0	-2 912 010	-2 971 034	-881 459
Liver cirrhosis	0	0	0	-888 583
Epilepsy	0	0	0	-4 406 711
Mental and behavioural disorders due to use of alcohol	0	0	0	-16 555 814
Cancers:				
Colon	-980 205	-410 361	-1 092 208	-1 521 163
Lung	0	-11 121 395	0	0
Breast	-1 020 701	-410 898	-791 577	-1 598 569
Prostata	-437 440	-656 930	0	0
Oesophageal	0	0	0	-2 586 596
Liver	0	0	0	-3 303 352
Total	-5 189 481	-37 799 471	-8 024 239	-32 619 272

The changes in health effects following a one percent decrease in risk factor prevalence estimated to occur in year 5 show a somewhat different pattern, see tables 18 and 19, than the cost decreases. A decrease in daily smoking is again estimated to lead to the highest gains in QALYS, quality-adjusted

Table 18. Estimated changes in QALYs at year 5.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	41.23	4.53	19.04	0.00
Ischaemic heart disease	12.58	28.95	10.86	0.00
Stroke	0.66	2.62	0.76	0.00
COPD	0.00	60.72	1.18	0.00
Depression	1.28	0.44	2.99	3.90
Hip fracture	0.00	3.34	3.40	1.01
Liver cirrhosis	0.00	0.00	0.00	4.69

Epilepsy	0.00	0.00	0.00	5.51
Mental and behavioural disorders due to use of alcohol	0.00	0.00	0.00	17.25
Cancers:				
Colon	1.12	0.47	1.25	1.74
Lung	0.00	16.99	0.00	0.00
Breast	0.85	0.34	0.66	1.33
Prostata	0.47	0.71	0.00	0.00
Oesophageal	0.00	0.00	0.00	1.62
Liver	0.00	0.00	0.00	2.06
Total	58.19	119.10	40.14	39.11

Table 19. Estimated changes in DALYs at year 5.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	3.64	0.40	1.68	0.00
Ischaemic heart disease	1.89	4.34	1.63	0.00
Stroke	0.11	0.44	0.13	0.00
COPD	0.00	42.73	0.83	0.00
Depression	1.64	0.56	3.83	4.99
Hip fracture	0.00	3.13	3.20	0.95
Liver cirrhosis	0.00	0.00	0.00	2.34
Epilepsy	0.00	0.00	0.00	4.90
Mental and behavioural disorders due to use of alcohol	0.00	0.00	0.00	22.42
Cancers:				
Colon	0.99	0.41	1.10	1.53
Lung	0.00	11.20	0.00	0.00
Breast	1.03	0.41	0.80	1.61
Prostata	0.44	0.66	0.00	0.00
Oesophageal	0.00	0.00	0.00	2.60
Liver	0.00	0.00	0.00	3.33
Total	9.73	64.29	13.19	44.68

life-years, and DALYs, disability-adjusted life-years, with decreases in the incidence of COPD causing around half of the gains. Following daily smoking, health measured as QALYs would increase the most for obesity, at 58 QALYs, and around 40 for the other two risk factors. Health measured as DALYs is estimated at lower levels than the QALYs, and risky consumption of alcohol is the second most important contributor to DALY gains, after daily smoking. The differences in the QALY and DALY estimates are most pronounced for the diseases diabetes type 2 and ischaemic heart disease.

Model estimates for year 10

The 10 year estimates include accumulated changes during years 5 to 10, i.e. a total of 6 years. The estimates reported here furthermore assume a 2 % change in risk factor prevalence in the current year, i.e. in 2012.

The changes in estimated costs and health by the risk factor change are considerable, exceeding 100 million SEK in cost decreases for all risk factors, see table 20, and with health gains of at least 350 QALYs or nearly or more than 100 DALYs , see table 21, for the Stockholm population of 1.6 million adults in the ages 18-85 years. As in the 5 year estimates, decreases in daily smoking yields the largest cost decreases and health increases, followed by risky consumption of alcohol.

Table 20. Estimated changes in societal costs between years 5 and 10, in SEK year 2012.

	Obesity	Daily smoking	Physical inactivity	Risky cons. of alcohol
Diabetes type 2	-39 099 851	-4 291 860	-18 056 851	0
Ischaemic heart disease	-37 874 096	-87 174 407	-32 701 131	0
Stroke	-3 043 123	-12 046 946	-3 492 549	0
COPD	0	-330 888 705	-6 426 359	0
Depression	-4 723 090	-1 605 852	-11 014 339	-14 379 908
Hip fracture	0	-45 563 863	-46 487 403	-13 792 086
Liver cirrhosis	0	0	0	-23 702 953
Epilepsy	0	0	0	-68 069 908
Mental and behavioural disorders due to use of alcohol	0	0	0	-209 689 738
Cancers:				
Colon	-13 092 150	-5 481 008	-14 588 124	-20 317 470
Lung	0	-153 423 434	0	0
Breast	-13 033 852	-5 246 968	-10 108 051	-20 412 946
Prostata	-5 642 970	-8 474 398	0	0
Oesophageal	0	0	0	-36 818 581
Liver	0	0	0	-45 782 394
Total	-116 509 132	-654 197 439	-142 874 806	-452 965 984

Table 21. Estimated changes in QALYs and DALYs between years 5 and 10.

	Obesity		Daily smoking		Physical inactivity		Risky cons. of alcohol	
	QALY	DALY	QALY	DALY	QALY	DALY	QALY	DALY
Diabetes type 2	371	33	41	4	171	15	0	0
Ischaemic heart disease	113	17	261	39	98	15	0	0
Stroke	6	1	24	4	7	1	0	0
COPD	0	0	546	385	11	7	0	0

Depression	12	15	4	5	27	34	35	45
Hip fracture	0	0	30	28	31	29	9	9
Liver cirrhosis	0	0	0	0	0	0	42	21
Epilepsy	0	0	0	0	0	0	50	44
Mental and behavioural disorders due to use of alcohol	0	0	0	0	0	0	155	202
Cancers:								
Colon	10	9	4	4	11	10	16	14
Lung	0	0	153	101	0	0	0	0
Breast	8	9	3	4	6	7	12	14
Prostata	4	4	6	6	0	0	0	0
Oesophageal	0	0	0	0	0	0	15	23
Liver	0	0	0	0	0	0	19	30
Total	524	88	1 072	579	361	119	352	402

Discussion

This technical report describes the methods and data employed and assumptions required for the simulation model RHS (Risk factors, health and societal costs). The model describes the effects of changes in the population prevalence of four common lifestyle risk factors for disease in terms of disease incidence and related societal costs and health effects. The simulations use epidemiological data and methods in conjunction with health economic data on disease costs for three Swedish sectors of society and two different measures of health, to enable a comprehensive description of the potential effects of public health measures.

The model contains several assumptions and rather crude averages, which imply that the results from the scenarios should be regarded as mere simulations, or rough estimates, of the effects of successful prevention work. The model however contains the most relevant risk factors for disease in Sweden, according to the GBD 2010 (Global Burden of Disease 2010; Lim et al, 2012), and there are prevention measures that can affect these risk factors, according to the guidelines from the Swedish National Board of Health and Welfare (Socialstyrelsen, 2011a). The epidemiological method is similar to the one used for the GBD 2010 (Lim et al, 2012) and the disease risk are taken from renowned international scientific studies, while Swedish registers on disease incidence and healthcare patterns coupled with regional population surveys have been used whenever possible in order to reflect Swedish and regional circumstances.

The most significant uncertainty of data validity is probably found in the model estimates for the municipal care costs and the sickness insurance costs, as the lack of data forced us to resort to crude assumptions (maybe best denominated as "guess estimates") on the disease-specific costs. The lack of disease-specific costs for the two sectors of society is well-known in Sweden, and as the overall objectives of the two sectors is focused on functional disabilities rather than specific diseases it is implausible that comprehensive data on disease-specific costs will be collated in the near future. The methodology employed here, to convert diseases into functional disabilities, might thus be the most tractable way to enable inclusion of costs for these two important Swedish sectors.

The model aim is not to calculate future disease incidence and related costs for the Swedish population, but merely to calculate the implications of minor changes in the prevalence of some risk factors for disease. A more comprehensive, and complex, model would include more risk factors as well as mortality and morbidity patterns for a wide range of diseases. It is of course not possible to avoid all diseases, and deaths, -every person contracts disease and die, eventually. The model does not include any of these dynamic effects, often called competing risks within epidemiology, that imply that decreases in the incidence for one disease leads to increases in other diseases instead. This substitution disease of course implies costs and ill-health. Furthermore, the model does not include mortality.

Partly due to these reasons, we recommend that the model results are reported as changes, in the number of diseased persons, in health and in societal costs. The modelling however is performed as estimates of the risk factor effects on the total number of diseased persons, on the total societal costs and on the numbers of QALYs and DALYs. Many other factors affect the future situation, apart from the prevalence of the four risk factors, such as changes in the demographic structure, changes in medical technology and practice, changes in other risk factors for disease, and changes in other environmental and societal circumstances. We thus strongly recommend that the model results are interpreted in a restrictive manner –in terms of changes following minor changes in population risk factor prevalence under the (unrealistic) assumption that everything else remains identical.

The results do not sum the number of cases avoided, the increased health nor the decreased costs over the risk factors. The reason is that there is a strong correlation between two of the risk factors; obesity and physical inactivity. These are often concurrent in individuals, preventive primary care work often addresses the two risk factors simultaneously and the disease patterns are similar. In fact, physical inactivity could be regarded a risk factor for obesity. On individual-level the risk for overestimates is obvious; a person that increases the physical activity and thus decrease his/her BMI can only avoid one case of myocardial infarction. Albeit to a lesser extent, this overestimate can occur also on population-level. But, the risks might also be multiplicative, so that a person with several risk factors might run a higher risk of contracting disease, which is not included in the estimates. It is unclear how the two aspects are related; do they lead to under- or overestimates? In order to present conservative estimates, we recommend not to sum the effects of the risk factors, in contrast to the GBD 2010.

The model generates relevant data for several Swedish sectors of society; the national social benefits system, the regional healthcare sector and the local municipal sector, that we think are important stakeholders for the Swedish public health. Instead of productivity costs, i.e. the loss of societal resources due to individuals´ inability to engage in remunerated work, the model includes the payments of sickness insurance that cover individuals´ loss of income due to sickness, i.e. transfer payments. The reason is that the model is constructed to supply information on potential gains for public health stakeholders, and we believe that potential decreases in sickness insurance costs are relevant arguments for Swedish national level decision-maker. For the same reasons the model contains two different measures of health effects; QALYs and DALYs, as the preferences of decision-makers on health measures differ. We thus believe that the model estimates can supply relevant and valid arguments for decision-makers in the three sectors of Swedish society that have the largest potentials to influence the Swedish population health.

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