Avoidable cancers in the Nordic countries – the impact of overweight and obesity

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Abstract (207 words)

Background: Several types of cancers are causally linked to overweight and obesity which are increasing in the Nordic countries. The aim of this study was to quantify the proportion of the cancer burden linked to overweight and obesity in the Nordic countries and estimate the potential for cancer prevention.

Methods: Under different prevalence scenarios of overweight and obesity, numbers of cancers in the Nordic countries in the coming 30 years (2016-2045) were estimated for 13 cancer sites, and compared to the projected number of cancers if the prevalence stayed constant. The Prevent macro-simulation model was used.

Results: Over the period 2016-2045, 205,000 cancer cases out of the 2.1 million expected for the 13 studied cancer sites (9.5%) could be avoided in the Nordic countries.by totally eliminating overweight and obesity. The largest proportional impact was found for esophageal adenocarcinoma (24%), and the highest absolute impacts was observed for colon (44638) and postmenopausal breast cancer (41135).

Conclusion: Decreased prevalence of overweight and obesity would reduce the cancer burden in the Nordic countries. The results from this study form an important step to increase awareness and priorities in cancer control by controlling overweight and obesity.

Introduction

Overweight and obesity has many health consequences, including risk of cardiovascular disease, diabetes and different types of cancer.(1-3) In part, the link to cancer may be explained by alterations in the metabolism of endogenous hormones, including sex steroids, insulin, and insulin-like growth factors, distorting the balance between cell proliferation, differentiation and apoptosis, or a low-grade chronic inflammatory state promoting tumour development.(4) The increasing prevalence of overweight and obesity in the Nordic and other countries (5-7) and cancers attributable to this, make prevention of overweight and obesity an important public health approach to lower the future cancer burden in the Nordic countries.

Estimation of the cancer burden has focused on the population attributable fraction (PAF) of overweight and obesity interpreting it as the fraction of avoidable cancers if the risk factor could be removed from the population. (8-15) For primary prevention purposes, it is more important to understand the impact of reducing exposure prevalence to realistic levels. The aim of this study was to quantify the fraction of the cancer burden in the Nordic countries (Finland, Denmark, Iceland, Norway and Sweden) linked to overweight and obesity and estimate the potential for cancer prevention under different scenarios.

Material and Methods

We chose the cancer sites for our analyses based on reports by the World Cancer Research Fund (WCRF) and the International Agency for Research on Cancer (IARC) working group on the preventive effects of avoidance of excess body fatness on cancer risk.(2, 3, 16) All cancer sites

where convincing/sufficient evidence of a causal link to body fatness exists in at least one of these sources were included, except meningioma of the brain and prostate cancer. The cancer sites included were cancers of breast (postmenopausal), colon, rectum, pancreas, endometrium, kidney, liver, oesophagus (adenocarcinoma), gastric cardia, gall bladder, ovary, thyroid and multiple myeloma. Meningioma is from a pathological point of view a benign tumour, and recording of these in cancer registries are heterogeneous and incomplete. The IARC working group concluded "limited evidence for an association with fatal prostate cancer "(2) but fatal cases are difficult to define. We therefore decided not to include these two sites into our study. A link between body fatness and diffuse B-cell lymphoma is not fully established hence we did not include this cancer site either. The 13 cancer sites included account for 36% of the cancers diagnosed in the Nordic countries in 2009-2013.(17)

We modelled projections of the future number of cancers in the Nordic countries for 30 years (2016-2045). We studied different prevalence scenarios of overweight and obesity, compared to the projected number of cases estimated if the age and sex specific prevalence of overweight and obesity remained constant at the levels observed in the last year of available data. The predictions were calculated using the Prevent macro simulation model,(18, 19) as adapted for the EUROCADET project,(20-24) and used in several studies for estimating the impact of potential interventions on the cancer burden.(25-28) Data needed for use of the Prevent model are disease incidence, demographic data (projected population sizes), risk factor prevalence (current and historical information), relative risk (RR) estimates, and change in risk factor prevalence under the scenarios of interest.

