The Economics of Prevention

Efficiency and distributional impact of interventions to prevent chronic diseases linked to unhealthy diets and sedentary lifestyles

OECD Conference Centre, 2 rue André Pascal, 75016 Paris, France
10-11 December 2008

Note: This annex is circulated as a draft and may be further revised prior to publication as a joint OECD/WHO working paper. Written comments are invited on its contents.

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JT03257217

Document complet disponible sur OLIS dans son format d'origine
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ABSTRACT

In an attempt to contain rising trends in obesity and associated chronic diseases, many governments have been considering and implementing a range of policies to promote healthy lifestyles. These efforts have been hindered by the limited availability of evidence of the effectiveness of interventions in changing lifestyles and reducing obesity. Evaluations of the cost-effectiveness and distributional impacts of such interventions are even fewer and narrower in terms of numbers of options considered. An economic analysis was developed as part of this project, with the aim of contributing to strengthening the existing evidence-base on the efficiency of interventions to tackle unhealthy diets and sedentary lifestyles. The analysis was undertaken in collaboration with the WHO, broadly based on the WHO-CHOICE (CHOosing Intervention that are Cost-Effective) approach. The aim of the analysis was to assess the efficiency of a range of policy options to tackle unhealthy lifestyle and related chronic diseases. Additionally, compared to the traditional CHOICE framework, the analysis involved an assessment of the distributional impacts of preventive strategies on costs and health outcomes. Most of the preventive interventions evaluated as part of the project appear to have favourable cost-effectiveness ratios, relative to a scenario in which no systematic prevention is undertaken and chronic diseases are treated once they emerge. However, none of the interventions assessed in the analysis may provide the means for a significant reduction of the scale of the obesity problem, if implemented in isolation. Although the most efficient interventions appear to be outside the health sector, health care systems can make the largest impact on obesity and related chronic conditions by focusing on individuals at high risk. Interventions targeting younger age groups are unlikely to have any significant health effects at the population level for many years. The cost-effectiveness profiles of such interventions may be favourable in the long-term, but may remain very unfavourable for several decades at the start of the interventions. Preventive interventions do not always generate reductions in health expenditure, even when the analysis is limited to a set of diseases that are more directly affected by diet, physical activity and obesity. Governments should determine what level of resources (budgets) they are willing and able to convey to prevention, and they may use the findings of our economic analysis to assess what portfolio of interventions would make the best use of such budgets.
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SECTION I

1.1. Introduction

1. There is a widespread concern in OECD countries about increasingly unhealthy dietary habits and sedentary lifestyles. Concerns have been prompted in most cases by rising rates of overweight and obesity and by an increasing burden associated with chronic diseases such as diabetes. In an attempt to contrast these trends, governments have been considering and implementing a range of policies, among which interventions to promote lifestyle changes play a major role. A strategy based on improving health-related behaviours is strongly supported, for instance, by the WHO, which consider diet and physical activity as “public health priorities”. In 2004, the WHO published a “Global strategy on diet, physical activity and health” (WHO, 2004). Action on diet and physical activity may both contribute to the prevention of further increases in overweight, obesity and chronic diseases, and help to reduce the magnitude of the existing problem.

2. However, such efforts are severely limited by the lack of a sound evidence base on the effectiveness of interventions aimed at improving health habits. A large part of the evaluations produced in recent years have been based on qualitative research, or have measured intermediate outcomes that do not provide a clear idea of the extent to which interventions may reduce the incidence of chronic diseases or improve mortality in the long run. For example, studies such as the PorGrow project (Millstone and Lobstein, 2007) and Foresight’s “Tackling obesities” (Butland et al., 2007) were mainly based on stakeholder or expert ratings of a number of possible policy options, in terms of their acceptability and potential impact. At the same time, intergovernmental organisations have produced reviews of policy developments (e.g. WHO Europe, 2006; EC, 2007; OECD, 2008) showing how countries are increasingly taking action to promote a healthier nutrition and physical activity. Despite this, only a limited number studies undertaken at the national level have gathered empirical evidence on the effectiveness of interventions to improve diet and increase physical activity.

3. Evaluations of the cost-effectiveness of policies on diet and physical activity are even fewer, and narrower in terms of numbers of options considered, and no comprehensive assessment of large-scale interventions has ever been carried out. Although there is evidence that interventions promoting healthy diets and physical activity would be effective in the short term, there is no certainty of a long-term sustainability of these results and of an impact of behaviour changes on risk factors such as overweight, or blood glucose and lipid levels.

1.2. Aims

4. The primary aim of the cost-effectiveness modelling component of the Economics of Prevention project is to develop an economic model of the impact of interventions to tackle overweight/obesity and associated risk factors (particularly unhealthy diets and lack of physical activity) at the population level. The economic analysis model, as well as the underlying epidemiological model, is designed to be broadly applicable to the largest possible number of OECD and EU countries. The model was used to appraise a range of interventions in terms of their efficiency and their distributional impact across different life-stages and socio-economic conditions. The focus of the modelling work was on identifying efficient and equitable
means of pursuing population health improvements through appropriate combinations of prevention and treatment of chronic diseases.

1.3. Existing evidence about efficiency and distributional impact

5. A review was undertaken to identify existing cost-benefit and cost-effectiveness analyses of interventions to improve diet and physical activity. This follows a previous preliminary review of the “Cost-effectiveness of interventions to prevent or treat obesity and type 2 diabetes” undertaken by the OECD Secretariat in the year 2004 (SG/ADHOC/HEA(2004)12).

6. The interventions and the studies reviewed are listed, respectively, in annex 1 and in annex 2. The inclusion criteria for the present review were set along three dimensions: target population, intervention domain, and study design. In particular, we chose to limit our review to interventions targeting healthy individuals, regardless of their BMI, therefore including interventions on the general population as well as those targeting overweight/obese individuals in good health. As a consequence, we excluded studies of interventions targeting sub-groups such as individuals with diabetes or cardiovascular disease. However, given the higher risk for obese individuals to develop chronic diseases, some interventions do include in their samples small proportions of individuals with diabetes or hypertension. In terms of intervention domain, we exclusively reviewed studies aimed at improving lifestyles by increasing physical activity and/or promoting healthy diets. Thus, other interventions such as surgery or pharmacological interventions were excluded. Finally, in terms of study design, only cost-benefit and cost-effectiveness analyses were selected for inclusion in the review.

7. Electronic searches were conducted using the medical literature database Medline and the Cochrane Library. In both cases we used the embedded hierarchy of MeSH (Medical Subject Heading) terms. This system is designed to retrieve publications that were previously indexed by multiple descriptors and qualifiers. In the case of Medline we used as plausible descriptors a number of combinations of the following terms: overweight/obesity, diet, food technology, nutrition technology, motor activity, cost-benefit analysis and primary prevention. In our search of the Cochrane Library we used obesity as main term and diet therapy, economics, prevention & control as qualifiers. Every time a potentially relevant paper was identified, we manually browsed through the studies identified by the relevant search engines as “related articles”. Electronic literature searches were complemented by web-based searches of grey literature, mainly official documents produced by national governments and inter-governmental organisations.

8. Twenty-one studies covering thirty-four interventions met our inclusion criteria. Eleven interventions exclusively involved changes in dietary habits, twelve aimed at improving physical activity while eleven entailed a modification of both diet and physical activity. With four exceptions, papers were generally published in the period 1998-2006. Countries analyzed are mainly Australia and the US with a smaller set of studies coming from the UK and from Nordic countries.

9. Generally, economic evaluations were carried out alongside randomised controlled trials (nine studies). In a further 3 studies, economic evaluations were undertaken on the basis of previous trials. Two studies were cost analyses, three reported results based on models, and three were reviews of studies undertaken previously. Finally one paper reported cost ratios per service user.

10. The outcomes used in different studies were very heterogeneous. Seven studies assessed interventions in terms of before-after differences in variables such as body mass index, weight or other biological indicators (e.g. blood pressure or level of blood lipids), five studies reports results in terms of QALYs gained or DALYs averted, five studies assess the differences in self-reported modifications of behaviours (i.e. physical activity and/or diet), and, finally, 4 studies reported benefit/cost ratios.
11. Evaluations focused on a wide range of interventions, which we grouped into the following four areas: counselling in the community, counselling in general practice, school-based interventions, and environmental modifications. Six additional isolated interventions did not easily fit into any of the above groups; therefore they were labelled as “others”. Figure 1 shows, for each group, the numbers of interventions in each of the three domains: diet, physical activity and both.

![Figure 1. Number of interventions per category and domain](image)

12. A brief description of the main characteristics and outcomes of each intervention is reported in the table in annex 1. To facilitate comparisons, all cost values were transformed in 2005 US $ using OECD purchasing power parity conversion rates. In the reminder of this section, we shall present a discussion of the main findings of the review in each of the 5 groups of interventions. In particular, the discussion will focus on methodological aspects, analytical approaches and key results from each evaluation.

13. The group of interventions defined as counselling in the community is the second largest in terms of numbers of studies available. This group includes outreach actions delivered in community settings, generally by professionals such as physiologists, nutritionists, nurses, or even medical doctors. Programmes tended to focus on adult individuals who were overweight or obese, or those who presented one or more risk factors for obesity. This included, for instance, individuals with a self-assessed tendency to be physically inactive. Some interventions targeted families whose children were identified as being overweight.

14. Individuals were often recruited through general practices or schools and were offered a series of information sessions organized either on an individual basis or in small groups. In some cases, complementary written information was provided. Some studies attempted to compare traditional delivery methods with innovative approaches such as computer-based systems or videotaped messages. In two
cases, interventions not only provided information on the benefits of physical activity but required participants to undertake certain physical activities. This was done by providing free subscriptions to gyms, or by organizing after-school activities for pupils.

15. Results are not always directly comparable, because a variety of outcome measures were used to assess interventions in this group. Two studies measuring outcomes in terms of DALYs show how costs per DALY averted over the life course can vary from almost $2,750 to $61,990. In a similar way, the cost for an additional serving of fruit or vegetables varies between $390 and $1,460.

16. The group of interventions under the name of counselling in general practice includes all those services involving the delivery of lifestyle advice in a general practice setting. Such advice was generally provided by health professionals, in most cases general practitioners themselves, but sometimes by dieticians or nurses. Individuals were often targeted opportunistically, when they visited a practice for a normal consultation. The individuals selected for receiving lifestyle advice may be those who had a BMI or waist circumference above a certain threshold, or those who belonged to specific population groups. In these cases, advice was delivered at the beginning or at the end of the consultation. Alternatively, some interventions involved a mailing of invitations to individuals deemed to be at risk for obesity or chronic diseases, for instance through a school-based screening based on the measurement of children’s height and weight.

17. Advice was provided orally on an individual basis. In some cases oral information was complemented by supporting written materials. In one case, a telephone follow-up was organised after advice sessions. None of the interventions reviewed involved an explicit requirement for individuals to undertake specific physical activities.

18. Three studies measured outcomes in terms of QALYs: two of these reported average cost per QALY ratios and one reported an incremental cost-effectiveness ratio relative to usual care (which may involve the delivery of lifestyle advice, but not on a systematic basis). One paper measured outcomes in DALYs averted compared to usual care. Other results focused on the cost of persuading an individual to eat at least 5 portions of fruits or vegetables a day or on the cost of losing one kilogram of body weight.

19. Compared to other categories, school-based interventions are relatively homogeneous. This group includes interventions delivered during the school year, in most cases as part of the standard school curriculum. Most interventions entailed the delivery of educational sessions held either by health professionals or by school teachers appropriately trained or supported by health professionals. One program additionally involved the participation of responsible older students who acted as peer counsellors, while others involved children’s families. Two interventions did not entail an educational component. Of these, one encouraged children to walk to school and another was aimed at promoting exercise through specific public events.

20. All interventions targeted children in primary school (i.e. about 7 to 11 years old), with the exception of one aimed at pupils in middle school. Programmes were directed to whole classes and only in one case they focused on children that were believed to be at risk for obesity. Intervention usually involved the delivery of interactive teaching sessions on the benefits of a healthy diet and of physical activity. Four interventions required children to do additional exercise by introducing extra hours of physical activity into the curriculum and organizing community events such as “leave the car at home week”.

21. Most evaluations assessed outcomes in terms of DALYs and used current practice as the comparator. In summary, interventions involving extra physical activity had cost-effectiveness ratios ranging from $4,820 to $0.53 million per DALY averted over the life course. Intervention without physical activity had cost-effectiveness ratios from $2,070 to $9,640.
22. Four interventions labelled as environmental modifications targeted the environments in which people live in trying to make healthier choices simpler. Since these interventions directly modify environments they target whole communities. Three interventions increased the availability of facilities for physical exercise, primarily by building or improving walking and cycling track networks. In one case, a hypothetical intervention involved a ban on television advertising of food products with high fat and/or sugar density during times when at least 15% of the audience is composed by youngsters of up to 14 years of age.

23. In this group, results were often expressed as benefit to cost ratios. For example, estimates were produced of the costs of building and maintaining trails, compared with the sum of the social costs avoided (e.g. environmental and health burden) and the individual benefits arising (e.g. reduced congestion). Benefit/cost ratios for implementing trails would range from 1.4:1 to 14:1 according to the different parameters considered and the features of the track. The advertising ban intervention seems one of the most cost-effective approaches, as it would avert one DALY for only $2.5, relative to unregulated advertising.

24. The last group (other interventions) is a collection of intervention that cannot be classified in any of the five clusters above. A multimedia campaign was analysed in one study. It consisted of a television advertising campaign to promote a healthy diet and, particularly, an increase in the consumption of fruits and vegetables. The campaign was divided into different phases, each focused on a specific target group, such as individuals in poor socio-economic circumstances, or mothers with children. The results suggest a cost of $36 per QALY gained compared with doing nothing, over a 20 year period.

25. Two interventions were aimed at improving nutrition through hospital prescribed diets, compared either with doing nothing or with a low carbohydrate diet. One modelling study assessed the benefits of the regular practice of physical exercise. A similar study was performed on a hypothetical cohort of overweight and obese women to assess the effect of an intervention comprising diet, exercise and behavioural modification. One last study reported the effects of a behavioural programme administered by correspondence. The populations targeted by these interventions varied from the general population to overweight and obese individuals. In one case the group was restricted to females. Outcomes were usually measured in terms of QALYs and cost-effectiveness ratios ranged from $13,800 to $19,280 per QALY gained.

26. Independently from the environments in which interventions were implemented (i.e. community, general practice, school), they usually implied some form of individual education. This may be achieved through school-based classes or through counselling sessions aimed at either individuals or groups. The objective is to make individuals more informed and therefore, at least in principle, more oriented towards making healthy choices. Only a limited number of studies investigated the effects of modifying the environments in which individuals live, rather than individual attitudes. This is partially because modifying the environment generally takes a longer time and possibly because assessing the effects of environmental interventions may be more complicated as it may require the study of a larger number of individuals.

27. A further issue arises in relation to the time horizon of the studies reviewed. Many interventions produce discernible effects, for example on weight, only after a substantial time lag. Besides, once positive results are generated, it is important to assess how long these will last and whether they could be sustained in the long term. In our analysis, the effectiveness of interventions is typically evaluated only in a short term perspective, while cost-effectiveness calculations are generally made on the assumption that the improvements obtained at the end of the follow-up period will persist throughout the rest of the lives of the individuals concerned. Thus, the credibility of the results may be, at least in part, weakened. One last issue arises in relation to the difficulties associated with making comparisons across studies, even within the same groups, mainly due to differences in the outcome measures used in assessing the effectiveness of interventions.
1.4. Cost-effectiveness analysis: a generalized approach

28. Cost-effectiveness analysis (CEA) is concerned with how to make the best use of scarce health resources. The large and growing literature on the topic is dominated by the comparison of interventions aimed at a particular disease, risk factor or health problem, which provides relevant information to programme managers or practitioners with this specific disease mandate. In practice, however, different types of policy makers and practitioners have different demands. Managers of hospital drug formularies must decide which of a vast array of pharmaceuticals they should stock, taking into account the available budget. Countries where health is funded predominantly from the public purse make decisions on what type of pharmaceuticals or technologies can be publicly funded or subsidized, while all types of health insurance - social, community or private - must select a package of services that will be provided. These types of decisions require a broader set of information, involving comparison of different types of interventions across the entire health sector - whether they are aimed at treating diabetes, reducing the risk of stroke, or providing kidney transplants. This type of analysis can be referred to as "sectoral cost-effectiveness analysis".

29. Although the number of published cost-effectiveness studies is now huge, there are a series of practical problems in using them for sectoral decision making (Hutubessy et al., 2003). The first is that most published studies take an incremental approach, addressing questions such as how best should small changes (almost always increases) in resources be allocated, or whether a new technology is more cost-effective than the existing one it would replace. Traditional analysis has not been used to address whether existing health resources are allocated efficiently, despite evidence that in many settings current resources do not in fact achieve as much as they could (Tengs et al., 1995). A second problem is that most studies are very context specific. The efficiency of additional investment in an intervention aimed at a given disease depends partially on the level and quality of the existing health infrastructure (including human resources). This varies substantially across settings and is related to a third problem - individual interventions are almost always evaluated in isolation despite the fact that the effectiveness and costs of most will vary according to whether other related interventions are currently undertaken or are likely to be introduced in the future.

30. In response to these concerns, a more generalized approach to CEA has been developed by WHO in order to allow policy makers to evaluate the efficiency of the mix of health interventions currently available and to maximize the generalizability of results across settings. Generalized cost-effectiveness analysis (GCEA) and its implementation via the CHOICE project allows for an assessment of the efficiency of the current mix of interventions by analysing all interventions and combinations incremental on doing nothing (Murray et al., 2000; Tan Torres et al., 2003; www.who.int/choice). Operationally, the counterfactual that has been adopted in applied studies is defined in terms of what would happen to population health if all interventions being provided now were stopped.

31. Many interventions interact in terms of either costs or effects at the population level and interacting interventions are undertaken in different combinations in different settings. The health impact of undertaking two interventions together is not necessarily additive, nor are the costs of their joint production. To understand whether they are efficient uses of resources independently or in combination requires assessing their costs and health effects independently and in combination. Only then is it possible to account for non-linearities in costs and effects.

32. GCEA seeks to maximize generalizability across settings. Most cost-effectiveness studies have been undertaken in developed countries, but not even the richest have been able to evaluate the full set of interventions required to undertake a sectoral analysis specific to their own country. All countries need to borrow results of cost or effectiveness studies from other settings, but the fact that most published studies
are very specific to a particular setting makes this difficult. WHO-CHOICE reports results for 14 sub-regions of the world, but has developed tools enabling county-level analysis too.

33. GCEA has now been applied to a wide range of specific diseases (including malaria, tuberculosis, cancers and mental disorders) as well as risk factors (for example, child under-nutrition, unsafe sex, unsafe water, hygiene and sanitation, hypertension and smoking) (see, for example, Chisholm et al., 2004a; Chisholm et al., 2004b; Groot et al., 2006; Murray et al., 2003; Shibuya et al., 2003; WHO, 2002). Like all CEA, GCEA focuses on only one outcome, population health. There are many other possible outcomes people care about - inequalities in health, responsiveness, fairness of financing, for example (Murray and Evans, 2003). Accordingly, the results of GCEA cannot be used to set priorities by themselves but should be introduced into the policy debate to be considered along with the impact of different policy and intervention mixes on other outcomes.
SECTION II

2.2. Epidemiological model

34. The epidemiological model (called "LifeStyle") used in the economic analysis implements a "causal web" of lifestyle-oriented risk factors for selected adult chronic diseases. The concept of a causal web includes the idea that risk factors range in the immediacy of their effect on disease events from more distant exposures ("distal risk factors"), which are several steps away from disease events in the chain of causation, to more proximate exposures ("proximal risk factors"), which are more immediately connected to disease events. The causal web concept also typically includes the possibility, as also implemented here, that risk factors can influence other risk factors. Thus, in a causal web, disease events are influenced by risk factors both directly and indirectly. The definition of the risk factors, as well as the thresholds used to identify individuals at risk, is largely based on data provided by the WHO publication “Comparative quantification of health risks” (Ezzati et al., 2004).

35. The model explicitly accounts for three groups of chronic diseases: stroke, ischemic heart diseases and cancer (including lung, colorectal and breast cancer). Proximal risk factors, such as high blood pressure, high cholesterol and high blood glucose, have a direct influence on the probability of developing such chronic diseases, usually through altered physiological mechanisms. Conversely, distal risk factors such as low intake of fruit and vegetables, high fat intake and insufficient physical activity have an indirect influence on chronic diseases, generally mediated by BMI, which acts as an intermediate risk factor, as well as on proximal risk factors. The model accounts for mortality from all possible causes of death, assuming that mortality associated with diseases that are not explicitly modelled will remain stable at the rates currently observed in the relevant populations.

36. The LifeStyle model is a stochastic microsimulation model. The term "microsimulation" refers to the fact that the model separately represents the lifetimes of many different individuals; emergent properties about the population are then obtained by "adding up" across individual histories. The term "stochastic" refers to the fact that the model employs random variation, for example, individuals are randomly assigned risk factor status and are randomly assigned waiting times for disease and mortality events; the program ensures that, on average, the number of individuals with, for example, a given risk factor status matches the observed risk factor prevalence in the population being modelled, and that the annual disease rates of simulated individuals in the model matches, on average, the disease rates in the population being modelled.

37. The model is dynamic in the sense that effects are measured with reference to individual life histories that have unique beginning and end points in the model's representation of calendar time. The initial population in the model moreover reproduces the demographic features of the population being modelled in cross section at an arbitrary point in time, for example "current time". The model thus contains a full age, period and cohort representation of the simulated population. Typical lifetable variables, such as residence time in particular states, are collected and reported for the purpose of measuring health effects and reporting other epidemiological features of interest.

38. The epidemiological model used here was written in a C++ pre-compiler called Modgen (http://www.statcan.gc.ca/spsd/Modgen.htm), which is a generic a "Model Generator" language created by Statistics Canada for developing and working with microsimulation models.
39. The LifeStyle model is based on an earlier prototype ChildHealth model originally created by Statistics Canada based on a design provided by the World Health Organization. As the ChildHealth model also implemented a version of a causal web, it provided a useful starting point for the development of the LifeStyle model.

2.3. Parameters of the epidemiological model

40. The model requires a series of epidemiological data by gender (males and females), by class of age (age 0 to age 100) and, in some cases, by socioeconomic stats (upper and lower). A first group of parameters allows the software to model the general population changes over time. This includes global mortality, fertility and prevalence of individuals by gender and age.

41. The second group refers to the three levels of risk factors (i.e. distal, intermediate and proximal). In this component we need four types of epidemiological parameters: prevalence, incidence of new cases, remission rates, and relative risks. The first three reflect the epidemiology of the population as a whole. For example, the incidence of pre-obesity identifies the fraction of the overall population becoming pre-obese in a given period of time. RRs, instead, reflect either the probability of individual to fall in one category (i.e. what we have called the static causal web) or the likelihood of someone with a risk factor of moving in the next step of the web, compared to someone of the same gender and with the same age but without that specific risk factor (i.e. what we have called dynamic causal web).

42. The last group details the parameters is used to model diseases. As before, we will consider prevalence, incidence rates, remission rates and relative risks. Additionally, now, there is a further parameter called case-fatality hazard. This corresponds to the hazard of dying due to a disease for individuals who have that disease. Relative risks can be divided into three categories: RRs of fatality, RRs of incidence of new cases and RRs of remission from the diseases. In the latter case, the value is in the range 0-1 as the presence of a risk factor negatively influences the likelihood of recovering from a disease and, therefore, people for instance with diabetes are less likely than people without diabetes to recover from stroke. Finally one should specify the values to be assigned to each year of life spent in full health, with a disease or with combinations of diseases. Assigning weighted values to years spent in less than full health allows the estimation of the burden of disease in qualitative, as well as in quantitative, terms.

43. We used the best available sources of information on the epidemiology of risk factors and chronic diseases to populate the micro-simulation model. A full reference list, by parameter, can be found in annex 3. In general most of the data we use to feed the model comes from WHO datasets, while RRs where obtained from peer reviewed publications. When it has not been possible to find inputs in this way, they were calculated through the WHO software DisMod II (Barendregt et al., 2003) or directly by using national health surveys. We selected data following two main criteria: i) maximize the representativeness of the population and ii) use data evaluated in a homogeneous period.

44. DISMOD II is a software able to evaluate age and gender specific epidemiologic features of a population. It works using seven diseases specific variables (incidence, prevalence, remission, case fatality, duration, mortality, RR mortality) and two population variables (population structure and mortality). By inputting at least three of the disease specific variables DisMod II can calculate the other four.
Table 1. Parameters used to feed the model and their reference.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ischemic heart disease</strong></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>Lopez et al., 2006</td>
</tr>
<tr>
<td>Incidence hazard</td>
<td>Lopez et al., 2006</td>
</tr>
<tr>
<td>RR of incidence relative to high blood pressure</td>
<td>Lim et al., 2007</td>
</tr>
<tr>
<td>RR of incidence relative to high cholesterol</td>
<td>Lim et al., 2007</td>
</tr>
<tr>
<td>RR of incidence relative to diabetes</td>
<td>van Baal et al., 2008</td>
</tr>
<tr>
<td>RR of incidence relative to obesity</td>
<td>van Baal et al., 2008</td>
</tr>
<tr>
<td>RR of incidence relative to SES</td>
<td>Forssas et al., 2008; Salomaa et al., 2000</td>
</tr>
<tr>
<td>RR of fatality relative to high blood pressure</td>
<td>Hart et al., 2005b; Stevens et al., 2004; Hart et al., 1999</td>
</tr>
<tr>
<td>RR of fatality relative to high cholesterol</td>
<td>Hu et al., 2005a; Hu et al., 2006; Hu et al., 2005b; Hart et al., 1999</td>
</tr>
<tr>
<td>RR of fatality relative to diabetes</td>
<td>Batty et al., 2006; Pardo Silva et al., 2006</td>
</tr>
<tr>
<td>RR of fatality relative to obesity</td>
<td>Haan et al., 1987; Logue et al., 1990; Kaplan et al., 1993</td>
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<tr>
<td>RR of mortality relative to SES</td>
<td></td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>Lopez et al., 2006</td>
</tr>
<tr>
<td>Incidence hazard</td>
<td>Lopez et al., 2006</td>
</tr>
<tr>
<td>RR of incidence relative to high blood pressure</td>
<td>Lim et al., 2007</td>
</tr>
<tr>
<td>RR of incidence relative to high cholesterol</td>
<td>Lim et al., 2007</td>
</tr>
<tr>
<td>RR of incidence relative to diabetes</td>
<td>van Baal et al., 2008</td>
</tr>
<tr>
<td>RR of incidence relative to obesity</td>
<td>van Baal et al., 2008</td>
</tr>
<tr>
<td>RR of incidence relative to SES</td>
<td>Hart et al., 2000; Kuper et al., 2007</td>
</tr>
<tr>
<td>RR of fatality relative to high blood pressure</td>
<td>Stevens et al., 2004; Boshuizen et al., 2007; Menotti et al., 2003</td>
</tr>
<tr>
<td>RR of fatality relative to high cholesterol</td>
<td>Boshuizen et al., 2007; Menotti et al., 2003</td>
</tr>
<tr>
<td>RR of fatality relative to diabetes</td>
<td>Hu et al., 2005a; Wannamethee et al., 2004</td>
</tr>
<tr>
<td>RR of fatality relative to obesity</td>
<td>Batty et al., 2006; Pardo Silva et al., 2006</td>
</tr>
<tr>
<td>RR of mortality relative to SES</td>
<td>Arrich et al., 2005; Jakovljević et al., 2001</td>
</tr>
<tr>
<td><strong>Cancer</strong></td>
<td></td>
</tr>
<tr>
<td>Incidence hazard</td>
<td>Parkin et al., 2005</td>
</tr>
<tr>
<td>RR of incidence relative to fibre consumption</td>
<td>Lock K et al., 2005</td>
</tr>
<tr>
<td>RR of incidence relative to obesity</td>
<td>van Baal et al., 2008</td>
</tr>
<tr>
<td>RR of incidence relative to SES</td>
<td>van Loo n et al., 1995</td>
</tr>
<tr>
<td>RR of fatality relative to fibre consumption</td>
<td>Skuladottir et al., 2006; Pierce et al., 2007; Jansen et al., 1999</td>
</tr>
<tr>
<td>RR of fatality relative to obesity</td>
<td>Calle et al., 2003</td>
</tr>
<tr>
<td>RR of mortality relative to SES</td>
<td>van Loo n et al., 1995</td>
</tr>
<tr>
<td><strong>proximal risk factors</strong></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>Lawes et al., 2004b</td>
</tr>
<tr>
<td>mortality</td>
<td>Stamler et al., 2000</td>
</tr>
<tr>
<td>RR of high cholesterol relative to obesity</td>
<td>based on Health Survey for England</td>
</tr>
<tr>
<td>prevalence</td>
<td>Lawes et al., 2004a</td>
</tr>
</tbody>
</table>
2.4. Cost analysis

45. At a conceptual level, the benefit of an intervention is the gain in welfare associated with the health improvement, while the cost is the loss of welfare associated with foregone non-health consumption (due to resources being used to provide the intervention). Accordingly, costs should be measured from the perspective of society as a whole, to understand how best to use resources regardless of who pays for them, or indeed, whether they are paid for at all. In practical terms, however, there are a number of cost consequences that are difficult to quantify due to lack of good-quality or consistent data, for example the costs incurred by people to access services (e.g. travel costs) or provide informal care-giving. The impact of interventions on the time and potential earnings of patients and unpaid carers - i.e. work time lost - is a vexing question in cost-effectiveness analysis but are often excluded on ethical grounds (inclusion would give priority to extending the life of people who earn more). Domestic taxes are also typically excluded from consideration, since they simply transfer financial resources from one person to another and do not use up a physical resource such as capital or labour. The conceptual foundations and practical implementation of costing within a Generalized cost-effectiveness framework are discussed in greater detail elsewhere (Tan Torres et al., 2003; Evans et al., 2005).

46. In the implementation of GCEA via the WHO-CHOICE project, costs are divided into those incurred at the patient or programme level. Patient-level costs involve face to face delivery by a health provider (broadly defined) to a recipient - e.g. medicines, outpatient visits, in-patient stays, individual health education messages. Programme-level costs include all resources required to establish and maintain...
an intervention - administration, publicity, training, delivery of supplies. Interventions like radio delivery of health education messages largely involve the former, while treatment at health centres largely involves the latter. A standardized ingredients approach is used, requiring information on the quantities of physical inputs needed and their unit cost (i.e. total costs are quantities of inputs multiplied by their unit costs). For programme-level costs, the physical inputs - human resources, office space, vehicles, electricity, other services, and a variety of consumables - required to introduce and run a programme are based on estimates by costing experts commissioned for this purpose, using a standard template (Johns et al., 2003, 2006). This was supplemented by information from programme managers in other countries known by WHO staff. These resource estimates represent a key building block for estimation of the costs of population-based intervention strategies, such as tobacco control or salt reduction programmes.

47. For patient-level costs, quantities are taken from a variety of sources. Where effectiveness estimates were available from published studies, the resources necessary to ensure the observed level of effectiveness are identified. In other cases, the resources implied by the activities outlined in WHO treatment practice guidelines were estimated. Since it is not always possible to identify the exact quantities of primary inputs (human resources, consumables) necessary for patient-level costs, certain quantities and prices are estimated at an intermediate level for several inputs - inpatient days at different hospital levels, outpatient visits and health centre visits.

48. Unit costs for each input were derived from an extensive search of published and unpublished literature and databases along with consultation with costing experts. For goods that are traded internationally, the most competitive price available internationally was used. For example, the prices of medicines were taken from the latest WHO negotiated prices. A mark up is included for transportation costs. For goods available only locally (e.g. human resources, inpatient bed days) unit costs have been shown to vary substantially within countries. As a result, cross country regressions have been run using the collected data to estimate the average cost (with adjustments for capacity utilization) for each setting (Adam et al., 2003, 2006).

49. Costs are reported in international (I$) rather than US dollars (US$) with 2005 the base year. Future costs are discounted using a 3% discount rate. These costs do not translate directly into the financial or cash requirements to run or expand interventions; rather, the task is to estimate the opportunity cost of all resources required to provide interventions, regardless of who pays for them, to explore the combination of interventions that makes the best use of these resources.

2.5. Interventions

50. We evaluated a full range of interventions from different government departments: mass media campaigns, school-based interventions, worksite interventions, fiscal measures, regulation of food advertising to children and compulsory food labelling. The choice, the design as well as the gathering of the quantitative data that were used to feed the model were based on a review of studies about the effectiveness of interventions to improve diet and physical activity.

51. From the body of evidence we collected, we selected those studies which appeared particularly strong because of the size of the sample, the duration of the study and the robustness of the experimental design. For some interventions (e.g. school-based, worksite) we were able to retrieve multiple studies. In this case we identified studies which adopted homogeneous interventions and combined results. In other cases (e.g. regulation of food advertisement) we selected one single study.

52. Costs of interventions were evaluated using the standard WHO-CHOICE “ingredient” approach. The total cost of an intervention is calculated as the sum of three components: cost at the target level (e.g. working hours of health personnel, equipments), program costs (e.g. planning and enforcing at the central
level) and training costs (i.e. education of personnel involved in the intervention). Consumption of resources was directly retrieved by the source papers, while the cost of each component was provided by the WHO. Although these costs might have a certain grade of inaccuracy, they offer the undeniable advantage of allowing cross-country comparison. Costs are expressed in 2000 $ Purchasing Power Parities.

2.5.1 Review of the evidence on the effectiveness of interventions

53. The interventions reviewed are described in annex 5 and listed in annex 6. Studies included in the review were identified through the following literature databases: Medline, Cochrane Library, Embase, National Research Register, HSRProj database, CDSR, CRD ongoing review-DARE, PsycINFO, restricting the year of publication between 1995 and (June) 2006. The studies identified evaluated group, community, or population level interventions, with an additional emphasis on disadvantaged communities. Studies of individual level interventions were not included, unless individual components were part of a population-based approach. In order to satisfy inclusion criteria, studies should have targeted apparently healthy adults and children or specific subpopulations at risk, such as overweight persons.

54. In order to facilitate comparisons across studies, we grouped interventions into the eight macro-areas defined in the taxonomy of preventive interventions proposed in Sassi and Hurst (2008). These are: interventions on the broader economic and social environment; interventions on the physical environment and transport system; interventions on the work or school environment; interventions on the supply of lifestyle commodities; educational interventions; health sector interventions; interventions on social and community networks; interventions aimed at directly influencing lifestyle choices.

55. The remainder of this section will cover the main findings of our review. As in the section concerning the cost-effectiveness of interventions, we will present the different groups one by one, describing the common features shared by interventions in the same groups, target populations and key results.

56. In total, 108 interventions extrapolated from 152 studies were reviewed. Of these, 48 aimed at promoting dietary changes, 26 aimed at increasing physical activity and 32 adopted a combined approach. The numbers of interventions per area and domain are shown in figure 2. Educational interventions are clearly the ones that have been investigated the most. However, this group may be divided into two subgroups based on different approaches. Part of the interventions involved only a strictly educational approach where individuals, either still in school or selected among the population are taught principles of healthy living or educated in how to improve their behaviours. Interventions in a second sub-group combined the approach previously described with environmental changes, such as improvements in the food served in local canteens. Distribution by country is heavily imbalanced: 66 studies (61%) were undertaken in the US, 11 in the UK, 9 in Australia or New Zealand, 6 in Canada, 10 in other OECD countries. Finally, 6 studies were undertaken in developing countries.
The group defined as “interventions on the broader economic and social environment” gathers all those interventions implying modification of policies at national (e.g. general fiscal policies) and international (e.g. international trade agreements) level. In the only study falling in this category we were able to find, researchers assessed the effects of a policy of free fruit and vegetables delivered at home for low income elderly. Results would suggest a significant increase in the number of servings eaten daily and a related 50% increase in the individuals eating at least five portions a day.

The group of interventions under the name “physical environment and transport system” includes policies undertaken by government offices at the national and local levels involving changes in aspects such as the urban environment, means of transportation, housing conditions. Most of the studies in this area focus on interventions aimed at increasing physical activity, for instance, by encouraging walking and cycling to work and to school, by increasing the safety of trails, or by organizing public events such as banning car circulation on certain roads during the week-ends. In general, the target of such interventions is not limited to any subgroup, but some studies focus their efforts on evaluating results in particular population groups such as employees or school children. Additionally, in no study the maximum age of individuals is set above the threshold of 69 years. Given the large number of individuals involved, studies usually report results as percentage variations in people doing exercise (e.g. after improving the safety of trails, children cycling to school increased by 114%).

Seven interventions on diet and one intervention on physical activity fall in the category “interventions on the work or school environment”. Investigations in this category involve a range of modifications of the work environment to facilitate healthier choices. Although most studies in this area assessed interventions which included an educational component, their primary outcomes were
environmental changes. Interventions generally targeted workers, with some additionally focusing on subgroups such as males, low-income or sedentary individuals. In some cases, interventions targeted whole groups of individuals, while in other cases participation was voluntary and individuals were asked to sign up to specific programmes. An example of the latter is a study investigating the effects of the use of pedometers. Interventions are very different in their design and implementation. Most studies in this area investigated the effectiveness of improving the quality of food in terms of basic nutrients, or increasing the provision of healthy foods, for example fruit and vegetables, in canteens or cafeterias. In many cases, interventions were not just on food, but also on the environment in which the food was delivered. For example, in one experiment staff working in the canteen was taught how to better present food and posters showing the composition of a correct meal were displayed. Results are generally expressed in quantities of fruit and vegetables consumed or variations in sales of healthy foods. In three cases other parameters such as fat intake or BMI changes are reported.

60. The three interventions labelled as “supply of lifestyle commodities” work essentially by modifying the availability of certain commodities, access to some facilities, or the composition of food. Target populations and methods of intervention are very different according to the domains concerned. In the case of diet, the only study available investigated the effects of changing the composition of cooking oil involving a decrease in the intake of saturated fatty acids. In the case of physical activity, two studies report the effects of providing free access to physical activity sessions for seniors in different socioeconomic conditions. In terms of results, changing oil components would significantly decrease both cholesterol blood levels and the estimated intake of saturated fats in males and females, while granting free utilization of sports centres would result in a decrease in systolic blood pressure.

61. “Educational interventions” are by far the largest group. Most of the seventy-seven interventions falling into this category are addressed to students at different stages of their school education. A number of interventions in this group were aimed at increasing awareness of the benefits of healthy lifestyles in the general population, or in specific subgroups. About one third of the interventions evaluated, mainly those delivered in closed environments such as schools, adopted combined approaches associating education with environmental changes. The latter interventions are labelled in annex 5 as “education + interventions on the work or school environment”. Target populations vary according to the approaches used. Interventions that were merely educational targeted broader groups of individuals, generally children older than six and adults, with some studies targeting specific sub-groups believed to be at risk, such as postmenopausal women or individuals in disadvantaged socioeconomic conditions. Combined interventions tended to target younger groups, even though a small number of interventions were still addressed to adults at work. Teaching is usually aimed at promoting healthy diets, or diet and physical activity, rather than physical activity alone. The approach is typically through individual or group sessions, more often school classes. In some cases, new forms of communication of health and lifestyle messages, such as telephone calls or multimedia campaigns, were compared to traditional methods such as booklets or newsletters. When environmental modifications are included, the latter include improvements in the direct provision of foods, or in access to facilities for physical activity.

62. Results are reported in different ways depending on selected objectives. In general three different types of results can be found: most of the studies assessed outcomes in terms of self-reported or measured variations in parameters used as proxies for a healthy life. Examples are numbers of servings of fruit and vegetables eaten in a day, minutes of physical activity undertaken, quantities of fibre or fat consumed, or calories spent. Some studies report changes in the level of physiological parameters such as blood cholesterol, BMI, weight, etc. Finally, some studies report differences in proportions of overweight or obese individuals.

63. At this stage, we chose to categorize in the “health care interventions” group only interventions delivered by health professionals. These generally target the adult population, and often consider groups at
risk, for example individuals with high levels of cholesterol or relatives of people who experienced heart problems. Interventions usually involve an initial health check-up, in one case limited only to blood tests, followed by oral counselling and occasionally supported by written information. Results are generally expressed in terms of variations of physiological components of blood levels (e.g. cholesterol); additional outcomes reported in the studies include variations in BMI, blood pressure or variation in the intake of fruit and vegetables.

64. Only one intervention is labelled as “interventions on social and community networks”. This is a multilevel intervention that, at least for a component, entailed community partnerships and involvement. Its main aim was to improve health behaviours through a combined approach. The target population was individuals older than nineteen years, without distinction. Results for this evaluation were not yet available.

65. The last group of interventions is “direct interventions on lifestyle choices”. This class comprises interventions that try to directly influence choices for example by implementing policies inducing people towards healthier habits. These studies usually target the population in general with school students being the most represented. Interventions range from reducing the choice of calorie dense food in canteens to putting signs stating that the use of the stairs is more beneficial the elevator and inviting to do exercise. Results are generally expressed in terms of sale variation of food or number of individuals preferring the use the stairs.

66. As noted for the review of cost-effectiveness studies, educational interventions are the ones most often evaluated in the existing literature. A large number of the studies reviewed here focused on interventions taking place either in schools or workplaces. In fact, these two environments appear particularly suitable for the types of interventions examined in our review. Target populations are relatively small, easy to reach and to monitor. Unlike the cost-effectiveness studies review earlier in this paper, only few effectiveness studies focused on interventions delivered in general practice settings (5% of the studies, compared with 26% of the cost-effectiveness analyses).

2.5.2 Modelled interventions

67. The main characteristics of some of the interventions evaluated in the analysis are summarised below. The most important effects (share of the population affected, impacts on risk factors and costs) of such interventions are reported in table 1.

2.5.2.1 Counselling of at-risk individuals in primary care.

68. In many OECD countries most citizens have a primary care physician who acts as their first point of contact with the health service and as a usual source of primary health care. Primary care physicians are also an important source of information and advice on lifestyles and the prevention of chronic diseases. However, such advice is not offered systematically, and is generally provided in response to specific individual demands.
Table 2. Summary of coverage and main effects of selected preventive interventions

<table>
<thead>
<tr>
<th>Target Intervention</th>
<th>School-based childrens intervention</th>
<th>Worksite intervention</th>
<th>Mass media Campaign</th>
<th>Fiscal measures</th>
<th>Physician counselling</th>
<th>Physician/dietician counselling</th>
<th>Food advertising regulation</th>
<th>Self-reg. food advertising</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age range</td>
<td>8-9</td>
<td>18-65</td>
<td>18+</td>
<td>0+</td>
<td>22-65</td>
<td>None</td>
<td>BMI≥25 or high chol/blood pressure or diabetes</td>
<td>2-18</td>
</tr>
<tr>
<td>Restrictions</td>
<td>only school-children</td>
<td>large employers</td>
<td>none</td>
<td>none</td>
<td>BMI≥25 or high chol/blood pressure or diabetes</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Target as % of the population</td>
<td>2.3%</td>
<td>5.8%</td>
<td>79.4%</td>
<td>100%</td>
<td>7.22%</td>
<td>9.71%</td>
<td>19.7%</td>
<td>97.9%</td>
</tr>
<tr>
<td>% Pop. affected at steady-state</td>
<td>91.3%</td>
<td>7.2%</td>
<td>79.4%</td>
<td>100%</td>
<td>9.71%</td>
<td>97.9%</td>
<td>97.9%</td>
<td>97.9%</td>
</tr>
</tbody>
</table>

**Effectiveness**

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Fruit/vegetables (g/day)</th>
<th>Fat (% of total energy from fat)</th>
<th>Physical activity (% of active)</th>
<th>BMI (kg/m²)</th>
<th>Cholesterol (mmol/l)</th>
<th>Systolic blood press. (mmHg)</th>
<th>Costs ($PPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ 37.6</td>
<td>- 1.64</td>
<td>-</td>
<td>-</td>
<td>- 0.83</td>
<td>- 2.3</td>
<td>$112.95</td>
</tr>
<tr>
<td></td>
<td>+ 45.6</td>
<td>- 2.2</td>
<td>+ 11.9</td>
<td>+ 2.4</td>
<td>- 0.12</td>
<td>- 2.3</td>
<td>$77.13</td>
</tr>
<tr>
<td></td>
<td>+ 18.4</td>
<td>-</td>
<td>+ 11.9</td>
<td>+ 2.4</td>
<td>- 0.12</td>
<td>- 2.3</td>
<td>$2.27</td>
</tr>
<tr>
<td></td>
<td>+ 8.6</td>
<td>- 0.77</td>
<td>-</td>
<td>-</td>
<td>- 0.55</td>
<td>- 2.3</td>
<td>$0.28</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>1.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>$99.13</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1 to 0.35</td>
<td>- 0.05 to 0.018</td>
<td>$210.82</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1 to 0.35</td>
<td>- 0.05 to 0.018</td>
<td>$7.11</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>0.55</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td>$0.51</td>
</tr>
</tbody>
</table>

**Costs ($PPP)**

- Per target individual: $112.95, $77.13, $2.27, $0.28, $99.13, $210.82, $7.11, $0.51
- Per capita (whole population): $2.59, $4.51, $1.80, $0.28, $7.16, $15.23, $1.40, $0.10
The intervention

69. The intervention targets individuals between the ages of 25 and 65 who present at least one of the following risk factors: a BMI of 25 kg/m² or above, high cholesterol (75th percentile or above), high systolic blood pressure (>140 mmHg), and type II diabetes. Based on a selection of three studies which provide detailed accounts of controlled experiments of similar counselling interventions in primary care (Ockene et al., 1996; Herbert et al., 1999; Pritchard et al., 1999), it was assumed that 80% of primary care physicians join the programme and that 90% of eligible individuals choose to participate in the programme. Of the latter, 75% successfully complete the program.

70. Candidates are either recruited opportunistically, by screening patients waiting for a consultation (Pritchard et al., 1999), or identified using the information contained in practice records and invited for a consultation through a telephone call (Ockene et al., 1996; Herbert et al., 1999). Individuals are asked to complete a health and lifestyle questionnaire while they wait for their consultation, which will be used to tailor physician advice. Physicians spend roughly 8-10 minutes providing information and advice on lifestyle, and particularly on diet. The same information is repeated in following consultations.

71. A second, more intensive, version of the intervention involves additional counselling provided by a dietician upon referral. This consists of a first 45 minute individual session, followed by 5 group sessions of 15 minutes and by a final 45 minute individual session.

Effects

72. The intervention will modify risk factors at all the three levels modelled in the analysis. It will decrease fat consumption, body mass index, systolic blood pressure and total cholesterol. Effects are assumed to persist in a reduced form after the completion of the intervention.

73. The estimated cost of the intervention is about $100 per target individual ($210 in the more intensive version). A large share of this covers the cost of extra working hours of physicians and other health professionals, including dieticians and office support staff. Costs for the training of health professionals and basic organization costs account for less than $10.

2.5.2.2 Mass media campaigns.

74. The mass media can reach vast audiences rapidly and directly. Health promotion campaigns broadcast by radio and television may raise awareness of health issues and increase health information and knowledge in a large part of the population.

The intervention

75. The campaign is assumed to be broadcast on television and radio channels at the national and local levels, and to follow a two year pattern alternating 6 months of intensive broadcasting with 3 months of less intensive broadcasting. During the more intensive phases television and radio channels broadcast 30 second advertisements 6 times a day, 7 days a week. In the less intensive phases they broadcast 15 second advertisements 3 times a day, 7 days a week. Advertisements contain messages both on diet and physical activity. Broadcast messages are associated with the distribution of printed material, which is assumed to reach 10% of households.

Effects
76. Based on the evidence provided in three studies selected from a broader literature review (Dixon et al., 1998; Foerster et al., 1995; Craig et al., 2006), the intervention will increase consumption of fruit and vegetables as well as the proportion of the population undertaking adequate levels of physical activity.

77. The estimated cost of the intervention is 2.27$ per target individual, most of which is spent in broadcasting advertisements on national and local radio and television channels. Planning and administration costs are spread over a large target population.

2.5.2.3 School-based interventions.

78. School enrolment is nearly universal in the OECD area at younger ages; therefore, schools provide the means for reaching a large audience of children from all backgrounds. Additionally, food preferences are formed during childhood and helping children to develop a taste for healthier foods may have an effect on their diets persisting into their adult life.

The intervention

79. The intervention targets all children attending school in the age group 8-9, but it is assumed that just above 60% of children will fully participate in the activities which form part of the intervention.

80. The intervention entails the integration of health education into the existing school curriculum with support from indirect education and minor environmental changes such as healthier food choices in cafeterias. The main component is represented by an additional 30 hours per school year (about 1 hour per week) of health education focused on the benefits of a healthy diet and an active lifestyle. This is associated with an opening lecture held by a guest speaker, and further activities during ordinary teaching hours (e.g. science) with the support of school nurses. Indirect education consists of the distribution of brochures or posters, while environmental changes are pursued by re-negotiating food service contracts and re-training of staff.

Effects

81. A range of studies (Gortmaker et al., 1999; Luepker et al., 1998; Perry et al., 1998; Reynolds et al., 2000) indicate that school-based interventions of the kind described above modify distal risk factors, particularly by increasing the intake of fruit and vegetables and decreasing energy from fat. The analysis was based on the assumption that children will enjoy the benefits of the intervention throughout the course of their lives, although dietary changes will be reduced after exposure to the programme ceases.

82. The estimated cost per target individual is 113$, divided in the following way: 60% is spent in organization costs and training of teachers and food service staff; 25% on hours of extra teaching for additional curricular activities; and the remainder on brochures, books, posters and equipment in general. Costs do not include change in food service contract, vouchers/coupons from sponsors and school nurse time.

2.5.2.4 Worksite interventions.

83. Working adults spend a large part of their time at the workplace, where they are exposed to a number of factors that may influence their lifestyles and health habits. Existing evidence suggests that health education, peer pressure, and changes in the work environment contribute to changing lifestyles and preventing certain chronic diseases.

The intervention
84. The intervention targets individuals between the ages of 18 and 65 working for companies with at least 50 employees. It is assumed that 50% of employers, and 45% of their employees, will participate in the programme.

85. The intervention involves an introductory lecture by a guest speaker and a series of 20 minute group sessions with a nutritionist every two weeks for twenty months. Messages are reinforced by the distribution of information materials and posters in common areas and cafeterias. Other activities are coordinated by volunteers who also act as peer educators and organize “walk-clubs” or similar initiatives. As part of the intervention, catering staff are re-trained to prepare healthy dishes and food service contracts are re-negotiated.

Effects

86. Based on evidence provided in a range of studies (Sorensen et al., 1996; 1998; 1999; Emmons et al., 1999; Buller et al., 1999), the intervention increases the consumption of fruit and vegetables and physical activity, and decreases fat intake. After retirement, those exposed to the intervention retain some of the benefits accrued.

87. The estimated cost per target individual is 77$. Organization and training of peer-educators and food service staff account for less than 9%, while the largest component of the cost of the intervention (about 80%) is represented by seminar organisation and nutritionist fees. Other costs include information materials and a guest speaker. The costs involved in re-negotiating food service contracts or accessory measures (e.g. installation of bicycle racks) were not included in the analysis.

2.5.2.5 Fiscal measures to promote consumption of fruit and vegetables and reduce consumption of fats.

88. Fiscal incentives can directly affect consumption behaviours, and therefore influence lifestyle choices. Taxes, tax exemptions and subsidies are widely used in agriculture and food markets in the OECD area. Differential taxation of food products is relatively common. Sales taxes, or value added taxes, are often applied at different rates to different types of food. In many countries most foods are exempt, or subject to a reduced rate taxation, but certain foods are often subject to higher rates, particularly manufactured foods, or foods containing larger amounts of certain ingredients, such as sugar. Food taxes are often viewed as not particularly effective in changing patterns of food consumption, but several studies suggest that they can have an impact on both consumption of unhealthy foods and people’s weight. Fiscal measures may be complex to design and enforce, and their impacts may be somewhat unpredictable as the price elasticity of lifestyle commodities varies across individuals and population groups, and substitution effects are not always obvious. Fiscal measures also have potentially large re-distributive effects which should be accounted for in any economic evaluation.

The intervention

89. Taxes and subsidies typically affect all consumers. The intervention assessed in the analysis involves fiscal measures that will both increase the price of foods with a high fat content (e.g. many dairy products) by 10% and will decrease the price of fruit and vegetables in the same proportion. No assumptions are made as to what specific measures should be taken to achieve those price changes.

Effects

90. Based on some of the most conservative estimates of the price elasticity of demand for foods high in fat and for fruit and vegetables, among those discussed in a recent report issued by the French Government (Hespel and Berthod-Wurmser, 2008), it was estimated that a 10% change in price will produce, on average, a 2% change in consumption in the opposite direction. The health outcomes presented
in this paper are based on the assumption that price elasticity is the same across population groups, which may slightly overestimate the responsiveness of low income groups to changes in the prices of fruit and vegetables, and correspondingly underestimate the responsiveness of high income groups. However, the health effects of the intervention appear to favour those in poorer socio-economic circumstances more than their better off counterparts. The financial burden of the tax, however, will also be significantly greater for poorer households.

91. The costs of the intervention include basic administration, planning, monitoring and enforcement at the national level. The latter, in particular, accounts for most of the cost. Potential revenues from the tax, as well as expenditures originating from the subsidy, are not accounted for in the analysis, as they represent transfers rather than costs.

2.5.2.6 Restrictions on food advertising.

92. Heavy marketing of fast food and energy-dense food is regarded as a potential causal factor in weight gain and obesity, particularly because of its impact on dietary habits in children and teenagers. Most advertising explicitly directed to children is broadcast on television. Some countries have already taken formal regulatory steps to limit food advertising to children. On the other hand, major international players in the food industry are adopting forms of self-regulation, which may be viewed as an alternative, or a complement, to government regulation.

The intervention

93. The intervention is targeted to children between the ages of 2 and 16. The intervention is intended to limit children’s exposure to food advertising on television, particularly in programmes primarily aimed at children and during times of the day when a large proportion of the audience is made up by children in the above age group. The best evidence currently available on the impact of restrictions on food advertising concerns the advertising of fast food (Chou et al., 2008), therefore the intervention designed for the analysis focused on this type of advertising. Two versions of the intervention were assessed in the analysis: the first involving formal government regulation introduced by law and enforced by communication authorities; the second involving self-regulation by the food industry and broadcasters, with the government acting only in a monitoring and supervisory role.

Effects

94. The intervention will reduce children’s BMI through changes in dietary habits. Chou et al. (2008) suggest that in the absence of fast food advertising to children, the number of overweight children would be reduced by 12%. It was assumed in the analysis that the effect of advertising restrictions will be only 50% of the above, because children will remain exposed to a certain amount of advertising, either because they watch television programmes outside the hours in which restrictions are enforced, or because the industry may substitute television advertising with other forms of advertising to which children remain exposed. The effects of the intervention were assumed to persist into adult life in a reduced form. In the case of self-regulation, the effects of the intervention were assumed to be half of those produced by formal regulatory measures, because of the voluntary nature of the intervention and possibly slightly looser limitations self-imposed on advertising.

95. The intervention involves basic administration and planning costs at the national and local levels, as well as monitoring and enforcement costs. In addition, minor training may be required for communication authority staff charged with the task of overseeing the implementation of the scheme. In the case of self-regulation, basic administration, facilitation and supervision costs will arise at the national
level. Enforcement costs will be largely reduced, but there will remain a need for monitoring of compliance and effects.

2.6. Sensitivity analysis

96. The LifeStyle model is designed to produce estimates of cost-effectiveness and distributional impacts based on a wide range of input data derived from a variety of sources, and on assumptions regarding the relationships among such inputs and between model inputs and outputs. Similarly to other epidemiological and economic analysis models, the estimates produced by LifeStyle are subject to a certain degree of uncertainty in relation to the following factors:

1. Input parameters are derived from heterogeneous sources. Although efforts were made to select the most reliable sources for each parameter, the need to combine parameters from different sources may lead to potential inconsistencies (e.g. the sources used may reflect the characteristics of diverse settings, or populations).

2. Parameter estimates are subject to measurement error, as they are often the result of stochastic assessments based on relatively small samples of individuals. Large studies, or meta-analyses, of the role of risk factors in disease processes, or the effectiveness of interventions to improve risk factors and health outcomes, are rare.

3. Estimates of the effectiveness of interventions are normally derived from studies involving a relatively short observation of outcomes. Studies providing assessments of the long-term sustainability (over several years) of the effects achieved by specific lifestyle interventions are lacking, therefore assumptions are required to estimate such effects.

4. Studies of the effectiveness of interventions tend to focus on interventions with (sometimes slightly) different characteristics. Direct comparisons of the findings of such studies may be difficult, and it is often preferable to extrapolate information on the effectiveness of a given intervention from a single study, rather than attempting a synthesis of effectiveness data based on potentially misleading comparisons across heterogeneous studies.

5. The disability weights assigned to the three sets of diseases explicitly modelled in the analysis are based on Global Burden of Disease estimates. These are predominantly based on expert judgement and do not reflect potential variations across geographical areas. Similarly, the discount rate used in the analysis for both costs and health outcomes (3%) is based on standard practice within the WHO-CHOICE framework, which may not reflect local circumstances.

6. Estimates of the costs of treating risk factors and chronic diseases, as well as estimates of the costs of preventive interventions, are based on standard schedules of resource inputs derived from treatment protocols and experimental studies of the effectiveness of interventions. Standard costs were assigned to each resource item, reflecting regional averages of country-specific costs. Large-scale empirical cost analyses would provide more accurate and reliable cost estimates, but these were not available in the areas of interest for this analysis.

7. The overall structure of the LifeStyle model, the layers of risk factors and chronic diseases involved, and the relationships, static and dynamic, among those risk factors and diseases, provide a simplified representation of actual disease processes. It is possible that the exclusion of further concomitant risk factors, or interactions between risk factors, may lead to imprecise estimates of the impact of given preventive interventions.
8. Finally, the LifeStyle model generates estimates based on a stochastic process involving the simulation of large numbers of individual lives. As the latter numbers become larger, model estimates tend to converge towards central values. However, a trade-off exists between the computational power required to undertake simulations based on large numbers of hypothetical individuals and the degree of confidence of the estimates produced.

97. We made efforts to address as many as possible of the likely sources of uncertainty illustrated above, and to assess the robustness of model estimates to assumptions built into the modelling process and potential variation in input parameters. We used the most accurate and reliable evidence available for each parameter. Whenever possible, we used the confidence intervals associated with individual parameter estimates to conduct sensitivity analyses. We made conservative assumptions regarding any parameters for which no empirical estimates were available, and tested such assumptions as extensively as possible. We were particularly careful in assessing the robustness of cost estimates, testing the effects of cost variations within given ranges on final model outputs. Using all available computational power, we were able to run simulations of intervention scenarios in which one modelled individual corresponded to 2,500 real individuals, for a total of 20 iterations for each scenario. Further sensitivity analyses were undertaken using the software MCLeague, based on Monte Carlo simulation, which provided the means to test the robustness of model outputs to alternative assumptions regarding mean estimates and distributions of input parameters.
SECTION III

THE IMPACTS OF PREVENTIVE INTERVENTIONS

3.1. Health effects of interventions

3.1.1 Effects on obesity

98. Most interventions were shown to have only a limited impact on the overall scale of the obesity problem. Figure 3 reports the proportional decrease in obesity achieved by each intervention at steady state, compared to the baseline scenario. Interventions modifying distal risk factors (e.g. school-based and fiscal measures) such as diet and physical activity seem to have a somewhat smaller effect. The main cause of this is that they need more time to generate changes in body mass index. The situation is different when considering physical activity, as we modelled a stronger association between physical activity and BMI. In principle, we should be able to observe a stronger effect for interventions such as worksite and mass media. This does not completely happen because worksite interventions cover, even at steady state, only a rather limited number of people (about 7% of the population), while mass media interventions have a broader coverage but generate a substantially smaller effect, equivalent to a 2.4% increase in the proportion of those doing sufficient physical activity.

99. The best results are achieved by primary care counselling (intensive). This intervention entails long and comprehensive sessions with a health specialist who tailors the intervention on the individual. Additionally, although this intervention covers only a small share of the total population, it focuses on people considered at risk and, among these, people with a BMI higher than 25. Therefore, the effects of the interventions are concentrated on those who may benefit the most. This last consideration holds also for the more basic version of the primary care counselling intervention. Restrictions on advertisement produce a noteworthy reduction of obesity in young people while their effects fade in older individuals.
Figure 3. Decrease in obesity rates for 25 and 65 year olds and whole population (European region)

3.1.2 Incidence of chronic diseases

100. The Incidence of the three groups of chronic diseases modelled in the analysis (ischaemic heart disease, stroke and cancer) is reduced by the preventive interventions investigated, although to a relatively small extent. Figure 4 reports the decrease in percentage points, in a 100 year time-perspective, between the incidences of the three diseases under the no-intervention scenario and with the interventions. A decrease of 0.1% means that an individual experiences a decrease of 0.1% in the yearly probability of developing the disease. Although the decrease can be considered rather limited, one should bear in mind that this graph shows the effect on the whole population and, hence, it is weakened by under 40 year olds for who the probability of developing a disease is naturally very low.

101. The first four interventions: school-based, worksite, mass media and fiscal have particularly high effects on cancer. All of them entail a moderate increase in the consumption of fruit and vegetables. The model accounts for a direct link between consumption of fruit and vegetable and cancer. On the contrary, the other four interventions, based on primary care counselling and regulation of TV advertising, have larger effects on ischemic heart diseases. Primary care counselling (intensive) has the highest global effect by decreasing stroke of up to 0.9% (about 1 case every 100,000 individuals).
3.1.3 Life years and disability-adjusted life years

Figure 5 shows the increase in health outcomes (healthy life years and life years) for all the interventions compared to the baseline. Results are presented for the whole population. With the exception of the self-regulation of food advertising, for which the gain in disability-adjusted life years is almost equivalent to the gain in life years, for all the other interventions the gain in healthy life years is higher. In practical terms, this means that interventions can delay the start of chronic diseases, but they are less able to affect deaths. 100% of the morbidity of the studied population is caused by the modelled diseases, while only 42% of the total mortality is caused by the same diseases. As a consequence, 58% of the mortality is not minimally affected by the intervention and, in vivo, it might be even plausible that other diseases increase their mortality (i.e. the number of deaths) even assuming a constant fatality rate (i.e. the fraction of people with a disease who dies because of the disease) only because the number of people at risk and, therefore, the number of people with the disease increases.

Primary care counselling is the intervention providing the highest gain both in terms of healthy life years and life years. Globally, it increases 1 year of life every 28 individuals and 1 year of disability-adjusted life every 19 persons. At the bottom of the scale there is self-regulation of food advertising which would assure only a gain of 1 life year/disability-adjusted life year every 275 individuals. While all other programmes present a linear increase in their effectiveness on health outcome, primary care counselling (intense) appears to be an outlier and presents, by far, the largest improvements. However, it should be remembered, that this is a particular intensive intervention targeting a specific group and providing tailored programmes. This is reflected also in the costs (§ section 3.1.4).
Figure 5. Health outcomes at the population level (European region)

- food adv restriction (self-reg)
- worksite
- food adv restriction (enforced)
- school-based
- mass media campaign
- primary care counselling
- fiscal intervention
- primary care counselling (intensive)

104. Figure 6 reports the gain in life years and disease adjusted life years by class of age. As expected, interventions show to have almost no effect on people less than 40 year old. Our model incorporates chronic diseases typically affecting middle-aged or old-aged individuals, therefore even if interventions decrease the prevalence of intermediate (i.e. BMI) and proximal risk factors (e.g. high blood pressure), the effects on diseases are not visible because the risk factors need time to cause the disease and, in any case, the incidence of the diseases is so low that the effect is not appreciable.

105. Additionally, it should be noted that gain in disability-adjusted life years is higher in the age group 41-80 while the gain in life years is usually higher in the age groups 81-100. This is caused by the interaction between the nature of chronic diseases, generally entailing a slow course of the disease before death, and the effects of preventive interventions which delay the onset of the diseases. As a consequence, in the age group 40 to 80, the decrease of new cases produce an higher gain in healthy life years (where healthy means no chronic diseases). As the population gets older, the incidence of the diseases increases and, consequently the impact on disease-adjusted life years weakens. At the same time, in the scenario without interventions people who are now 80 year olds and who had developed the disease when they were younger start dying while under the intervention scenario they only start developing the disease. Consequently there is an increase in life years and a relative decrease in disability-adjusted life years.
Figure 6. Health outcomes of the interventions by age group (European region)

School-based

Mass media

Primary care

Primary care (intensive)

Worksite

Fiscal
106. Not all the interventions achieve the steady state at the same time. School-based intervention targets 8 and 9 year olds and therefore needs 91 years to show effects on the whole population (we model ages 0 to 100 and 9 year olds take 91 years to become 100 year olds). On the contrary, other interventions such as fiscal measures directly target the whole population and therefore need just 1 year to cover the whole population. Table 3 allows a comparison of the effectiveness of the interventions at steady state. Column two shows the yearly gain in disability-adjusted life years respectively for 1 million residents while column four reports the respective on the whole population. Column three illustrates the population coverage at steady state, at steady state the population coverage is given by the population targeted plus the population that still benefits from the intervention even if it is not directly targeted. For example, in the worksite intervention, the population directly targeted is 18 to 65 year olds, additionally we model a halved effect for individuals aged 66 to 100 years.

Table 3. Disability-adjusted life years gained at steady state (European region)

<table>
<thead>
<tr>
<th>intervention</th>
<th>average effect (life yrs. per million population)</th>
<th>coverage</th>
<th>total effect (life years)</th>
<th>years to steady state</th>
</tr>
</thead>
<tbody>
<tr>
<td>School-based</td>
<td>332</td>
<td>91.30%</td>
<td>114,542</td>
<td>91</td>
</tr>
<tr>
<td>Worksite</td>
<td>1409</td>
<td>7.20%</td>
<td>38,350</td>
<td>35</td>
</tr>
<tr>
<td>Mass media</td>
<td>281</td>
<td>79.40%</td>
<td>84,461</td>
<td>1</td>
</tr>
<tr>
<td>Primary care</td>
<td>2242</td>
<td>9.71%</td>
<td>82,285</td>
<td>35</td>
</tr>
<tr>
<td>Primary care (intense)</td>
<td>8419</td>
<td>9.71%</td>
<td>309,164</td>
<td>35</td>
</tr>
<tr>
<td>Enforced food advert restriction</td>
<td>186</td>
<td>97.90%</td>
<td>68,835</td>
<td>82</td>
</tr>
<tr>
<td>Self-regulation of food advertising</td>
<td>79</td>
<td>97.90%</td>
<td>29,241</td>
<td>82</td>
</tr>
<tr>
<td>Fiscal measures</td>
<td>261</td>
<td>100.00%</td>
<td>98,626</td>
<td>1</td>
</tr>
</tbody>
</table>

107. Figure 7 shows the time needed by each intervention in obtaining the maximum effect. The vertical axis reports the number of disease adjusted life years while the horizontal axis reports the time frame of our analysis. Disability-adjusted life years are discounted with a 3% rate. In general, interventions targeting youngsters (e.g. school-based and regulation of food advertisement) require more time to reach the steady state and, consequently, their total effectiveness in the first 100 years is affected by this with lower gains. All the intervention but mass media and fiscal measures present a first increasing segment followed by a decreasing one. This effect is given by the discounting which shrinks the real effectiveness of an intervention through time.
Primary care counselling (intensive) becomes the most effective intervention only starting from the twelfth year with fiscal measures and mass media campaign having the best performances in the short term. School-based becomes the second most effective intervention at year 79 and, in the long run, it is more effective than many other interventions (for example, mass media campaign or regulation of food advertising), still it takes more than 90 years to get to the steady state therefore the total effect during the first 100 years is somewhat limited (in fact, overall, school-based intervention is only fifth). Starting from year 35, mass media campaigns and primary care have almost the same annual effect; however primary care needs more than 30 years to reach the same level. After year 46 enforced food advertising restrictions become more effective than worksite interventions. Self-regulated advertising restriction is the least effective intervention throughout the whole period.
3.1.4 Total costs

109. Expectations about the potential impact of preventive interventions are often inaccurate, because such interventions produce multiple and sometimes interacting effects, which are difficult to predict. A common misconception, for instance, is that prevention will reduce future health care costs. In fact, this may or may not be the case. Prevention may reduce fatality rates associated with certain chronic diseases and extend life with those diseases, which may increase overall health care costs in the long run. Individuals who live longer as a result of prevention will also develop diseases other than those targeted by prevention, which may require treatment and increase health expenditure.

110. The preventive interventions assessed in the analysis reflect a wide variety of approaches and are based in diverse settings. The costs associated with those interventions may arise in different jurisdictions. Some of the costs are typically paid through public expenditure (e.g. the costs associated with regulatory measures), others typically not (e.g. most of the costs associated with worksite interventions). Some of the costs arise within the health sector (e.g. health care costs), others arise within other sectors of government intervention (e.g. most of the costs associated with school-based interventions). In principle, the costs associated with preventive interventions and with the treatment of risk factors and chronic diseases could be calculated at the national level, and the economic analysis could be set in the context of individual countries. However, for practical reasons we aggregated OECD countries into the three macro-regions mentioned previously, and the costs calculated for each region reflect average conditions across the countries that make up that region. Cost differences between countries undoubtedly exist, although international comparisons found similar cost-of-illness patterns in several OECD countries (Heijink et al., 2004). The costing methodology used in the joint OECD-WHO analysis involves an assessment of cost differences across countries based on a regression analysis approach, mainly accounting for country GDP and characteristics of the supply of health care.
111. Figure 8 describes the total economic assessment of the interventions. The portion below the 0 reports the savings on the total health expenditure (diseases, diabetes, high blood pressure, high cholesterol) due to the interventions. A better breakdown of this, by class of age, can be found in figure 9. The whole bar indicates the total expenditure for the intervention. Thus, the positive part accounts for what should be really spent by governments to implement the interventions (total expenditure – savings). Cost reported in figure 8 are expressed in hundreds of millions, 2000 $ Purchasing Power Parity and account.

112. Primary care (intensive) is the most expensive intervention with an expected cost of about 541 billion $ in 100 years, while self-regulated advertisement restriction is the least expensive intervention, costing about 3.8 billion $ in 100 years. The only cost-saving intervention is fiscal measure with a modelled savings of about 4 billion $.

113. Figure 9 shows the potential savings due to the interventions in 100 years. Figure 9 can be directly compared with figure 8 by considering that the sum of savings/expenditures is equal to the negative part of the associated bar in figure 8. In general, interventions are cost-savings in most age groups but become constantly more expensive than the baseline in the age group 90-100. The main cause of this is the increased life expectancy of the population: the number of individuals and, accordingly, the number of individuals with a disease is higher in the intervention scenario and, consequently, the costs for treating people affected increase as well.
Figure 9. Effects of interventions on health care costs by age group (European region)

School-based

Worksite

Mass media

Fiscal

Primary care

Primary care (intensive)
3.1.5 Cost-effectiveness

Most interventions appear to have a favourable efficiency profile, with fiscal measures leading to overall cost savings. Although the cost-effectiveness of the latter interventions seems very favourable in the long-term (100 years), in the first 20-30 years of their implementation cost-effectiveness ratios are extremely high. In general, the scale of the impact of individual interventions is limited by the difficulties involved in reaching a large proportion of the national population, either because only certain age groups are targeted by the intervention, in which case it may take many years before a large share of the population receives some exposure to the intervention, or because compliance rates are low, as is typically the case for several of the interventions examined, based on existing evidence.

Figure 10 shows the cost-effectiveness ratios for each of the preventive interventions at different points in time over the 100 years of the simulation. Both costs and effectiveness are discounted at a 3% rate.
Figure 10. Cost-effectiveness of interventions over time ($PPP per DALY, European region)
CONCLUSIONS

4.1. The efficiency of preventive interventions

116. The findings of the economic analysis provide a number of important indications for policies aimed at preventing chronic diseases linked to unhealthy diets and sedentary lifestyles:

- Most of the preventive interventions evaluated as part of the project appear to have favourable cost-effectiveness ratios. Therefore, those interventions may be regarded as efficient uses of resources when their benefits are measured in terms of life years, or disability-adjusted life years gained, relative to a scenario in which no systematic prevention is undertaken and chronic diseases are treated once they emerge.

- However, cost-effectiveness ratios do not provide information on the scale of the overall effects and costs associated with preventive interventions. When such effects are considered, it is clear that none of the interventions assessed in the analysis may provide the means for a significant reduction of the scale of the obesity problem, if implemented in isolation.

- Although the most efficient interventions appear to be outside the health sector, health care systems can make the largest impact on obesity and related chronic conditions by selecting individuals at high risk and by using existing facilities, particularly in primary care, to deliver effective counselling. However, it is also possible that the outcomes of primary-care-based interventions appear superior to those of other interventions because a more detailed assessment of their impact on risk factors could be made in a clinical setting.

- Among the most important reasons for the limited overall impact of individual interventions are the difficulties involved in reaching large sectors of national populations through preventive interventions, and those involved in securing their active participation in such programmes. In fact, the interventions that are capable of reaching the largest numbers of individuals (e.g. mass media campaigns, or fiscal measures), are among those that appear to have the largest impacts, even if the effects of the latter interventions are smaller at the individual level.

- Interventions that target younger age groups are unlikely to have any significant health effects at the population level for many years. The cost-effectiveness profiles of such interventions may be favourable in the long-term, but may remain very unfavourable for several decades at the start of the interventions.
• Preventive interventions do not always generate reductions in health expenditure, even when the analysis is limited to a set of diseases that are more directly affected by diet, physical activity and obesity. