**ABSTRACT**

**Objective:** This study uses a modelling approach to compare the potential impact of future risk factor scenarios relating to smoking, physical activity levels, dietary salt, saturated fat intake, mean body mass index (BMI) levels, diabetes prevalence and fruit and vegetable (F&V) consumption on future coronary heart disease (CHD) mortality in Turkey for year 2025.

**Design:** A CHD mortality model previously developed and validated in Turkey was extended to predict potential trends in CHD mortality from 2008 to 2025.

**Setting:** Using risk factor trends data from recent surveys as a baseline, we modelled alternative evidence-based future risk factor scenarios (modest/ideal scenarios). Probabilistic sensitivity analyses were conducted to account for uncertainties.

**Subject:** Projected populations in 2025 (aged 25–84) of 54 million in Turkey.

**Results:** Assuming lower mortality, modest policy changes in risk factors would result in 25635 (range: 20290–31125) fewer CHD deaths in the year 2025; 35.6% attributed to reductions in salt consumption, 20.9% to falls in diabetes, 14.6% to declines in saturated fat intake and 13.6% to increase in F&V intake. In the ideal scenario, 45950 (range: 36780–55450) CHD deaths could be prevented in 2025. Again, 33.2% of this would be attributed to reductions in salt reduction, 19.8% to increases in F&V intake, 16.7% to reductions in saturated fat intake and 14.0% to the fall in diabetes prevalence.

**Conclusions:** Only modest risk factor changes in salt, saturated/unsaturated fats and F&V intake could prevent around 16,000 CHD deaths in the year 2025 in Turkey, even assuming mortality continues to decline. Implementation of population-based, multisectoral interventions to reduce salt and saturated fat consumption and increase F&V consumption should be scaled up in Turkey.

**BACKGROUND**

Cardiovascular diseases (CVDs) are the leading cause of death in the world. Low-income and middle-income countries are disproportionately affected from the burden of CVDs; more than 80% of global CVD deaths take place in these countries. The main types of CVDs are coronary heart disease (CHD) and stroke, and it is estimated that 80% of premature (<80 years old) deaths from these diseases can be prevented. Turkey is a developing upper-middle-income country according to the World Bank with a population of ~74 million. According to the National Burden of Disease Study, 8% of the total burden of disease was due to CHD in 2004, and CHD was the leading cause of morbidity among adults in Turkey. CHD prevalence was 5.0% in men and 2.6% in women over the age of 20 in 2011. The burden of CVDs is rising rapidly all over the world as a result of population growth, ageing and due to increases in major CVD risk factors. The major modifiable risk factors of CVDs are diabetes...
mellitus (DM), high blood pressure, high saturated fat intake, hyperlipidaemia, smoking, physical inactivity, obesity and low fruit and vegetable (F&V) intake. Many population-based interventions have been proven to be effective for reducing CVD mortality. For example, decreasing saturated fat intake by 1% of total energy reduces CHD deaths by 3.6% due to the decline in blood cholesterol; decreasing salt intake by 1 g/day reduces CHD deaths by 3.4% due to decline in blood pressure; and increasing F&V intake by 1 portion/day results in a 4.0% reduction in CHD deaths due to decline in blood cholesterol; decreasing salt intake by 1 g/day reduces CHD deaths by 3.6% due to the decline in systolic blood pressure (SBP) levels and smoking rates. However, increases in obesity and diabetes were estimated to have resulted in over 9000 additional deaths in 2008. Recently, the Turkish Ministry of Health (MoH) prepared strategies and action plans in order to reduce the burden of cardiovascular risk factors in Turkey, but this strategic plan is not comprehensive and evidence based. Modelling studies are useful to determine the policy priorities through an evidence-based approach.

The aim of this study is to appraise the potential reductions in CHD mortality achievable by modest and ideal decreases in smoking, diabetes, physical inactivity, body mass index (BMI), consumption of saturated fat, salt and increases in consumption of F&V in Turkey by year 2025.