Incidence rates, by country, sex and 5-year age groups (except 85+), of each cancer were obtained from NORDCAN.(17, 29) ICD-codes defining the cancer sites and the average annual number of cases in the Nordic countries are shown in Table 1. The latest available calendar year in NORDCAN was 2013, but to reduce random variation due to small numbers within a single year, we used the average incidence for the years 2009-2013. We chose to consider cancer incidence from age 15 and above (age 50 for postmenopausal breast cancer). The reason for including incidence from age 15 (and not age 18) was to include the whole adult population, and the rates from NORDCAN are presented by 5-year age groups. To calculate the future number of cancers, assumptions about the future cancer incidence are needed. We assumed that the incidence rates would stay constant at the levels observed in 2009-2013, except for changes due to the changing overweight and obesity prevalence. In sensitivity analyses, the modelled trend in incidence rates based on the estimated annual percentage change was also used for future incidence rates. Data on estimated projections of the population size by gender and five-year age groups in the period 2016-2045 were obtained from the statistical bureaus in the respective countries.(30-34) When more than one scenario for population projection were presented by the different national statistical bureaus, for example with low, medium and high levels of deaths or birth rates, the middle category was used.

As the measure of overweight and obesity, we used BMI (weight/height^2 in kg/m^2). We classify BMI <25 as normal weight, ≥25 but <30 as overweight and ≥30 as obese. All Nordic countries have nationally representative surveys where BMI has been measured (mostly self-reported weight and height, in some objectively measured), and the overweight and obesity prevalence from these surveys were used.(35-41) We also used historical data, to account for the lag time between the observed exposure levels and the effect on the incidence. Detailed information about the surveys

and data used for each country and a table showing the prevalence of overweight and obesity in each country by sex and age group in the last available calendar year can be found in Appendix A. The prevalence of overweight and obesity is as elsewhere increasing in the Nordic countries (6, 7) but comparable across the Nordic countries and similar to France and Germany, with the exception of Iceland where the prevalence is higher and comparable to the prevalence seen in the United States.

The WCRF Continuous Update Project (CUP) presents summary measures of the RR for cancer sites linked to body fatness based on meta-analyses for a 1- or 5-unit increase in BMI.(16) We used RR from the WCRF CUP when available, assuming that the RR for overweight is the same as the RR for a 5-unit increase in BMI and RR for obese as for a 10-unit increase. This approach was also used by Parkin et al.(10) Due to a large number of studies for colorectal cancer, we could use sex-specific RRs for colon and rectal cancer.(10, 42) For thyroid cancer, multiple myeloma and gastric cardia cancer we used RRs from the meta analyses referred to in the report from the IARC working group, assuming that the RR for obese is the RR for overweight squared when categorical exposure was used.(2, 43-45) The RRs used in our estimations are presented in Table 1.

The Prevent model takes into account that there is a time lag between changes in exposure prevalence and changes in risk of disease by the use of LAT and LAG times. LAT is the number of years that the risk remains unchanged after a change in risk factor, and LAG is the number of years it takes from the time the risk among previously exposed starts to change until the risk among previously exposed is the same as for unexposed. We have used a LAT of 1 year and a LAG of 9 years, where the risk decreases linearly during the LAG time, as done by De Vries et al.(25) Parkin

et al. and Arnold et al. used a 10 year shift in prevalence and incidence, but did not distinguish between LAT and LAG.(10, 15)

We set up four hypothetical scenarios A, B, C and D to show the potential impact on the cancer burden of changes in overweight and obesity.

A. Elimination: A total elimination of overweight and obesity. This is comparable to estimates of the PAF presented in other studies.
B. Increasing trend: Similarly to de Vries et al.(25) we modelled a continued increasing trend, assumed for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females. This is in compliance with a public health report on trends in risk factors in the Danish population.(46)
C. Short term reduction: An intervention that would reduce the prevalence of overweight by 1% annually and obesity by 2% annually for 5 years after which the proportions stay constant at the new levels reached. Decreasing obesity more than overweight is due to the assumption that a large proportion of the obese will move to the overweight group.
D. Longer term reduction: An intervention that would reduce the proportion of overweight and obese by 50% over a 20-year period (same annual percentage decrease each year), after which the prevalence stay constant at the new levels reached.

The scenarios were chosen so that the first will estimate the total impact of an elimination of overweight and obesity, the second will estimate the impact of the increasing trend in overweight and obesity observed in the Nordic countries, and the two last alternative scenarios assume small or extensive reductions in the prevalence of overweight an obesity. All scenarios were assumed to start in 2016. The numbers of avoidable or extra number of cancers under each scenario were calculated

for the 30-year period 2016-2045. Scenarios A, C and D model a decrease in overweight and obesity compared to a constant prevalence and will therefore give an estimate of avoidable number of cases, whereas scenario B models an increase in prevalence and estimates a number of extra cases.

The Prevent model is described in detail elsewhere,(18, 26) but in short the model predicts the number of cancers expected to occur in future years based on the current and historical prevalence of a risk factor (base scenario) and contrasts this with predictions based on an altered prevalence level (intervention scenario). Therefore, the same assumptions are used for the base scenario as for the intervention scenario, and the only difference between them is the difference due to exposure prevalence (here prevalence of overweight and obesity). The Prevent model should not be used as a tool for predicting the future cancer incidence, but rather to investigate different hypothetical scenarios to measure the impact of alterations in exposure prevalence. We applied the Prevent model separately to each country and to 13 cancer sites (listed in Table 1), causally linked to body fatness, which gave 65 separate estimations for each scenario investigated.

The estimated results and projections are based on the input data and assumptions that form the foundation for the model. Sensitivity analyses, with varying LAT and LAG as well as inclusion of a trend in cancer incidence, were carried out to estimate the influence of these assumptions on the results. The sensitivity analyses are described in Appendix B.

Results

The expected number of incident cancers in the Nordic countries (base scenario) for the 13 cancer sites combined and for each investigated scenario, and the difference between each investigated scenario and the expected number of cancers in the base scenario, i.e. the avoidable or additional number of cancers, are presented in Figure 1. The effect of the investigated scenarios starts after 1 year, the LAT time, and increases during the following 9 years, the LAG time, after which the scenarios reach their full effect.

The number of avoidable cancers and percentage of avoidable cancers, due to overweight and obesity, are presented for the 13 cancer sites, for each investigated scenario and each country as well as the Nordic countries combined, in Tables 2-7. The results are presented for the whole 30-year study period, and for the year 2045 alone, when the intervention scenarios have reached their full effect.

In total, 204,503 cancers could be avoided in the Nordic countries over the period 2016-2045 by eliminating overweight and obesity (Table 2), which correspond to 9.5% out of all cancers expected for the 13 cancer sites. The number of avoidable cancers varies across the Nordic countries, mainly due to differences in population size, but also to differences in cancer incidence rates and prevalence of overweight and obesity. Colon cancer has the highest number of avoidable cases in Denmark, Norway and Sweden, with 11,300 (9.3%) number of avoidable cases in Denmark in a 30 year period if overweight and obesity was eliminated in 2016 (Scenario A), 9,930 (8.4%) in Norway and 14,947 (9.1) in Sweden (Table 3-7). In Finland and Iceland, the highest number of avoidable cancers is observed for postmenopausal breast cancer, 10,507 (8.1%) cases in Finland over the 30-year period and 701 (9.4%) in Iceland. The highest percentage of avoidable cancers over the 30-year period is for esophageal adenocarcinoma, with 24.8% in Denmark, 26.3% in Finland, 30.0% in

Iceland, 22.5% in Norway and 23.9% in Sweden. The smallest relative effect is in ovarian cancer - less than 5% over 2016-2045 in all countries. For all cancer sites, except gastric cardia, Iceland had the highest percentage of avoidable cancer. Norway had the lowest percentage of avoidable cancer for each site, except thyroid cancer.

If overweight and obesity prevalence would continue to increase (scenario B), 32,345 extra cancers would occur in the Nordic countries in the coming 30 years, compared to a constant prevalence (Table 2, Figure 2), which correspond to 1.5% out of all cancers expected for the 13 cancer sites. The small reduction in overweight and obesity prevalence modelled in scenario C would lead to 13,562 number of avoided cancers (0.6% of the expected cases for the 13 sites) over 30 years in the Nordic countries (Table 2, Figure 2). If the prevalence of overweight and obesity was reduced by 50% in the next 20 years (scenario D), 70,043 number of cancers (3.3% of the expected cases for the 13 sites) would be avoided in the Nordic countries in the 30-year period (Table 2, Figure 2).

Scenario B (increasing trend) can be combined with scenario A, C or D to evaluate the effect of a modelled intervention relative to an increasing trend in prevalence. Thus, comparing the numbers from scenario A and B could show the highest possible number of avoidable cancers. This would give a total number of 2486 avoidable cancers in Denmark in 2045 due to overweight and obesity, 2542 in Finland, 174 in Iceland, 2087 in Norway, and 3654 in Sweden.

Results from the sensitivity analyses are presented in Appendix B. The number of avoidable cancers differs somewhat between the different analyses, although the percentage of avoidable cancers is fairly robust.

Discussion

Based on the current evidence on cancer, overweight and obesity, we have estimated the number of avoidable cancers in the Nordic countries over the coming 30 years, under different prevalence scenarios of overweight and obesity. A major public health impact is possible since about 205,000 cancers, out of the 2.1 million expected for the 13 studied cancer sites, could be avoided in the Nordic countries over the period 2016-2045 by completely eliminating overweight and obesity as from year 2016 and onwards. Even with a fairly small short-term reduction in overweight and obesity prevalence (model C), approximately 14,000 cases could be avoided over the period 2016-2045. The effect in absolute numbers of changing the prevalence of overweight and obesity is greatest for colorectal cancer and postmenopausal breast cancer, the more common cancer sites. The largest proportional impact is observed for esophageal adenocarcinoma, the cancer site with the second highest RR.

