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Exploring potential mortality reductions in 9 European countries by improving diet and lifestyle: A modelling approach

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ABSTRACT

Background: Coronary heart disease (CHD) death rates have fallen across most of Europe in recent decades. However, substantial risk factor reductions have not been achieved across all Europe. Our aim was to quantify the potential impact of future policy scenarios on diet and lifestyle on CHD mortality in 9 European countries.

Methods: We updated the previously validated IMPACT CHD models in 9 European countries and extended them to 2010–11 (the baseline year) to predict reductions in CHD mortality to 2020(ages 25–74 years). We compared three scenarios: conservative, intermediate and optimistic on smoking prevalence (absolute decreases of 5%, 10% and 15%); saturated fat intake (1%, 2% and 3% absolute decreases in % energy intake, replaced by unsaturated fats); salt (relative decreases of 10%, 20% and 30%), and physical inactivity (absolute decreases of 5%, 10% and 15%). Probabilistic sensitivity analyses were conducted.

Results: Under the conservative, intermediate and optimistic scenarios, we estimated 10.8% (95% CI: 7.3–14.0), 20.7% (95% CI: 15.6–25.2) and 29.1% (95% CI: 22.6–35.0) fewer CHD deaths in 2020. For the optimistic scenario, 15% absolute reductions in smoking could decrease CHD deaths by 8.9%–11.6%, Salt intake relative reductions of 30% by approximately 5.9–8.9%; 3% reductions in saturated fat intake by 6.3–7.5%, and 15% absolute increases in physical activity by 3.7–5.3%.

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Conclusions: Modest and feasible policy-based reductions in cardiovascular risk factors (already been achieved in some other countries) could translate into substantial reductions in future CHD deaths across Europe. However, this would require the European Union to more effectively implement powerful evidence-based prevention policies.

1. Introduction

Cardiovascular disease (CVD), particularly coronary heart disease (CHD), continues to be a significant health problem in Europe and globally. Despite a sustained decline in premature CVD morbidity and mortality over two decades, this continuing burden will exert significant pressure on future healthcare systems, particularly given the sustained population ageing that most European countries are experiencing [1]. Prevention of CVD is therefore still a high priority, as recently stressed by the World Health Assembly [2].

Poor diet, tobacco, alcohol and physical inactivity are recognized as key drivers of the CVD epidemic [3,4]. Furthermore structural, population wide policies can achieve substantial improvements resulting in large and rapid reductions in mortality [5] while also being cost-saving, making them attractive from a public health perspective [6,7]. Some countries across the European region are therefore actively promoting their own nutritional, physical activity and tobacco control policies. However, the picture is mixed and many of the actions are limited, focusing on health promotion and education rather than the more powerful taxation and regulatory policy options [8]. Still, these latter strategies are perceived as politically more challenging to implement and their potential benefits are thus often overlooked.

The aim of this study was therefore to assess the number of deaths from CHD preventable by a range of population wide structural interventions. These aimed to modify the main lifestyle-related cardiovascular risk factors (smoking, salt and saturated fat intake and physical activity level) in nine European countries participating in the EuroHeart II project (Czech Republic, Finland, Iceland, Italy, Republic of Ireland, Northern Ireland, Poland, Scotland, Sweden).

2. Methods

To forecast the number of deaths potentially preventable in 2020 we adapted original IMPACT CHD Models in each country [9–19]. The data that the IMPACT model used to translate changes in risk factors (systolic blood pressure, total cholesterol, physical activity and smoking) into mortality reductions are detailed in the Technical Appendix (A2.1–2.4), and description of the general modelling methods is available in previous publications [20]. The original model estimates the deaths prevented or postponed (DPPs) that may be attributable to specific risk factor changes or treatment changes over a period of time. Here we summarize the methodology used to extend the IMPACT model to explore further policies around changes in specific nutrients (salt and saturated fat intakes) and perform forecasts of future mortality to 2020.

2.1. Estimating future trends in CHD mortality to 2020

In order to estimate future CHD mortality in 2020 for each country, an exponential decay model was fitted using Matlab. This took account of historical CHD mortality rates (annual trends by 10 year age group (from ages 25–74) and sex in each country. Annual trend data on CHD mortality was available over a period varying between 17 and 26 years for each country i.e. from the 1980s or 1990s up to the year 2010–11). Official population projections were obtained from national statistics agencies for the year 2020. This allowed us to capture both change in population structure and ongoing change in risk of mortality. This may therefore be a more realistic future mortality scenario compared to the traditional indirect standardization method that only captures population demographic changes, and simplistically assumes that CHD risk will remain constant at baseline levels. CHD mortality trends and population projections were obtained from national statistical offices in each country. For comparison, our analysis presented both the exponential decay model counterfactual ("continuing decline in mortality") and the indirect standardized one ("no change in mortality").

2.2. Updated IMPACT CHD model: translating changes in salt and saturated fat intake into mortality reductions

Using dichotomous risk factor values, the impact of future levels of physical inactivity and smoking on CHD mortality to 2020 was quantified using a population attributable change based method, as in previous work [20].

The original IMPACT model had no functionality to calculate deaths prevented or postponed (DPPs) according to changes in salt consumption and saturated/unsaturated fatty acids intake. For this project, we adapted the national IMPACT models by creating two additional layers to translate the effects of changes in these risk factors to changes in blood pressure and total cholesterol levels, as previously developed for analysis in the UK and Ireland [21–23]. Translating the effect of salt intake variation to changes in blood pressure was based on data published in a Cochrane systematic review [24] which quantified the effect of salt reduction on blood pressure in hypertensive and normotensive patients. We then used conventional IMPACT modelling methodology to translate the change in SBP levels into mortality reductions (see A2.1). In order to model the effect of saturated fat intake on serum cholesterol levels, we used the Clarke equations [25] to translate a change in saturated fat intake into a change in total cholesterol levels, assuming iso-caloric replacement with polyunsaturated and mono-saturated fats (assuming that each 1% absolute reduction in energy from saturated fat was replaced by 0.1% energy from mono- and 0.9% energy from poly-unsaturated fats). We estimated the effect of changes in multiple risk factors using a multiplicative approach, based on the methods used by Bajekal et al. [20].

The structure of the updated model is presented on Fig. 1.

2.3. Policy scenarios

Three policy scenarios were modelled to quantify the impact of potential future changes in risk factors on future CHD mortality. The first (S1), most conservative scenario assumed a small decrease in energy from saturated fats (and replacing it with energy from mono- and polyunsaturates), a modest 10% decrease in current salt intake, and a 5% decrease in the prevalence of smokers and physically inactive people.

The most optimistic scenario (S3) assumed improvements already achieved in exemplar countries. A salt intake reduction of 30% (as in Finland and Japan) [26,27]; a 15% decrease in the prevalence of smoking (Australia and California) [28,29] and 15% decline in physical in activity (Finland, Cuba) [30,31]; and an absolute decrease of 5% in energy from saturated fats (Finland [32]).

Finally, the intermediate and plausible scenario (S2) used reductions between the conservative and optimistic ones, and its feasibility taking into account the baseline levels of the behavioural and biological risk factors are presented in the appending (Table A1.1 and A1.2, Technical Appendix).

Finally, we estimated the maximum theoretical reductions in CHD mortality to 2020 achievable in each country with "optimal" risk factor profiles for both smoking (assuming no-one in the country ever smoked) and physical inactivity (no inactive individuals).

2.4. Sensitivity analysis

We quantified the degree of stochastic uncertainty using Monte Carlo simulation implemented with R software. We repeated random draws from specified distributions for the input variables to iteratively recalculate the model. We calculated the uncertainty intervals based on 10,000 draws taking the 95% uncertainty intervals as the 2.5th and 97.5th percentiles. Input variables taken from external sources (e.g. beta coefficients and relative risk reductions) were randomly drawn from specified distributions. Distributions used for main input parameters are listed in the Technical Appendix (Table A3).

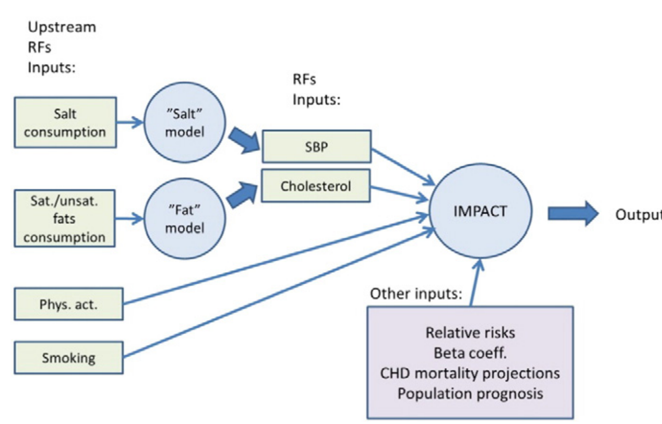

Fig. 1. Structure of updated IMPACT CHD model.