

# Potential cardiovascular mortality reductions with stricter food policies in the United Kingdom of Great Britain and Northern Ireland

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**Objective** To estimate how much more cardiovascular disease (CVD) mortality could be reduced in the United Kingdom through more progressive nutritional targets.

**Methods** Potential reductions in CVD mortality in the United Kingdom between 2006 (baseline) and 2015 were estimated by synthesizing data on population, diet and mortality among adults aged 25 to 84 years. The effect of specific dietary changes on CVD mortality was obtained from recent meta-analyses. The potential reduction in CVD deaths was then estimated for two dietary policy scenarios: (i) modest improvements (simply assuming recent trends will continue until 2015) and (ii) more substantial but feasible reductions (already seen in several countries) in saturated fats, industrial trans fats and salt consumption, plus increased fruit and vegetable intake. A probabilistic sensitivity analysis was conducted. Results were stratified by age and sex.

**Findings** The first scenario would result in approximately 12 500 fewer CVD deaths per year (range: 5500–30 300). Approximately 4800 fewer deaths from coronary heart disease and 1800 fewer deaths from stroke would occur among men, and 3500 and 2400 fewer, respectively, would occur among women. More substantial dietary improvements (no industrial trans fats, reduction in saturated fats and salt and substantial increases in fruit and vegetable intake) could result in approximately 30 000 fewer (range: 13 300–74 900) CVD deaths.

**Conclusion** Excess dietary trans fats, saturated fats and salt, along with insufficient fruits and vegetables, generate a substantial burden of CVD in the United Kingdom. Further improvements resembling those attained by other countries are achievable through stricter dietary policies.

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## Introduction

Cardiovascular diseases (CVDs) are the leading cause of death in the United Kingdom, where coronary heart disease (CHD) and stroke cause 150 000 deaths every year. Of these CVD deaths, more than 40 000 occur prematurely, in people younger than 75 years.<sup>1</sup> Apart from smoking, the main risk factors for CVD are elevated blood cholesterol, elevated blood pressure, obesity and diabetes, all related to poor eating habits. According to the United Kingdom's government report for 2008, poor nutrition causes more than 70 000 preventable premature deaths annually, mainly from CVD.<sup>2</sup> A recent paper estimated this figure at 33 000 deaths.<sup>3</sup> Regardless, the health effects of poor nutrition pose an enormous economic burden; poor diet alone costs the government of the United Kingdom an annual 6 billion pounds sterling.<sup>3</sup>

CVD is consistently associated with the so-called "Western" diet, consisting mainly of dairy products, meat and processed foods.<sup>2–5</sup> CVD mortality rates are twice as high among segments of society that follow such a diet than among people who eat sensibly.<sup>2–4</sup> Salt, sugar, saturated fat and trans fats are harmful when consumed in excess; conversely, fruit and vegetables (which contain potassium, antioxidants and fibre), polyunsaturated fats (e.g. from sunflower and canola oil), mono-unsaturated fats (e.g. from olive oil), whole grains, pulses, nuts and fish have consistently shown a protective effect against CVD.<sup>2–4</sup>

In the United Kingdom and the United States of America, processed foods and fast, takeaway foods are the main dietary sources of excess salt, saturated fats, trans fats and excess calories. In 2001 the Food Standards Agency (FSA) of the

United Kingdom began working with industry to develop a range of healthy food strategies,<sup>5</sup> including voluntary product reformulation, clearer (traffic light) package labelling of nutrient levels and media campaigns. The FSA's salt strategy helped reduce the average daily salt intake by nearly 1 g between 2001 and 2008 (from 9.5 to 8.6 g, respectively).<sup>6</sup> However, outside the United Kingdom stricter regulatory policies have resulted in much greater reductions.<sup>7</sup> For instance, between 1979 and 2002 Finland's daily average salt intake fell from 12 g to 9 g.<sup>7</sup>

The FSA's strategy in the United Kingdom also sought to reduce the daily average intake of saturated fat from 13.3% to 11% of total food energy by 2010,<sup>5</sup> yet currently the figure stands at 12.8%.<sup>6</sup> Finland and Iceland, on the other hand, reduced saturated fat intake by 5% of total energy in one or two decades.<sup>4,8</sup> Furthermore, in the traditional Italian and Japanese diets and the successful DASH and OMNI diets, 6% of total energy comes from saturated fats.<sup>9</sup>

Dietary industrial trans fats, resulting from the partial hydrogenation of vegetable oils, are particularly toxic. By raising serum low-density lipoprotein (LDL or "bad" cholesterol) and reducing high-density lipoprotein (HDL or "good" cholesterol), they substantially increase the risk of CHD and stroke.<sup>10</sup> The Government of the United Kingdom currently recommends consuming less than 2% of total energy in the form of trans fats. Average trans fat intake for adults in the United Kingdom reportedly represents only 0.8% of total energy consumption.<sup>6,11</sup> However, the true value is probably closer to 1% because routine surveys tend to underestimate consumption outside the home, particularly from fast foods. Furthermore, ethnic minorities, low-income adults and children probably consume substantially more.<sup>12</sup> In contrast, Den-

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mark's 2004 legislative ban eliminated the consumption of dietary industrial trans fats within a year (from a baseline of 4%).<sup>13</sup> Currently Austria, Canada, Iceland, Switzerland and several states in the United States are aggressively working to eliminate trans fats.<sup>10</sup>

Finally, the average quantity of fruit and vegetables eaten daily in the United Kingdom has levelled at about 245 g since 2003.<sup>6</sup> This is much lower than the pragmatic target of 400 g (five portions) and less than half of the 600 g per day already achieved in much of France, Greece and Italy and now recommended for the entire European Union.<sup>14</sup>

The FSA reasonably estimated that approximately 7000 CVD deaths would be averted annually if people in the United Kingdom reached the current (modest) dietary targets for saturated fat and trans fats.<sup>5,11</sup> However, the potential benefit of more ambitious dietary targets remains unclear. We therefore estimated the potential reduction in CVD mortality achievable in the United Kingdom if stricter, yet feasible food policies were established, as in other countries, to further decrease the intake of salt, saturated fats and trans fats and increase fruit and vegetable consumption.

## Methods

The potential decrease in CVD deaths was estimated for two policy scenarios:

- i) conservative: modest dietary improvements, based on assuming that recent trends will continue to 2015, yielding further small reductions in intake (by 0.5% of total energy for trans fat; by 1% of total energy for saturated fat; by 1 g per day for salt) and one additional daily portion of fruit or vegetables;
- ii) aggressive: more substantial (but feasible) dietary improvements, as seen elsewhere, yielding larger reductions in intake (by 1% of total energy for trans fat; by 3% of total energy for saturated fat; by 3 g per day for salt) and three additional daily portions of fruit or vegetables.

We developed a spreadsheet model to quantify the deaths potentially averted by adopting healthier food policies. Contemporary data on diet and mortality among adults aged 25 to 84 years in the United Kingdom were obtained from national surveys and official statistics. Potential reductions in CVD mortality

were then calculated by synthesizing age-specific population, dietary and mortality data (Appendix A, available at: <http://research.ncl.ac.uk/medchamps/assets/WHObulletinUKFoodPolicyOptionsAppend2April12.pdf>).<sup>1,6</sup>

### Modelling approach

The CVD deaths averted by each food policy intervention were calculated by multiplying the number of deaths observed in the United Kingdom in 2006 (baseline year) for all age groups between 25 and 84 years by the reduction in the relative risk (RR) of dying from CHD or stroke. The reductions in RR were estimated on the basis of age- and sex-specific values obtained from the largest and most recent meta-analyses and systematic reviews of large controlled trials and observational studies (Appendix B, available at: <http://research.ncl.ac.uk/medchamps/assets/WHObulletinUKFoodPolicyOptionsAppend2April12.pdf>).

#### Reduced trans fats

We first assumed, under the conservative policy scenario, that by 2015 the fraction of total energy derived from trans fats would have decreased by an additional 0.5%. We subsequently assumed, under the aggressive policy scenario, that a legislative ban on industrial trans fats would essentially eliminate their intake, as witnessed in Denmark,<sup>13</sup> and would further decrease trans fats intake by approximately 1% of total energy.

We then used the RR from the largest meta-analysis to estimate the CVD deaths that would be averted under the aggressive scenario.<sup>15</sup> If the 2% total energy derived from industrial trans fats were completely replaced by monounsaturated and polyunsaturated fats, mortality from CHD would drop by approximately 23%.<sup>15</sup> Thus, if the total energy derived from trans fats were reduced by 0.5%, the number of CHD deaths would drop by approximately 6%.<sup>15</sup>

The number of CHD deaths averted under the aggressive scenario was then calculated by multiplying by 0.06 the number of deaths from CHD in the United Kingdom in 2006 in each age group. For example, in 2006 11 947 CHD deaths occurred among men aged 65 to 74 years. The estimated number of CHD deaths averted in this group would thus be approximately:

$$11\,947 \times 0.06 = 950$$

This process was repeated for all other age groups and for both men and women.

We followed a similar procedure to calculate the number of deaths from stroke potentially averted under the aggressive scenario. If the total energy derived from trans fats were reduced by 0.5%, stroke deaths would be reduced by approximately 3% in both men and women (Appendix B).<sup>15</sup>

#### Reduced saturated fats

We assumed that by 2015 the fraction of total energy derived from saturated fats would have been reduced by an additional 1% under the conservative policy scenario, and by an additional 3% under the aggressive policy scenario (from an average of 12.8%<sup>5,6</sup> to 9.8%). Using summary estimates from Mozaffarian et al.'s meta-analysis,<sup>16</sup> we determined that replacing the 5% of total energy derived from saturated fats with polyunsaturated fats would reduce CHD mortality by approximately 11.5%.<sup>16</sup> However, since complete replacement of saturated fats with polyunsaturated fats would be an unrealistic goal, we assumed that only half of the saturated fat would be replaced by polyunsaturated fat and the other half by monounsaturated fat. This would effectively halve the reduction in deaths from both CHD and stroke.<sup>16</sup>

#### Reduced salt

We assumed that by 2015 the average salt intake would have decreased by 1 g per day in the conservative scenario and by 3 g per day in the aggressive policy scenario (i.e. from 8.6 to 5.6 g).<sup>7</sup> The number of CHD deaths preventable by reducing daily salt intake by 1 g and 3 g was then calculated, as for other nutrients, by multiplying the number of deaths from CHD in the United Kingdom in 2006 by the predicted percentage reduction in CHD deaths. Based on a meta-analysis by Strazzullo et al., we determined that reducing daily salt intake by 5 g (equivalent to 2000 mg less sodium per day) would translate into approximately 17% fewer CHD deaths and approximately 23% fewer stroke deaths annually.<sup>17</sup>

We followed the same procedure to calculate the potential reduction in deaths from stroke.

#### Increased fruits and vegetables

We assumed that by 2015 the average intake of fruits and vegetables would have increased by one daily portion of either (from the current average of three portions to four) in the conservative

policy scenario and by three portions (i.e. to 500 g or about six portions daily) in the aggressive policy.<sup>14</sup>

One additional portion a day would reduce CHD deaths by approximately 4% and stroke deaths by approximately 5%, according to Dauchet et al.<sup>18,19</sup> To calculate the CHD deaths averted by one and three additional daily portions of fruit and vegetables, we multiplied the number of CHD deaths observed in 2006 by 0.04 and the number of deaths from stroke by 0.05.

### Effect of age on mortality

We incorporated age attrition into our model using a method followed by leading cardiovascular epidemiologists.<sup>20,21</sup> Specifically, we assumed that the reduction in deaths from CVD associated with a change in the intake of specific macronutrients decreased with age. We modelled this age gradient to mirror the age-specific decreases in the risk of death from CVD associated with both hypertension and elevated total cholesterol.<sup>20,21</sup>

Cumulative effects: Like other researchers,<sup>8,16,17</sup> we assumed that simultaneous improvements in the intake of all macronutrients would have a cumulative rather than a merely additive effect on mortality. For instance, if a reduction of 3 g in daily salt intake had already reduced deaths from CVD by approximately 20%, any additional benefit from reducing trans fats could only act on the residual risk, namely, 80% (i.e.  $1 - 0.20$ ).

We therefore estimated the total benefit using the following standard formula:

$$\text{Total benefit} = 1 - [(1 - a) \times (1 - b) \times (1 - c) \times (1 - d)]$$

where *a*, *b*, *c* and *d* represent the percentage reductions in deaths for changes in the intake of salt, saturated fat, trans fats and fruit and vegetables, respectively.<sup>8,16,17</sup>

### Sensitivity analyses

All modelling involves uncertainty. We therefore explored the effects of changes in food policy on CVD risk factors and deaths by performing a probabilistic sensitivity analysis. The uncertainty of the hazards ratio and the RR parameters were characterized using a log-normal distribution. We performed Monte Car-

lo simulations, allowing the parameters based on the effect sizes obtained from the literature to vary stochastically. All calculations were performed separately for men and women and were stratified by age. Results were rounded to the nearest hundred and summarized as medians; 95% CIs for the median were generated using the bootstrap percentile method in Stata version 9 (StataCorp. LP, College Station, United States of America).<sup>22</sup>

## Results

### Conservative scenario

In 2006 (the base year), 149 840 CVD deaths occurred in the United Kingdom (94 660 from CHD and 55 180 from stroke). Given population ageing and growth, by 2015 an estimated 168 520 CVD deaths will occur in the United Kingdom (107 140 CHD and 61 380 stroke deaths), representing a rise of approximately 11% if 2006 rates do not change (Appendix C, available at: <http://research.ncl.ac.uk/medchamps/assets/WHObulletinUKFoodPolicyOptionsAppend2April12.pdf>).

Reducing the total energy from trans fats by 0.5% and from saturated fat by 1%, reducing salt consumption by 1 g per day, and increasing fruit and vegetable intake by 1 portion per day could result in approximately 12 500 fewer CVD deaths (minimum: 5490; maximum: 30 260) (Table 1). This would represent an 8% reduction from the total CVD deaths otherwise expected in 2015 in the United Kingdom.

Approximately 3500 of the 12 500 fewer CVD deaths would result from a decrease of 0.5% in the total energy derived from trans fats; around 4000 from a decrease of 1.0% in the total energy derived from saturated fats; approximately 2300 from a decrease of 1 g in salt consumption, and about 2700 from one additional portion of fruit or vegetables daily. (Table 1)

The 12 500 fewer CVD deaths would comprise approximately 4800 fewer deaths from CHD among men (range: 2050–12 030) and 3500 (range: 1500–8700) fewer among women, and in 1820 fewer deaths from stroke in men (range: 900–4000) and 2400 in women (range: 1050–5500). Approximately 30% of the specific mortality decrease in men and 10% in women would represent reductions in people younger than 65 years (Table 2).

### Aggressive scenario

Fig. 1 shows the potential reduction in CVD deaths for each dietary scenario, bounded by minimum and maximum estimates from the sensitivity analysis.

The more substantial decreases in harmful macronutrients and increased consumption of fruit and vegetables could result in approximately 29 900 fewer CVD deaths per year (range: 13 300–74 900) (Table 1 and Table 3). This would represent a reduction in total CVD deaths in the United Kingdom of approximately 20%.

Legislation to effectively eliminate the consumption of trans fats (to reach 0% of total energy) could result in approximately 4700 fewer deaths (range: 2500–8800) per year.

A reduction of 3% in total energy from saturated fats (from 12.8% to 9.8% of total energy) could result in approximately 11 200 fewer deaths (range: 5900–21 600).

A daily reduction of 3 g in salt intake (from 8.6 to 5.6 g per day) might generate approximately 6600 fewer CVD deaths (range: 1700–26 000) per year, while an additional three portions of fruit and vegetables daily could result in approximately 7420 fewer deaths (range: 3160–18 410).

### Sensitivity analyses

The relative mortality contributions from these dietary changes remained reasonably consistent in robust sensitivity analyses (Fig. 1 and Table 1).

## Discussion

Our conservative estimates suggest that modest dietary improvements in the United Kingdom could avert approximately 12 000 annual deaths from CVD by 2015. However, more substantial improvements could avert about 30 000 CVD deaths annually (still fewer than recorded elsewhere). This would represent a 20% reduction in CVD deaths in the United Kingdom, almost one third of which would have occurred prematurely (< 75 years). These results remained robust in the sensitivity analysis.

The more substantial improvements would probably require more radical policy interventions. In a recent US study, approximately 40% of all premature CVD deaths (in people less than 70 years of age) might be avoided by optimizing various dietary risk factors.<sup>23</sup> The modest discrepancies between this

Table 1. Overall annual falls in deaths from coronary heart disease and stroke potentially attributable to (A) modest and (B) more substantial dietary improvements, United Kingdom

	Total			Decreased trans fats			Decreased saturated fats			Decreased salt			Increased fruit and vegetables		
	Fewer deaths	Min.	Max.	Fewer deaths	Min.	Max.	Fewer deaths	Min.	Max.	Fewer deaths	Min.	Max.	Fewer deaths	Min.	Max.
<b>A</b>															
Men	6600	2950	16 040	1900	980	3690	2000	1040	3880	1100	250	4890	1600	680	3580
Women	5900	2540	14 220	1600	840	3130	2000	1000	3760	1200	320	4610	1100	380	2720
Total	12 500	5490	30 260	3500	1820	6820	4000	2040	7640	2300	570	9500	2700	1060	6300
<b>B</b>															
Men	15 850	7120	39 320	2500	1310	4740	5600	2960	10 910	3200	820	13 310	4400	2030	10 360
Women	14 100	6160	35 560	2200	1160	4090	5500	2950	10 680	3300	920	12 740	3000	1130	8050
Total	29 900	13 280	74 880	4700	2500	8800	11 200	5900	21 600	6600	1700	26 000	7400	3160	18 410

min., minimum; max, maximum.

study's findings and ours could well reflect methodological differences, since Danaei et al. optimistically assumed ideal dietary intake targets that practically eliminated the risk factor.<sup>23</sup> Two recent US studies on salt reduction also reported comparable mortality decreases, along with impressive cost savings.<sup>22,24</sup> Furthermore, comparable cost savings might be confidently anticipated for all population-wide dietary improvements.<sup>25,26</sup>

Our estimate of approximately 4700 fewer CVD deaths following trans fat elimination is also reassuringly close to the 7000 quoted in a recent *BMJ* editorial.<sup>10</sup> The benefit for individuals and ethnic groups with insulin resistance may be even greater.<sup>10,15</sup> In Denmark, legislation passed in 2004 banning industrial trans fats resulted in a rapid drop to zero consumption.<sup>13</sup> After initial opposition, the EU slowly relented and subsequently discussed a ban across Europe.<sup>27</sup> Following Denmark, several countries, including Austria, Canada, Iceland and Switzerland (and several US cities and states), have recently taken steps to reduce or ban industrial trans fats in food.<sup>10</sup> Canada was the first country to require that the trans fats levels in pre-packaged foods be included on the mandatory nutrition facts table. Though less powerful, labelling regulations inform consumers, motivate industry to reformulate its products and favourably influence social norms. Many manufacturers have now reduced trans fat content.<sup>28</sup> In Seattle, a programme to phase out industrial trans fats in fast food outlets encountered surprisingly little opposition from commercial interests; most stakeholders apparently considered it a logical step.<sup>29</sup>

Diet powerfully contributes to health inequity. Low-income groups, which also suffer the highest burden of CVD and other chronic diseases, have consistently worse diet patterns.<sup>30,31</sup> The Government of the United Kingdom has spent over a decade promoting fruit and vegetable consumption, but with frustratingly small improvements.<sup>6</sup> Social marketing campaigns and free fruit schemes for schools have clearly not sufficed. Energy-dense, nutrient-poor "junk food" remains cheap and is aggressively marketed,<sup>32</sup> whereas fruit and vegetables remain relatively expensive.<sup>2,30</sup> Improvements will clearly require additional structural changes.<sup>25,32-34</sup>

Policy decisions at the European level can powerfully affect food availability and consumption at the national level, both directly and indirectly. The EU Common Agricultural Policy (CAP), which massively influences agriculture and nutrition across Europe, has an annual expenditure of approximately 45 billion euros. This sum represents about 45% of the overall EU budget.<sup>27</sup> To deal with the historical threat of food shortages, the CAP has tended to increase the availability of cheap saturated fats while raising the price of and reducing the availability of healthy foods such as fruit and vegetables.<sup>14,33,34</sup> CAP reform is urgently needed and should ideally incorporate Finland's request to the EU for "health in all policies" (including agriculture).

Other effective interventions also exist. Lessons from tobacco control appear surprisingly relevant. The key targets are affordability, accessibility and acceptability.<sup>32</sup> If the new government of the United Kingdom is seriously intent upon reducing the double burden of childhood obesity and adult CVD, taxing junk food and using the revenue to subsidize the fresh fruit and vegetable industry would be both feasible and cost-saving, even in an economic recession.<sup>10,22,24-26</sup>

Our study has several strengths. The methods employed are transparent and easily replicated. Risk factors were treated as continuous rather than categorical variables.<sup>35</sup> Diverse but realistic policy scenarios were examined, based upon changes actually observed in other European countries. We also assumed that the benefits would be cumulative rather than additive.<sup>36</sup> The estimated 12 000 deaths per year with modest dietary improvements were consistent with FSA estimates based on less rigorous dietary targets.<sup>5,11</sup> Our conservative estimates did not include the potential benefits of increasing the intake of nuts, whole grains, fibre and fish; these would have further reduced mortality.<sup>37</sup>

Our study also has limitations. We did not explicitly model lag times. However, substantial reductions in deaths from CVD following dietary changes can occur very rapidly in randomized cohorts and entire populations.<sup>28,38,39</sup> We also assumed that the effects of food policies on dietary intake in the United Kingdom would be quantitatively similar to those in other countries, without explicitly considering political, com-