Scenario A is comparable to estimates of PAFs, but the inclusion of LAT and LAG times gradually changes the cancer incidence due to the modelled complete elimination of overweight and obesity. Within the LAT and LAG time, there are more cases attributed to previous exposure to overweight and obesity than those prevented due to the elimination of overweight and obesity. Because of these remaining effects, the results from the Prevent model can only be interpreted as cancer cases "attributable" (the term often used in studies estimating the PAF) to overweight and obesity for the years following the combined LAT and LAG times of 10 years. When comparing our results for year 2045 (which is beyond the LAT and LAG times) to estimates of the PAF in the UK,(9-11) our results are lower, except for several sites for Iceland and postmenopausal breast cancer in Finland.

The proportions in our study are higher for esophageal cancer, but we restricted to adenocarcinoma and not all esophageal cancers as in the UK study. In a Nordic study from 1997, the PAFs of obesity for the year 2000 were estimated for cancers of the endometrium, kidney, gallbladder, colon, breast and prostate.(14) Those estimates are lower than our estimates for year 2045, which is not surprising since we are also including the effect of overweight (BMI 25-29), and the present prevalence of overweight and obesity in the Nordic population is higher than it was in the early 1990s. Lower estimates were also presented in a European study that estimated the proportion of incident cancers in 2002 attributed to excess body mass index in 30 countries, including the five Nordic countries, which could be explained by the increased prevalence of overweight and obesity.(8) Arnold et al (15), showed higher estimates of PAF for the Nordic countries than our study for almost all studied cancer sites, with the greatest differences seen for cancer of the gallbladder (estimates around 45% for women). Arnold et al used sex-specific RR estimates and treated BMI as a continuous covariate, and it is difficult to know how much this explains the differing results.

Scenario B (increasing trend) is likely the most probable of our scenarios, given that the epidemic of overweight and obesity shows no sign of levelling worldwide, nor in the Nordic countries.(6, 7) While scenario A is quite unrealistic, scenarios C and D are possible if effective public health interventions will be in place in the Nordic countries. In addition, although scenario C would lead to a reduction of only 0.6% of the expected cancers in the coming 30 years for the 13 cancer sites, reducing overweight and obesity would also lead to decreasing incidence rates of other diseases, and could thus have a general and great public health impact.

We only considered the effect of changing the prevalence of overweight and obesity and did not take into account that this likely will be connected to a change in physical inactivity. This is especially important for colon cancer, breast cancer and endometrial cancer, where physical inactivity is an independent risk factor. Another important interaction would be between HRT use and BMI. Arnold et al. showed that inclusion of HRT use in the overweight/obesity PAF calculation increased the PAF for endometrial cancer in Sweden and Finland by 5 percentage points and decreased the PAF for postmenopausal breast cancer by 5 percentage points.(15) Including an interaction with smoking, when estimating the PAF of overweight/obesity for pancreatic cancer, could also change the estimates by 0-5 percentage points.

One limitation of our study is that the surveys used for the prevalence estimates include a mixture of self-reported and objectively measured data. Self-reported BMI may be underestimated, and we might therefore have underestimated the number of avoidable cancer cases. Another potential limitation is over diagnosis of thyroid cancer, leading to an overestimate of avoidable cancers. However, over diagnosis of thyroid cancer has been shown to be less of a concern in the Nordic compared to many other countries, and our results should therefore not be substantially influenced by it.(47)

The Prevent model is a deterministic model, and does not provide confidence intervals or any other measure of uncertainty, which is a limitation. Estimates from the model should not be seen as valid predictions of the future cancer incidence, but the model is useful for measuring the impact of alterations in exposure prevalence. The model accuracy depends heavily on the data used and the assumptions made in the calculations, and it is therefore important to do sensitivity analyses when using the Prevent model. Our sensitivity analyses showed that the percentage of avoidable cancers

was fairly robust to changes in the LAT and LAG or the cancer incidence. Nevertheless, the results should be interpreted with caution, especially when comparing the results across countries due to potential differences in data quality for both cancer incidence and exposure prevalence.

The public health impact on cancer of interventions on overweight and obesity is substantial. It requires political will to regulate food consumption (fat/sugar taxes), collaboration with the food industry and the retail promoting healthy foods, as well as personal awareness and capacity to follow the advice in the European Code Against cancer. A large amount of cancers is avoidable the next 30 years, even with small changes in the prevalence of overweight and obesity. The focus of primary prevention should be preventing the rise in overweight and obesity in the population, as the effects of weight loss on cancer risk are not fully known.(48). The results from this study form an important step to increase awareness and priorities in cancer control by controlling overweight and obesity. Combined with similar studies on other major risk factors of cancer, the potential for prevention programs in the Nordic countries will be clear to the public and to health planners.

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Conflict of interest statement:

None declared

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Table 1: Cancer sites, relative risk estimates and the average annual incident cases (2009-2013) in the Nordic countries in study of avoidable cancers by overweight and obesity

Cancer site	ICD-10 codes	RR for overweight[*]	Avg. # cases per year
Breast (postmenopausal)	C50	1.13[†]	16139
Colon	C18	1.22 (Males)[§] 1.10 (Females)[§]	11280
Rectum	C19-20	1.10 (Males)[§] 1.05 (Females)[§]	5800
Pancreas	C25	1.10[†]	3874
Endometrium	C54	1.50[†]	3736
Kidney	C64	1.30[†]	3460
Ovary	C56 & C57.0-4	1.06[†]	2315
Multiple myeloma	C90	1.2[¶]	1779
Liver	C22	1.30[†]	1672
Thyroid	C73	1.17 (Males)[¶] 1.04 (Females)[¶]	1500
Gallbladder	C23-24	1.25[†]	1035
Esophageal adenocarcinoma	C15 & morphology 8140-8141, 8143-8145, 8190-8231, 8260-8263, 8310,8401, 8480-8490, 8550-8551, 8570-8574, 8576	1.48[†]	756
Gastric cardia	C16.0	1.2[¶]	714

[*] The RR for overweight is assumed the same as the RR for a 5-unit increase in BMI and RR for obese as for a 10-unit increase, equal to the RR for overweight squared.

[†] http://www.wcrf.org/int/cancer-facts-figures/link-between-lifestyle-cancer-risk/weight-cancer. In; Accessed January 2017.

[§] World Cancer Research Fund / American Institute for Cancer Research. Continuous Update Project Report. Food, Nutrition, Physical Activity, and the Prevention of Colorectal Cancer. In; 2011.

[¶] Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K, et al. Body Fatness and Cancer--Viewpoint of the IARC Working Group. N Engl J Med 2016;375(8):794-8.

Table 2: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in the **Nordic countries**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	41135	7.0	-7463	-1.3	2759	0.5	13963	2.4
Colon	44638	9.2	-6306	1.3	2894	0.6	15436	3.2
Rectum	11906	5.0	-1621	0.7	766	0.3	4083	1.7
Pancreas	9640	6.0	-1457	-0.9	638	0.4	3309	2.0
Endometrium	32964	22.9	-6059	-4.2	2268	1.6	11238	7.8
Kidney	22230	16.3	-3238	-2.4	1461	1.1	7590	5.6
Ovary	2710	3.2	-487	-0.6	183	0.2	923	1.1
Multiple myeloma	8468	11.3	-1250	-1.7	557	0.7	2923	3.9
Liver	11438	16.6	-1657	-2.4	753	1.1	3924	5.7
Thyroid	2157	4.1	-308	-0.6	132	0.3	725	1.4
Gallbladder	5990	13.7	-951	-2.2	399	0.9	2064	4.7
Esophageal adenocarcinoma	7799	24.4	-1079	-3.4	526	1.6	2686	8.4
Gastric cardia	3428	11.5	-469	-1.6	226	0.8	1179	4.0
Total**	204503	9.5	-32345	-1.5	13562	0.6	70043	3.3

Year 2045								
Breast (postmenopausal)	1760	8.2	-442	-2.1	127	0.6	880	4.1
Colon	2031	10.6	387	2.0	140	0.7	1014	5.3
Rectum	530	5.7	98	1.1	37	0.4	264	2.9
Pancreas	429	6.9	-88	-1.4	30	0.5	214	3.4
Endometrium	1419	26.8	-359	-6.8	105	2.0	709	13.4
Kidney	966	18.9	-195	-3.8	68	1.3	482	9.5
Ovary	117	3.7	-29	-0.9	9	0.3	59	1.9
Multiple myeloma	381	13.0	-75	-2.6	27	0.9	190	6.5
Liver	504	19.2	-101	-3.8	35	1.3	251	9.6
Thyroid	92	4.9	-18	-1.0	6	0.3	45	2.4
Gallbladder	270	15.9	-57	-3.4	20	1.2	135	8.0
Esophageal adenocarcinoma	347	28.1	-66	-5.4	26	2.1	174	14.1
Gastric cardia	153	13.4	-29	-2.5	10	0.9	77	6.7
Total**	8999	11.1	-1944	-2.4	640	0.8	4494	5.5

*A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Table 3: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in **Denmark**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	9977	6.7	-1800	-1.2	675	0.5	3355	2.2
Colon	11300	9.3	-1618	-1.3	746	0.6	3892	3.2
Rectum	3064	5.1	-426	-0.7	201	0.3	1042	1.7
Pancreas	2321	5.8	-350	-0.9	155	0.4	791	2.0
Endometrium	6552	22.2	-1205	-4.1	454	1.5	2217	7.5
Kidney	4505	16.3	-658	-2.4	300	1.1	1528	5.5
Ovary	636	3.0	-115	-0.5	38	0.2	212	1.0
Multiple myeloma	1704	11.3	-253	-1.7	113	0.7	583	3.9
Liver	2459	16.5	-354	-2.4	162	1.1	839	5.6
Thyroid	323	3.9	-50	-0.6	19	0.2	106	1.3
Gallbladder	1211	13.3	-193	-2.1	80	0.9	412	4.5
Esophageal adenocarcinoma	2524	28.6	-358	-3.5	172	1.7	864	8.5
Gastric cardia	1195	11.7	-163	-1.6	81	0.8	407	4.0
Total**	47771	9.3	-7543	-1.5	3196	0.6	16248	3.1

Year 2045								
Breast (postmenopausal)	409	7.8	-103	-2.0	30	0.6	204	3.9
Colon	503	10.8	-98	-2.1	35	0.8	251	5.4
Rectum	133	5.9	-25	-1.1	9	0.4	66	3.0
Pancreas	101	6.8	-21	-1.4	7	0.5	50	3.4
Endometrium	273	26.0	-70	-6.7	20	1.9	136	12.9
Kidney	189	19.0	-39	-3.9	13	1.3	94	9.4
Ovary	27	3.6	-7	-0.9	2	0.3	13	1.7
Multiple myeloma	74	13.1	-15	-2.7	6	1.1	37	6.5
Liver	105	19.3	-21	-3.9	8	1.5	52	9.5
Thyroid	13	4.5	-3	-1.0	1	0.3	6	2.1
Gallbladder	53	15.5	-11	-3.2	4	1.2	27	7.9
Esophageal adenocarcinoma	110	28.6	-21	-5.5	8	2.1	55	14.3
Gastric cardia	52	13.7	-10	-2.6	4	1.1	26	6.8
Total**	2042	10.8	-444	-2.4	147	0.8	1017	5.4

* A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Table 4: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in **Finland**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	10507	8.1	-1932	-1.5	726	0.6	3542	2.7
Colon	7880	10.3	-1163	-1.5	525	0.7	2705	3.5
Rectum	2312	5.5	-328	-0.8	155	0.4	789	1.9
Pancreas	3055	6.7	-480	-1.1	209	0.5	1047	2.3
Endometrium	7829	26.2	-1460	-4.9	561	1.9	2643	8.9
Kidney	6264	17.8	-968	-2.8	425	1.2	2128	6.1
Ovary	718	3.8	-127	-0.7	53	0.3	244	1.3
Multiple myeloma	1986	12.6	-309	-2.0	135	0.9	681	4.3
Liver	3757	18.0	-568	-2.7	256	1.2	1287	6.2
Thyroid	654	4.5	-91	-0.6	42	0.3	221	1.5
Gallbladder	1706	15.3	-286	-2.6	117	1.1	590	5.3
Esophageal adenocarcinoma	1259	26.3	-176	-3.7	86	1.8	427	8.9
Gastric cardia	622	12.6	-90	-1.8	40	0.8	212	4.3
Total**	48549	10.8	-7978	-1.8	3330	0.7	16516	3.7

Year 2045								
Breast (postmenopausal)	438	9.6	-112	-2.5	33	0.7	219	4.8
Colon	346	11.9	-69	-2.4	25	0.9	173	6.0
Rectum	99	6.30	-20	-1.3	7	0.4	50	3.2
Pancreas	134	7.8	-29	-1.7	10	0.6	67	3.9
Endometrium	323	31.0	-84	-8.1	25	2.4	161	15.5
Kidney	266	20.7	-57	-4.4	19	1.5	133	10.4
Ovary	30	4.5	-7	-1.0	3	0.4	15	2.2
Multiple myeloma	87	14.6	-18	-3.0	6	1.0	43	7.2
Liver	164	20.8	-34	-4.3	12	1.5	82	10.4
Thyroid	27	5.4	-6	-1.2	1	0.2	13	2.6
Gallbladder	77	17.8	-17	-3.9	6	1.4	38	8.8
Esophageal adenocarcinoma	54	30.9	-11	-6.3	4	2.3	27	15.4
Gastric cardia	28	14.8	-5	-2.6	2	1.1	14	7.4
Total**	2073	12.6	-469	-2.9	153	0.9	1035	6.3

*A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Table 5: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in **Iceland**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	701	9.4	-134	-1.8	50	0.6	245	3.3
Colon	581	12.1	-91	-1.9	40	0.8	204	4.3
Rectum	108	6.4	-16	-0.9	7	0.4	37	2.2
Pancreas	106	7.7	-18	-1.3	7	0.5	37	2.7
Endometrium	344	29.1	-67	-5.7	25	2.1	120	10.1
Kidney	480	20.6	-77	-3.3	33	1.4	166	7.1
Ovary	35	4.4	-7	-0.9	3	0.4	12	1.5
Multiple myeloma	125	14.4	-20	-2.3	8	0.9	44	5.1
Liver	122	20.4	-19	-3.2	9	1.5	43	7.2
Thyroid	75	5.9	-12	-0.9	5	0.4	26	2.0
Gallbladder	74	17.7	-12	-2.9	5	1.2	26	6.2
Esophageal adenocarcinoma	222	30.0	-34	-4.6	16	2.2	78	10.5
Gastric cardia	25	14.8	-4	-2.4	2	1.2	9	5.3
Total**	2998	12.6	-511	-2.2	210	0.9	1047	4.4

Year 2045								
Breast (postmenopausal)	33	10.7	-9	-2.9	2	1.0	17	5.5
Colon	28	13.7	-6	-2.9	2	1.0	14	6.9
Rectum	5	7.1	-1	-1.4	0	0	2	2.9
Pancreas	5	8.8	-1	-1.8	0	0	2	3.5
Endometrium	16	34.0	-4	-8.5	1	2.1	8	17.0
Kidney	22	23.9	-5	-5.4	2	2.2	11	12.0
Ovary	2	6.1	-1	-3.0	0	0	1	3.0
Multiple myeloma	6	16.2	-1	-2.7	0	0	3	8.1
Liver	6	24.0	-1	-4.0	0	0	3	12.0
Thyroid	3	5.9	-1	-2.0	0	0	2	3.9
Gallbladder	4	22.2	-1	-5.6	0	0	2	11.1
Esophageal adenocarcinoma	10	32.3	-2	-6.5	1	3.2	5	16.1
Gastric cardia	1	12.5	-0	-0	0	0	1	12.5
Total**	141	14.4	-33	-3.4	8	0.8	71	7.2

*A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Table 6: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in **Norway**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	5538	6.0	-981	-1.1	350	0.4	1906	2.1
Colon	9930	8.4	-1324	-1.1	615	0.5	3493	2.9
Rectum	2497	4.5	-318	-0.6	150	0.3	870	1.6
Pancreas	1674	5.2	-239	-0.7	104	0.3	584	1.8
Endometrium	6057	20.1	-1093	-3.6	396	1.3	2097	7.0
Kidney	4686	14.8	-626	-2.0	292	0.9	1623	5.1
Ovary	503	2.7	-89	-0.5	34	0.2	176	1.0
Multiple myeloma	1749	10.2	-240	-1.4	111	0.6	618	3.6
Liver	1369	14.7	-188	-2.0	83	0.9	478	5.1
Thyroid	437	3.8	-62	-0.5	25	0.2	146	1.3
Gallbladder	905	12.2	-135	-1.8	55	0.7	315	4.2
Esophageal adenocarcinoma	1342	22.5	-173	-2.9	89	1.5	472	7.9
Gastric cardia	558	10.5	-72	-1.4	38	0.7	199	3.7
Total**	37245	8.6	-5540	-1.3	2342	0.5	12977	3.0

Year 2045								
Breast (postmenopausal)	250	7.0	-61	-1.7	17	0.5	125	3.5
Colon	479	9.6	-85	-1.7	31	0.6	239	4.8
Rectum	117	5.2	-20	-0.9	8	0.4	58	2.6
Pancreas	80	6.0	-15	-1.1	5	0.4	40	3.0
Endometrium	275	23.4	-67	-5.7	20	1.7	138	11.7
Kidney	215	17.1	-39	-3.1	15	1.2	108	8.6
Ovary	23	3.2	-5	-0.7	2	0.3	12	1.7
Multiple myeloma	84	11.7	-15	-2.1	6	0.8	42	5.9
Liver	65	16.9	-12	-3.1	4	1.0	32	8.3
Thyroid	20	4.7	-3	-0.7	2	0.5	10	2.4
Gallbladder	43	14.0	-9	-2.9	3	1.0	21	6.8
Esophageal adenocarcinoma	63	25.7	-11	-4.5	5	2.0	32	13.1
Gastric cardia	26	12.1	-5	-2.3	1	0.5	13	6.0
Total**	1740	9.9	-347	-2.0	119	0.7	870	4.9

*A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Table 7: Number (#) and percentage of avoidable cancer cases during 2016-2045 and in 2045 in **Sweden**, under different scenarios of overweight and obesity prevalence, compared to a constant prevalence.

Cancer site	Scenario A*		Scenario B§		Scenario C†		Scenario D¶	
	#	%	#	%	#	%	#	%
Total period 2016-2045								
Breast (postmenopausal)	14412	6.9	-2616	-1.2	958	0.5	4915	2.3
Colon	14947	9.1	-2110	-1.3	968	0.6	5142	3.1
Rectum	3825	4.8	-533	-0.7	253	0.3	1345	1.7
Pancreas	2484	5.8	-370	-0.9	163	0.4	850	2.0
Endometrium	12182	23.0	-2234	-4.2	832	1.6	4161	7.8
Kidney	6295	15.9	-909	-2.3	411	1.0	2145	5.4
Ovary	818	3.1	-149	-0.6	55	0.2	279	1.1
Multiple myeloma	2904	11.1	-428	-1.6	190	0.7	997	3.8
Liver	3731	16.0	-528	-2.3	243	1.0	1277	5.5
Thyroid	668	4.0	-93	-0.6	41	0.2	226	1.4
Gallbladder	2094	13.4	-325	-2.1	142	0.9	721	4.6
Esophageal adenocarcinoma	2452	23.9	-338	-3.3	163	1.6	845	8.2
Gastric cardia	1028	11.2	-140	-1.5	65	0.7	352	3.8
Total**	67940	9.5	-10773	-1.5	4484	0.6	23255	3.2

Year 2045								
Breast (postmenopausal)	630	8.1	-157	-2.0	45	0.6	315	4.0
Colon	675	10.7	-129	-2.0	47	0.7	337	5.3
Rectum	176	5.7	-32	-1.0	13	0.4	88	2.8
Pancreas	109	6.8	-22	-1.4	8	0.5	55	3.4
Endometrium	532	26.9	-134	-6.8	39	2.0	266	13.5
Kidney	274	18.6	-55	-3.7	19	1.3	136	9.2
Ovary	35	3.6	-9	-0.9	2	0.2	18	1.9
Multiple myeloma	130	12.9	-26	-2.6	9	0.9	65	6.5
Liver	164	18.6	-33	-3.7	11	1.2	82	9.3
Thyroid	29	4.8	-5	-0.8	2	0.3	14	2.3
Gallbladder	93	15.6	-19	-3.2	7	1.2	47	7.9
Esophageal adenocarcinoma	110	27.6	-21	-5.3	8	2.0	55	13.8
Gastric cardia	46	13.1	-9	-2.6	3	0.9	23	6.6
Total**	3003	11.1	-651	-2.4	213	0.8	1501	5.5

*A total elimination of overweight and obesity in year 2016.

§ A continued increasing trend assumed to last for 15 years with an annual increase of 0.5% for each age group for overweight among males and 1.25% for females, and 1.75% for obesity among both males and females.

† A reduction in the prevalence of overweight and obesity assumed to last for 5 years with an annual decrease of 1% for each age group for overweight and 2% for obesity among both males and females.

¶ A 50% reduction in the proportion of overweight and obese over a 20-year period for all age groups and both males and females.

** Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites

Figure 1 legend & footnote:

Top panel: Total number of incident cancer cases for 13 cancer sites associated with overweight and obesity, during 2016-2045 in the Nordic countries, under different scenarios of overweight & obesity prevalence. Bottom panel: Total number of avoidable cancer cases for 13 cancer sites associated with overweight and obesity, during 2016-2045 in the Nordic countries, under different scenarios of overweight & obesity prevalence, compared to if the prevalence would stay constant.

A: Elimination, B: Increasing trend, C: Short term reduction, D: Longer term reduction

Figure 2 legend & footnote:

Number and percentage* of avoidable cancer cases during 2016-2045 and in 2045 in the Nordic countries under different scenarios of overweight & obesity prevalence, compared to if the prevalence would stay constant.

A: Elimination, B: Increasing trend, C: Short term reduction, D: Longer term reduction

* Percentage of avoidable cancer cases out of total number of expected cases for the 13 selected cancer sites