METHODS
The IMPACT model
The IMPACT model for Turkey has been previously published to explain past trends in CHD mortality (1995–2008). This model was validated by comparing the model-predicted CHD death rates in 2008 with observed CHD deaths (International Classification of Diseases, 10th revision (ICD-10) codes I20–I25) in 2008, stratified by age and gender. The model has also recently been validated for forward prediction in European populations. Appendices detailing the methods and data sources used for this model have already been published and are available from here (http://www.biomedcentral.com/content-supplementary/1471-2458-13-1135-s1.docx). We summarise in brief the data sources below. Microsoft Excel program was used in order to implement the model.

Estimating future CHD mortality to 2025
Future CHD mortality in 2025 was estimated using two approaches, recognising the uncertainty inherent in future predictions. First, ‘lower mortality’ values for 2025 were determined by fitting age-specific and gender-specific negative exponential decay models on historical CHD mortality rates between 1995 and 2008 using an iterative non-linear least squares model: \( y = a \times \exp(-b \times \text{year}) \), where \( a \) is the CHD mortality rate and \( b \) is the constant decay rate. Second, a ‘no mortality change’ estimate for CHD mortality in 2025 was calculated using an indirect standardisation approach, multiplying age-specific and gender-specific mortality rates for 2008 by the projected population for each 10-year age group in the year 2025.

Data sources
All data were stratified by gender and 10-year age groups for persons aged 25–84 years. Information on population, mortality and demographic changes was obtained from the census (1995) and Address Based Population Registration System (2008) of the Turkish Statistical Institute (TURKSTAT). Although the TURKSTAT data collection method changed between 1995 and 2008, population projections based on the census were very close to the population of address-based registration in 2008. We obtained estimates of the projected population in 2025 from the State Planning Organization in Turkey.

For the baseline year of the prediction model (2008), an extensive search was carried out for published and unpublished results. Population risk factor trend data, including SBP, total cholesterol, hypertension and smoking prevalence, were obtained from nationally representative surveys. Current and projected population-level trend data for diabetes and BMI were obtained from another published model for Turkey. Population risk factor trend data, including SBP, total cholesterol, hypertension and smoking prevalence, were obtained from nationally representative surveys.

Current and projected population-level trend data for diabetes and BMI were obtained from another published model for Turkey. Physical inactivity and F&V consumption trend data were generated by using information from national and regional surveys. All risk factor data trends for year 2025 were projected by using the available data and applying linear regression method by year and related prevalence rates assuming the same trend will continue in the future.

Method of estimating trends in mortality for a given risk factor change
Relative risks (RRs) estimated by expert working groups for the WHO’s Global Burden of Disease 2001 Study were used for changes in smoking, physical activity and diabetes. Regression coefficients from meta-analyses of cohort studies were used to quantify the effect of reducing salt intake on the change in mean SBP in the population and on the effect of replacing dietary saturated fat intake by either polyunsaturated fats or monounsaturated fats. Regression coefficients from meta-analyses of cohort studies were also included in the model to quantify the relationship between change in other risk factors (SBP, total cholesterol, F&V consumption, BMI) and change in CHD mortality.

A population-attributable risk fraction (PARF) approach was used to determine the number of deaths prevented or postponed (DPPs) in 2025 resulting from improvements in smoking, physical inactivity and diabetes trends. The PARF was calculated conventionally for 2008 and 2025 as \( \frac{P \times (RR-1)}{(1+P \times (RR-1))} \),
where $P$ is the prevalence of the risk factor and $RR$ is the relative risk for CHD mortality associated with the individual risk factor. The number of deaths prevented was calculated as the number of deaths in 2025 multiplied by the decrease in PARF between 2008 and 2025. Premature deaths were defined as deaths that occur before a person reaches the age of 85.

The number of CHD deaths potentially prevented in 2025, as a result of improved levels of BMI, F&V consumption, cholesterol and SBP in the population, was then estimated as the product of the three variables: the number of CHD deaths observed in 2008, the estimated absolute change in that risk factor between 2008 and 2025 and the adjusted regression coefficient quantifying the independent relationship between population change in a specific cardiovascular risk factor and the consequent change in mortality from CHD.

**Cumulative adjustment for risk factor changes done simultaneously**

CHD deaths are caused by multiple risk factors acting simultaneously. Enumerating mortality changes from risk factor trends should ideally therefore not use a simple additive approach. Instead, the effects of risk factor changes were jointly estimated using the cumulative relative benefit approach. This can be stated in the following equation:

$$
\text{Cumulative relative benefit} = 1 - \left( (1 - \text{relative reduction in mortality for risk factor } A) \times (1 - \text{relative reduction in mortality for risk factor } B) \times \cdots \times (1 - \text{relative reduction in mortality for risk factor } N) \right),
$$

where $N$ is the total number of additional risk factors (in this case 6 as in total we modelled 7). This approach is explained with an example in the online supplementary appendix.

This cumulative effect of change in all risk factors over the study period was calculated by age and gender. The ratio of the cumulative effect to the corresponding additive effect was then calculated, yielding 72 adjustment factors, which were used to scale down the additive DPPs for each risk factor. These adjusted DPPs, summed over all seven risk factors, then equalled the estimated total combined DPPs, capturing the multiplicative net impact of positive and adverse changes in risk factors. All risk factor DPPs quoted in the results tables refer to the adjusted DPPs.

**Scenario design**

When we evaluated CHD risk factor changes in Turkey between 1995 and 2008,11 smoking prevalence and the mean SBP decreased by 42% and 2%, respectively. In the same period, diabetes prevalence and mean BMI rose by 22% and 6%, respectively. Furthermore, there was a little decrease in total cholesterol, physical inactivity and an increase in F&V consumption.32 Recently, the MoH in Turkey developed strategic plans to control non-communicable diseases. However, national targets for cardiovascular risk factor reductions were not defined explicitly.12 The WHO set targets for reducing cardiovascular risk factors in order to decrease premature deaths from non-communicable diseases by 25% until 2025.33 The scenarios for 2025 were generated based on the information on recent trends in CVD risk factors in Turkey, from different surveys and targets set by the WHO.33

1. **Salt consumption:** Average daily salt consumption in Turkey decreased rapidly by 22% (from 18 to 15 g/day) from 2008 to 2012.34 35 In many countries, the average daily salt consumption varies between 9 and 12 g, and the WHO recommends <5 g daily salt consumption.33 We therefore evaluated the impact of modest and ideal changes in salt consumption, to 10 and 5 g/day, respectively.

2. **Saturated/unsaturated fat consumption:** Reduction in saturated fatty acid (SFA) consumption is a major focus of dietary recommendations to reduce the concentration of plasma lipoprotein cholesterol fractions.36 It is recommended that energy intake from dietary SFA should not exceed 10%, and recommended range for energy from total polyunsaturated fatty acid (PUFA) can range between 6% and 11%.36 In a recent national nutrition survey in Turkey, the percentage of total energy obtained from dietary SFA and PUFA among adults over 20 was 12% and 9%, respectively.37 The percentage of PUFA in the daily energy intake is in the recommended range in Turkey. Therefore, we only estimated the impact of reaching recommended levels of SFA intake in the Turkish population. Hence, we evaluated the impact of reaching modest and ideal targets in energy from dietary SFA of United Nations, 11% and 10%, respectively.

3. **Physical inactivity:** We estimated the impact of a 5% and 10% relative reduction in the prevalence of insufficient physical activity, the global targets set by the WHO in our modest and ideal scenario.33 34

a. **BMI:** It is estimated that mean BMI of Turkish population (aged 25–84) will increase between 2008 and 2025, from 29.0 to 30.4 kg/m².21 Finucane et al38 estimated the mean BMI trends between 1980 and 2008 worldwide increased by ∼0.04 kg/m² per year. Hence, we estimated that the increase in BMI in 17 years will be 0.68 kg/m² reaching to 29.7 kg/m² in 2025. Hence, we modelled a 0.7 unit or 2.3% decrease from the recent trend in BMI in our modest scenario. In the ideal scenario, we assumed that mean BMI of Turkish population will not change by 2025, remaining at 29.0 kg/m². As a result, we modelled the benefit of a 1.4 kg/m² or 4.6% reduction in mean BMI by 2025.

4. **Diabetes:** A recent US study reported that even if the most effective population prevention strategy was implemented, diabetes prevalence would still increase by about 65% over the 20 years (between 2010 and 2030) due to population ageing and
increasing BMI. For this reason, we assumed that diabetes prevalence would be maximum 29% (10% lower than that suggested by recent trends) in 2025 in the ideal scenario and 31% in the modest scenario (5% lower than suggested by recent trends).

5. Smoking: Smoking prevalence started to decline in Turkey after the implementation of the Framework Convention on Tobacco Control since 2008. According to the Turkish Global Adult Tobacco Survey (GATS) conducted in 2008 and 2012, smoking prevalence decreased by 13% in adults. Therefore, we modelled the impact of a 30% relative reduction in smoking prevalence by 2025 as the ideal scenario and 15% relative reduction as the modest scenario.

6. F&V consumption: There is enough evidence that F&V consumption plays a role in the prevention of CVDs. We examined the targets for F&V consumption set out by the European Union (EU) and WHO, which were 5 and 7 portions/day, ∼40% and 100% relative increase, respectively. Risk factor changes in the base year 2008 and projections to 2025 under two assumptions (modest and ideal scenarios) are presented as a summary in table 1.

Sensitivity analyses
Multivariate probabilistic sensitivity analyses using Monte Carlo simulation were conducted for all assumptions and variables. Distributions used for main input parameters in the model are presented in the online supplementary appendix. The 95% credible estimates reported are based on the 2.5th and 97.5th centiles of results generated from 1000 iterations of the model. The number of DPPs was rounded to the nearest whole number; maximum and minimum estimates are presented in the tables and figures, but only the best estimate is presented in the text to aid clarity.

RESULTS
The projected population in 2025 (adults aged 25–84) was 54 million in Turkey. Table 2 shows the estimated CHD deaths prevented by achieving risk factor policy targets (modest and ideal) for no mortality change scenario in men and women. If we assume no mortality change in 2025, modest changes in risk factor policy could result in 47 140 (minimum 38 175; maximum 56 310) fewer CHD deaths, a reduction of ∼30% of the number expected in 2025.

In both risk factor scenarios, ∼36.1–33.6% of the fewer CHD deaths could be attributed to reductions in salt intake, 13.6–15.6% to decreased saturated fat energy consumption levels, 13.1–19.2% to increased F&V consumption levels and 21.2–14.1% to decrease in diabetes prevalence if no mortality change occurs by 2025 (table 2, figure 1).

Table 3 shows the number of CHD deaths that are estimated for the lower mortality change scenario for 2025. Approximately 25 630–45 950 CHD deaths were prevented or postponed by modest and ideal scenarios, respectively.

If we assumed that mortality continued to decline and applied ideal scenarios in major risk factors by 2025, the breakdown of DPPs would be as follows:

A. Salt intake: Approximately 15 265 deaths will be prevented or postponed, assuming relative decrease in dietary salt intake by 70% (WHO target 5 g/day salt intake).

B. Saturated/unsaturated fat: Approximately 7690 deaths will be prevented or postponed, assuming absolute decrease in per cent energy from dietary saturated fat by 2% (target 10% energy from dietary saturated fat).

C. F&V consumption: Approximately 9095 deaths will be prevented or postponed, assuming relative increase in F&V consumption by 100% (target 7 portions/day F&V intake).

Table 1 Risk factor changes in the base year 2008 and projections to 2025 under two assumptions (modest and ideal scenarios)

| Risk factor changes | Modest scenario | Ideal scenario |
|---------------------|-----------------|---------------|
|                     | Changes (%)     | 2008          | 2025          | Changes (%) | 2008          | 2025          |
| Absolute smoking prevalence rate reduction | 3.0 | 22% | 19% | 6.0 | 22% | 16% |
| Relative decrease in dietary salt intake | 40.0 | 18 g/day | 10 g/day | 70.0 | 18 g/day | 5 g/day |
| Absolute diabetes prevalence rate reduction from the recent trends | 2.0 | 32% | 30% | 4.0 | 32% | 28% |
| Relative decrease in mean BMI from the recent trends | 2.3 | 30.4% | 29.7% | 4.6 | 30.4% | 29.0% |
| Absolute decrease in per cent energy from dietary saturated fat | 1.0 | 12% | 11% | 2.0 | 12% | 10% |
| Relative increase in F&V consumption | 40.0 | 3.5 portion/day | 5 portion/day | 100.0 | 3.5 portion/day | 7 portion/day |
| Absolute physical inactivity prevalence reduction | 3.0 | 64% | 61% | 6.0 | 64% | 58% |

BMI, body mass index; F&V, fruit and vegetable.
D. **Diabetes:** Approximately 6415 deaths will be prevented or postponed, assuming absolute diabetes prevalence rate reduction by 4% (target 10% lower than recent trends).

E. **BMI:** Approximately 1555 deaths will be prevented or postponed, assuming that relative decrease in mean BMI value will be 4.6% (target a mean reduction in BMI of 1.4 units in 17 years).

F. **Smoking:** Approximately 2025 deaths will be prevented or postponed, assuming that absolute smoking prevalence rate reduction will be 6% (30% relative reduction by WHO target).

G. **Physical inactivity:** Approximately 3905 deaths will be prevented or postponed, assuming that absolute physical inactivity prevalence reduction will be 6% (10% relative reduction by WHO target).

The largest contributions come from reductions in salt intake, energy from saturated fat and increase in F&V consumption (table 3, figure 2). For both scenarios, reductions in mean BMI, physical inactivity and smoking prevalence made <15% contribution to changes in CHD deaths in Turkey.

**DISCUSSION**

This study provided information by modelling the impact of improvements in the burden of main risk factors such as smoking, diabetes, physical inactivity, BMI, consumption of saturated fat, salt and consumption of F&V on avoidable CHD mortality in Turkey for year 2025. We present the estimates for one year only; benefits would be expected in other years if the improvements are made and sustained. Our modest change scenario estimates suggest that if there is lower mortality change, feasible risk factor improvements in Turkey could prevent or postpone ~25 600 deaths from CHD by 2025, a reduction of ~16% of CHD deaths expected in 2025. However, more ideal changes in risk factors could avoid about 46 000 CHD deaths, a reduction of ~30% of CHD deaths expected in 2025.

Based on all scenarios, the most substantial contributions came from the changes in salt intake, energy from saturated fat and increase in F&V consumption (table 3, figure 2). For both scenarios, reductions in mean BMI, physical inactivity and smoking prevalence made <15% contribution to changes in CHD deaths in Turkey.

**Table 2**

| Risk factors                        | Ideal scenario | Total (95% CI) | % |
|-------------------------------------|----------------|----------------|---|
| Men (95% CI)                        |                |                |   |
| Salt intake                         | 2775 (7265 to 1155) | 16 995 (15 625 to 18 405) | 13.1 |
| Saturated/unsaturated fat           | 2755 (8680 to 23 985) | 16 005 (14 605 to 17 405) | 13.1 |
| Fruit and vegetable                 | 3600 (1980 to 4835) | 14 480 (13 120 to 15 840) | 9.3  |
| Diabetes                            | 9855 (3895 to 5370) | 42 090 (39 175 to 45 005) | 19.2 |
| BMI (kg/m²)                         | 1215 (1065 to 1365) | 40 750 (38 095 to 43 405) | 18.9 |
| Physical inactivity                 | 2370 (1985 to 27 855) | 40 750 (38 095 to 43 405) | 18.9 |

BMI, body mass index; CHD, coronary heart disease.

Sahan C, et al. BMJ Open 2016;6:e011217. doi:10.1136/bmjopen-2016-011217
from decreases in blood total cholesterol and blood pressure.45–49

High salt consumption (15 g/day) is an important problem that can be ameliorated.35 Salt consumption was lowered by about 15% in 7 years in the UK by a national salt reduction programme which was considered to be a relatively weak intervention (relying mainly on voluntary agreements with the food industry, rather than more powerful legislative and fiscal policies).50 Greater falls in Turkey could be achieved by adopting wider salt reduction strategies, including working with the food industry, public health campaigns, monitoring progress and sustaining the strategies.51 Approximately 70–80% of sodium consumption comes from processed foods and ready meals in Western countries. However, the most important sources of sodium in the diet are sauces and adding salt in food preparation in Asian and African countries.52 In Turkey, the most important sources of sodium in diet are adding salt to food during preparation (56%), bread (32%) and adding salt on table (13%).35 Thus, a higher proportion of salt consumption in Turkey is ‘discretionary’ (added during cooking or eating) and potentially amenable to rapid reduction. Turkish cuisine also includes salty tomato paste that is added to home-made meals, salty pickles, olives and salty cheese. Therefore, strategies to reduce the salt in bread, remove salt from the table in restaurants and campaigns to inform the public about the harms of salt may be more effective. The recent National Salt Reduction Action Plan 2015 in Turkey has adopted salt reduction strategies, including reducing the amount of salt in bread and processed products by introducing legislation and to educate people to avoid adding salt on the table through health promotion campaigns.52 Recent modelling studies have estimated that the most cost-effective options to reduce salt intake in Turkey would be to implement three policy actions simultaneously (reformulation of products, product labelling and public health campaigns).53

The total daily energy intake from dietary SFA among adults over 20 years was 12% in Turkey, only slightly above the recommendations of the United Nation Agriculture Organisation (10%).36 37 It is still important to reduce consumption of SFA at a population level because of the significant impact on CHD deaths. According to a very conservative estimate, a 1% reduction in saturated fat energy intake would result in ~9800 fewer CHD deaths in Europe.54 The main effective strategies suggested to reduce SFA intakes are to encourage and support farmers to replace production from animal fat to healthy foods, to work with the food industry on product reformulation, reducing portion sizes, and to increase availability of healthier foods such as F&V.55

This study highlights the potentially large impact that increasing F&V intake could have on reducing CHD deaths in Turkey. The EU and WHO recommend to reach 5 and 7 portions/day F&V intake, respectively.40 41 Currently, daily F&V consumption (3.5 portions) is inadequate in Turkey,11 despite being a Mediterranean country. Fast food consumption has become widespread in urban areas, especially in children and young people. Also, consumption of bread and grain products is increasing due to socioeconomic problems and social inequalities in Turkey. A comprehensive study showed that increased F&V consumption up to an optimal level of intake could reduce the global burden of CHD by about 31%.56 There are some intervention strategies to increase F&V consumption such as point-of-purchase (POP) information, reduced prices and coupons, increased availability, variety and convenience, promotion and advertising.57 POP information is described as the use of shelf labels and/or signage that specifies healthy food choices in grocery stores, based on established criteria.57 Fresh F&V are more accessible and
relatively cheap in Turkey than other countries because of ideal climate and widespread production. Thus, POP information, promotion and advertising might be more effective than other interventions in Turkey.

Increasing F&V consumption limits the consumption of high-fat foods. For this reason, positive messages to increase the consumption of F&V might be more effective than the messages that fatty foods should not be consumed. In addition, high sugar-sweetened beverage (SSB) consumption increases with high salt and fat consumption. SSB consumption is one of the main causes of obesity and diabetes. Hence, SSB should be replaced with fresh F&V. There are some strategies to encourage low salt, sugar and fat levels among food products in the framework of the Turkey Healthy Diet and Active Life Program. Turkey has banned the sale of SSBs and high-calorie foods such as fried foods and crisps in elementary schools. Replacement of these harmful products by selling healthy foods such as milk, yoghurt and fruit was recommended by the MoH.

Some risk factors such as prevalence of DM and mean BMI values were increasing rapidly in Turkey, where they caused 9000 additional deaths in 2008. In our case, we might have underestimated the 2025 death rates as we did not take into account the impact of increasing trends in DM and BMI on CHD mortality. It is also likely that the contrasting trend of these factors might cancel out much of the benefits that would be attained from improvements in other risk factors. Hence, it calls for a better application of public health policies on reducing burden of DM and high BMI, as well as working to accelerate positive trends in salt, smoking and physical inactivity.

Owing to the high prevalence of diabetes, obesity and physical inactivity in Turkey, the MoH has action plans for preventing obesity, physical inactivity and diabetes, named the ‘Obesity Prevention and Control Program of Turkey’ and ‘Diabetes Prevention and Control Program’. The MoH aims to increase the number of environments suitable for physical activity in the community. Environmental regulations are needed to achieve this goal by cooperating with municipalities. However, there is neither sufficient political will nor resources to implement this across the country. Despite compulsory increased physical activity and low energy intake in Cuba for 4 years, the mean BMI of population decreased by only 1.5 units; to date, sustained falls in BMI have been hard to achieve at a population level.

The prevalence of smoking in adults significantly decreased by 13% between 2008 and 2012, due to the regulations related with Framework Convention on Tobacco Control in Turkey. Turkey implemented all MPOWER strategies, and it is regarded as one of the most successful countries in battling against smoking. The MoH is planning to prevent young people from starting to smoke by increasing monitoring, supervision and creating negative attitudes towards tobacco use in society.
Strengths and limitations

Models are practical and helpful tools for policy development. They merge and concurrently regard all data from many different sources. The validated Turkish IMPACT model was developed further in this study.11 Data were updated and additional components were added to the model to translate reductions in salt intake or energy from saturated fat intake into reductions in SBP or total cholesterol, respectively. We also made a cumulative adjustment for simultaneous risk factor improvements (since a CHD death can only be prevented once). This is not routinely implemented in modelling studies.25 This is the first comprehensive modelling study that examines the impact of changes in multiple risk factors and healthy food consumption on CHD mortality trends in Turkey.

The demographic information was obtained from the census data that covered the whole country; the risk factor trends were obtained from national epidemiological studies. In the Turkish IMPACT model, we assessed the potential maximum and minimum plausible effects of risk factors using rigorous probabilistic sensitivity analyses which systematically examine the influence of these uncertainties and the assumptions used in the studies. We used plausible estimates for changes in risk factor scenarios.

Our study has several potential limitations. The model included only those adults aged 25–84 years because of very limited data in older age groups. The lag times were not explicitly considered in this model. We measured only deaths from CHD and disregarded ‘competing causes’ such as cancer. Trends in treatment uptakes were not considered in this model, though they were already high in previous studies11 and are unlikely to deteriorate.

The risk/protective factors included in the study (physical inactivity, dietary salt, saturated fat intake, mean BMI levels, diabetes prevalence, smoking prevalence and F&V consumption) are highly interrelated. Some of the RRs or β coefficients were not adjusted for each factor due to the feature of the studies. This might cause a relatively small overestimation while calculating DPPs, after all cumulative adjustments. Multivariate probabilistic sensitivity analyses were conducted to deal with this limitation.

Conclusion

Only modest risk factor changes in salt, saturated fat and F&V intake could prevent around 16 000 CHD deaths in the year 2025 in Turkey, even assuming mortality continues to decline. The most impressive strategies in recent years will be those affecting healthy food policies. This model can be a useful tool to explore potential benefits of implementing certain strategies to prevent the future burden of CHD. Implementation of population-based, multisectoral interventions to encourage healthy food consumption should be scaled up.

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Contributors

CS and JC were involved in conception/design, drafting the article and providing final approval. KS was involved in analysis, drafting the article and providing final approval. BU and MO were involved in conception/design, drafting the article and providing final approval.

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Competing interests

None declared.

Provenance and peer review

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Data sharing statement

We add a supplementary file to explain where unpublished data come from. Extra data are available by emailing ceyda_sahan@hotmail.com.

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Potential benefits of healthy food and lifestyle policies for reducing coronary heart disease mortality in Turkish adults by 2025: a modelling study

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