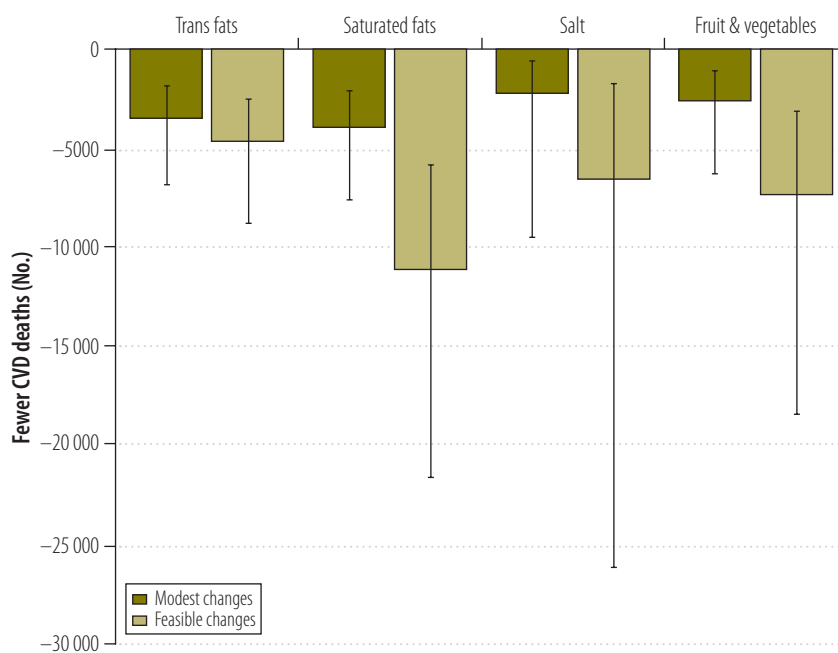
Table 2. **Age-specific falls in deaths from annual coronary heart disease (CHD) and stroke potentially attributable to modest<sup>a</sup> dietary improvements, United Kingdom**

	Decrease in CHD deaths			Decrease in stroke deaths			Decrease in total CVD deaths		
	Best estimate	Min.	Max.	Best estimate	Min.	Max.	Best estimate	Min.	Max.
<b>Men</b>									
All ages (years)	4800	2000	12 000	1800	900	4000	6600	2900	16 000
25–34	30	0	50	0	0	30	30	0	80
35–44	180	70	450	50	20	90	230	90	540
45–54	440	180	1100	90	60	210	530	240	1310
55–64	770	340	1920	140	60	320	910	400	2240
65–74	990	420	2490	270	140	600	1260	560	3090
75–84	2390	1040	6020	1270	620	2760	3660	1660	8780
< 65	1420	590	3520	280	140	650	1700	730	4170
< 75	2410	1010	6010	550	280	1250	2960	1290	7260
<b>Women</b>									
All ages (years)	3500	1500	8700	2400	1000	5500	5900	2500	14 000
25–34	0	0	0	0	0	20	0	0	20
35–44	40	20	100	30	10	80	70	30	180
45–54	90	40	230	70	30	150	160	70	380
55–64	210	100	540	100	40	210	310	140	750
65–74	460	200	1130	210	90	450	670	290	1580
75–84	2680	1150	6690	1970	860	4620	4650	2010	11 310
< 65	340	160	870	200	80	460	540	240	1330
< 75	800	360	2000	410	170	910	1210	530	2910

CVD, cardiovascular disease; min., minimum; max, maximum.

<sup>a</sup> 1% less energy from saturated fat, 0.5% less energy from trans fat, a decrease in salt intake of 1 g a day and one additional portion of fruit and vegetables daily, adjusted for cumulative effects.

Fig. 1. **Estimated annual reductions in deaths from cardiovascular disease (CVD) with modest and more substantial but feasible dietary improvements, United Kingdom**



mercial, cultural and socioeconomic differences or whether other countries' baseline dietary values were high or low. We also assumed commercial vested interests could be minimised. However, recent notable events include the industry lobbying behind the United Nations' recent high-level meeting on non-communicable diseases, and the undermining or sabotage of effective interventions such as EU's front-of-pack food labelling.<sup>40,41</sup> The DASH and Omni Heart randomized trials have demonstrated, nonetheless, that individuals can rapidly improve their dietary intake substantially and over the long term, even in the absence of the supportive social environments provided by healthy policies.<sup>9</sup>

We assumed that trans fats would be replaced by an equal mixture of "good" monounsaturated and polyunsaturated fats, not by "bad" saturated fats (as observed in Canada<sup>28</sup>). We also assumed that changes in dietary variable would be similar across all age groups. Variance and skew could be assessed in

Table 3. Age-specific falls in deaths from annual coronary heart disease (CHD) and stroke potentially attributable to more substantial dietary improvements, United Kingdom

	Decrease in CHD deaths			Decrease in stroke deaths			Decrease in total CVD deaths		
	Best estimate	Min. <sup>b</sup>	Max. <sup>b</sup>	Best estimate	Min. <sup>b</sup>	Max. <sup>b</sup>	Best estimate	Min. <sup>b</sup>	Max. <sup>b</sup>
<b>Men</b>									
All ages (years)	11 000	4 680	29 000	4 900	2 400	10 300	15 800	7 100	39 300
25–34	50	20	120	30	20	80	80	40	200
35–44	380	160	950	120	50	230	500	210	1 180
45–54	960	420	2 540	230	110	460	1 190	530	3 000
55–64	1 730	750	4 520	370	190	780	2 100	940	5 300
65–74	2 280	990	6 120	740	370	1 560	3 020	1 360	7 680
75–84	5 580	2 340	14 810	3 380	1 700	7 150	8 960	4 040	21 960
< 65	3 120	1 350	8 130	750	370	1 550	3 870	1 720	9 680
< 75	5 400	2 340	14 250	1 490	740	3 110	6 890	3 080	17 360
<b>Women</b>									
All ages (years)	8 000	3 400	21 400	6 000	2 700	14 200	14 100	6 200	35 500
25–34	0	0	40	20	10	50	20	10	90
35–44	90	40	240	90	30	210	180	70	450
45–54	220	90	560	160	80	370	380	170	930
55–64	500	210	1 320	220	90	540	720	300	1 860
65–74	1 060	450	2 750	500	230	1 200	1 560	680	3 950
75–84	6 170	2 630	16 470	5 070	2 300	11 810	11 240	4 930	28 280
< 65	810	340	2 160	490	210	1 170	1 300	550	3 330
< 75	1 870	790	4 910	990	440	2 370	2 860	1 230	7 280

CVD, cardiovascular disease; min., minimum; max, maximum.

<sup>a</sup> 3% less energy from saturated fat, 1% less energy from trans fat, a decrease in salt intake of 3 g per day and 3 additional portions of fruit and vegetables daily, adjusted for cumulative effects.

<sup>b</sup> From sensitivity analyses.

future models, along with compression of morbidity, social stratification and cumulative benefits over a lifetime.

Another assumption was that any effects of dietary changes on mortality would wane with increasing age, as with cholesterol and blood pressure.<sup>20,21</sup> Despite this, the greatest benefits were observed in individuals over 75 years of age. Furthermore, dietary changes may be more pronounced in younger people, meaning greater long-term benefits. We did not explicitly consider competing risks. However, healthier food and nutrient policies should also reduce rates of diabetes, common cancers and childhood obesity. Furthermore, we only quantified averted deaths; proportional reductions in non-fatal conditions might reasonably be expected.<sup>36</sup> Furthermore, several of our assumptions were tested by means of sensitivity analyses.

Unlike colleagues in the Netherlands and US, we did not model the effect of increasing the intake of nuts, whole grains, sugars, fish or marine

omega-3 fatty acids.<sup>23,36,37</sup> Promoting United Kingdom fish consumption might pose problems of affordability and sustainability.<sup>42</sup> However, even using a complex Markov model, the Dutch results were reassuringly similar: an estimated 21% reduction in cardiovascular events versus our 20%.<sup>36</sup> Our calculations only quantified deaths from CVD. Including common cancers might inflate benefits by another fifth, mainly through increased fruit and vegetable intake.<sup>3</sup>

In conclusion, stricter United Kingdom food policies could substantially and rapidly reduce cardiovascular mortality. Over the past decade, the United Kingdom Government and FSA's voluntary agreements and partnership with industry have resulted in modest dietary improvements.<sup>43</sup> However, the current United Kingdom dietary targets are clearly insufficient longer term. Cosy voluntary agreements with the processed food industry generally fail, much like tobacco policies in previous decades.<sup>32,44–46</sup> Conversely,

countries with healthier food policies (e.g. Denmark, Finland, Iceland, Norway and Sweden) have seen larger drops in major CVD risk factors and correspondingly bigger mortality reductions.<sup>8,43,44,47</sup> However, setting tougher United Kingdom dietary targets will require additional regulatory, legislative and fiscal initiatives: evidence-based policy interventions recommended by the British National Institute for Health and Clinical Excellence (NICE), the World Health Organization (WHO), The World Bank and the United Nations.<sup>37</sup> Indeed, both adults and children deserve better protection from the detrimental effects of cheap junk food and sugary drinks.<sup>32,40,41,45,46,48,49</sup> And a simple first step could be to eliminate industrial trans fats, as done successfully in Denmark and elsewhere.<sup>13</sup> ■

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**Competing interests:** SC was the vice-chair of the NICE PDG on CVD prevention in populations (2009–2010), and is a member of the British Heart Foundation

(BHF) prevention and care committee. However, our recommendations do not necessarily reflect the views of NICE or the BHF.

## ملخص

### الانخفاضات المحتملة في وفيات الأمراض القلبية الوعائية نتيجة لسياسات الأطعمة الأكثر صرامة في المملكة المتحدة لبريطانيا العظمى وأيرلندا الشمالية

التائج سينتج عن السيناريو الأول انخفاض وفيات الأمراض القلبية الوعائية بمقدار 12500 حالة وفاة سنوياً تقريباً (النطاق: 5500 - 30300). وسيحدث انخفاض في الوفيات الناجمة عن مرض القلب التاجي بين الرجال بمقدار 4800 حالة وفاة وعن السكتة بمقدار 1800 حالة وفاة، وسيحدث انخفاض في الوفيات الناجمة عن مرض القلب التاجي والسكتة بين النساء بمقدار 3500 حالة وفاة و2400 حالة وفاة على التوالي. وستنتج عن زيادة التحسينات الملحوظة التي يتم إدخالها على الأنظمة الغذائية (تجنب الدهون الصناعية المتحولة وخفض الدهون المشبعة والملح والزيادات الكبرى في تناول الفواكه والخضروات) انخفاض في الوفيات بمقدار 30000 حالة وفاة تقريباً (النطاق: 13300 - 74900) من حالات الوفاة الناجمة عن الأمراض القلبية الوعائية. الاستنتاج يسفر فرط الدهون المتحولة والدهون المشبعة والملح مع تناول كميات غير كافية من الفواكه والخضروات في الأنظمة الغذائية عن عبء كبير فيما يخص الأمراض القلبية الوعائية في المملكة المتحدة. ويمكن تحقيق المزيد من التحسينات المشابهة لتلك التي تم تحقيقها بواسطة البلدان الأخرى من خلال سياسات أكثر صرامة للأنظمة الغذائية.

الغرض تقدير حجم الانخفاض الذي يمكن أن يطرأ على وفيات الأمراض القلبية الوعائية (CVD) في المملكة المتحدة من خلال أهداف تغذوية أكثر تطوراً.

الطريقة تم تقدير الانخفاضات المحتملة في وفيات الأمراض القلبية الوعائية في المملكة المتحدة في الفترة ما بين عامي 2006 (خط الأساس) و2015 عن طريق استخلاص البيانات المتعلقة بالسكان والنظام الغذائي والوفيات بين البالغين الذين تتراوح أعمارهم ما بين 25 و84 سنة. وتم الحصول على أثر تغييرات أنظمة غذائية محددة على وفيات الأمراض القلبية الوعائية من التحليلات الوصفية الحديثة. وتلا ذلك تقدير الانخفاض المحتمل في وفيات الأمراض القلبية الوعائية بالنسبة لسيناريوهين يتعلقان بسياسة الأنظمة الغذائية: (1) التحسينات المتواضعة (ببساطة افتراض استمرار الاتجاهات الحديثة حتى عام 2015) و(2) الانخفاضات الملحوظة ذات الجدوى (تم مشاهدة ذلك بالفعل في عدد من البلدان) في الدهون المشبعة والدهون الصناعية المتحولة واستهلاك الملح، بالإضافة إلى زيادة تناول الفواكه والخضروات. وتم إجراء تحليل احتمالي للحساسية. كما تم ترتيب النتائج بحسب العمر والجنس.

## الخلاصة

### تخفيضات محتملة في وفيات الأمراض القلبية الوعائية من خلال سياسات أطعمة أكثر صرامة في المملكة المتحدة لبريطانيا العظمى وأيرلندا الشمالية

**الهدف** تقدير حجم الانخفاض الذي يمكن أن يطرأ على وفيات الأمراض القلبية الوعائية (CVD) من خلال أهداف تغذوية أكثر تطوراً.

**الطريقة** تم تقدير الانخفاضات المحتملة في وفيات الأمراض القلبية الوعائية في المملكة المتحدة في الفترة ما بين عامي 2006 (خط الأساس) و2015 عن طريق استخلاص البيانات المتعلقة بالسكان والنظام الغذائي والوفيات بين البالغين الذين تتراوح أعمارهم ما بين 25 و84 سنة. وتم الحصول على أثر تغييرات أنظمة غذائية محددة على وفيات الأمراض القلبية الوعائية من التحليلات الوصفية الحديثة. وتلا ذلك تقدير الانخفاض المحتمل في وفيات الأمراض القلبية الوعائية بالنسبة لسيناريوهين يتعلقان بسياسة الأنظمة الغذائية: (1) التحسينات المتواضعة (ببساطة افتراض استمرار الاتجاهات الحديثة حتى عام 2015) و(2) الانخفاضات الملحوظة ذات الجدوى (تم مشاهدة ذلك بالفعل في عدد من البلدان) في الدهون المشبعة والدهون الصناعية المتحولة واستهلاك الملح، بالإضافة إلى زيادة تناول الفواكه والخضروات. وتم إجراء تحليل احتمالي للحساسية. كما تم ترتيب النتائج بحسب العمر والجنس.

**النتائج** سينتج عن السيناريو الأول انخفاض وفيات الأمراض القلبية الوعائية بمقدار 12500 حالة وفاة سنوياً تقريباً (النطاق: 5500-30300). وسيحدث انخفاض في الوفيات الناجمة عن مرض القلب التاجي بين الرجال بمقدار 4800 حالة وفاة وعن السكتة بمقدار 1800 حالة وفاة، وسيحدث انخفاض في الوفيات الناجمة عن مرض القلب التاجي والسكتة بين النساء بمقدار 3500 حالة وفاة و2400 حالة وفاة على التوالي. وستنتج عن زيادة التحسينات الملحوظة التي يتم إدخالها على الأنظمة الغذائية (تجنب الدهون الصناعية المتحولة وخفض الدهون المشبعة والملح والزيادات الكبرى في تناول الفواكه والخضروات) انخفاض في الوفيات بمقدار 30000 حالة وفاة تقريباً (النطاق: 13300-74900) من حالات الوفاة الناجمة عن الأمراض القلبية الوعائية. الاستنتاج يسفر فرط الدهون المتحولة والدهون المشبعة والملح مع تناول كميات غير كافية من الفواكه والخضروات في الأنظمة الغذائية عن عبء كبير فيما يخص الأمراض القلبية الوعائية في المملكة المتحدة. ويمكن تحقيق المزيد من التحسينات المشابهة لتلك التي تم تحقيقها بواسطة البلدان الأخرى من خلال سياسات أكثر صرامة للأنظمة الغذائية.

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## Résumé

### Réductions potentielles de la mortalité d'origine cardiovasculaire par une politique alimentaire plus stricte au Royaume-Uni de Grande-Bretagne et d'Irlande du Nord

**Objectif** Estimer le niveau de réduction potentielle de la mortalité liée aux maladies cardiovasculaires (MCV) au Royaume-Uni par le biais d'objectifs nutritionnels plus progressistes.

**Méthodes** Les réductions potentielles de la mortalité par MCV au Royaume-Uni entre 2006 (base) et 2015 ont été estimées par la synthèse

des données sur la population, l'alimentation et la mortalité parmi les adultes âgés de 25 à 84 ans. L'effet des modifications spécifiques du régime alimentaire sur la mortalité par MCV a été obtenu à partir de méta-analyses récentes. La possible diminution du nombre de décès dus aux maladies cardiovasculaires a ensuite été estimée pour deux scénarios

de politique nutritionnelle: (i) des améliorations mineures (en supposant simplement que les tendances récentes se poursuivront jusqu'en 2015) et (ii) des réductions plus importantes, mais envisageables (déjà observées dans plusieurs pays) dans les graisses saturées, les graisses trans industrielles et dans la consommation de sel, accompagnées d'une augmentation de la consommation de fruits et légumes. Une analyse de sensibilité probabiliste a été réalisée. Les résultats ont été classés selon l'âge et le sexe.

**Résultats** Le premier scénario se traduirait par une réduction annuelle d'environ 12 500 décès par MCV (intervalle: 5500-30 300). Environ 4800 décès liés aux maladies coronariennes et 1800 décès par infarctus seraient évités chez les hommes, pour respectivement

3500 et 2400 décès chez les femmes. Des mesures alimentaires plus strictes (pas de matières grasses trans industrielles, une réduction de la consommation en graisses saturées et en sel, ainsi que des augmentations substantielles de la consommation de fruits et légumes) pourraient se traduire par une réduction d'environ 30 000 décès par MCV (intervalle: 13 300 à 74 900).

**Conclusion** Les excès en graisses trans alimentaires, en graisses saturées et en sel, ainsi que des apports insuffisants en fruits et légumes génèrent un impact substantiel des MCV au Royaume-Uni. Des améliorations semblables à celles obtenues dans d'autres pays sont réalisables grâce à des politiques alimentaires plus strictes.

## Резюме

### Потенциальное снижение смертности от сердечнососудистых заболеваний в результате ужесточения политики в отношении продуктов питания в Соединенном Королевстве Великобритании и Северной Ирландии

**Цель** Оценить, как можно снизить смертность от сердечнососудистых заболеваний (ССЗ) в Соединенном Королевстве путем введения более прогрессивных требований к продуктам питания.

**Методы** Потенциальное снижение смертности от ССЗ в Соединенном Королевстве за период с 2006 г. (базовый уровень) по 2015 г. было оценено путем синтеза данных о населении, диетических предпочтениях и смертности среди взрослого населения в возрасте от 25 до 84 лет. Влияние конкретных изменений диеты на уровень смертности от ССЗ было рассчитано на основе результатов последних мета-аналитических исследований. Потенциал снижения смертности от ССЗ был затем оценен для двух сценариев политики в отношении продуктов питания: (i) скромные улучшения (если просто предположить, что последние тенденции сохраняются до 2015 г.) и (ii) более существенное, но правдоподобное сокращение (уже наблюдаемое в ряде стран) содержания в рационе насыщенных жиров, транс-жиров и потребления соли, а также повышение потребления фруктов и овощей. Был проведен вероятностный

анализ чувствительности. Результаты были стратифицированы по возрасту и полу.

**Результаты** Согласно первому сценарию количество смертей от ССЗ снизится приблизительно на 12 500 в год (диапазон: 5500-30 300). Приблизительно, среди мужчин на 4800 сократится количество смертей от ишемической болезни сердца и на 1800 – от инсульта, а среди женщин – на 3500 и 2400, соответственно. Более существенные улучшения в диете (отказ от промышленных транс-жиров, снижение потребления насыщенных жиров и соли, а также существенное увеличение потребления фруктов и овощей) может привести к снижению смертности от ССЗ приблизительно на 30 000 (диапазон: 13 300-74 900).

**Вывод** Избыточное потребление транс-жиров, насыщенных жиров и соли, а также недостаточное потребление фруктов и овощей способствуют увеличению заболеваемости ССЗ в Соединенном Королевстве. Дальнейшие улучшения, аналогичные уже имеющим место в других странах, могут достигаться путем введения более строгой политики в отношении продуктов питания.

## Resumen

### Posible reducción de la mortalidad por enfermedades cardiovasculares a través de unas políticas alimentarias más estrictas en el Reino Unido de Gran Bretaña e Irlanda del Norte

**Objetivo** Calcular cuánto más podría reducirse la mortalidad por enfermedades cardiovasculares en el Reino Unido a través de objetivos nutricionales más progresivos.

**Métodos** Se calculó la reducción potencial de la mortalidad por enfermedades cardiovasculares en el Reino Unido entre los años 2006 (año de referencia) y 2015 sintetizando los datos acerca de la población, la dieta y la mortalidad entre adultos con edades comprendidas entre los 25 y los 84 años. El efecto de unos cambios dietéticos concretos sobre la mortalidad por enfermedades cardiovasculares se obtuvo a través de metaanálisis recientes. La posible reducción de los fallecimientos por enfermedades cardiovasculares se calculó entonces para dos supuestos con políticas dietéticas distintas: (i) mejoras moderadas (se asume simplemente que las tendencias recientes continuarán hasta el año 2015) y (ii) reducciones más importantes pero factibles (como ya se han observado en muchos países) en el consumo de grasas saturadas,

grasas trans industriales y sal, unidas a un mayor consumo de frutas y verduras. Se llevó a cabo un análisis de sensibilidad probabilístico y los resultados se estratificaron según la edad y el sexo.

**Resultados** El primer supuesto tendría como resultado aproximadamente 12 500 fallecimientos menos por enfermedad cardiovascular al año (margen: 5500-30 300). Entre los hombres se registrarían aproximadamente 4800 fallecimientos menos por cardiopatías coronarias y 1800 fallecimientos menos por accidentes cerebrovasculares. En el caso de las mujeres, se observaría una reducción de 3500 y 2400 fallecimientos menos, respectivamente. Unas mejoras dietéticas más sustanciales (erradicación de las grasas trans industriales, reducción de las grasas saturadas y la sal, unidas a un aumento en el consumo de frutas y verduras) podrían traducirse en aproximadamente 30 000 fallecimientos menos (margen: 13 000 – 74 900) por enfermedades cardiovasculares.



**Conclusión** El exceso de grasas trans, grasas saturadas y sal, así como un consumo insuficiente de fruta y verdura en la dieta genera una carga considerable de fallecimientos por enfermedades cardiovasculares en

el Reino Unido. A través de políticas alimentarias más estrictas pueden alcanzarse mejoras similares a las obtenidas por otros países.

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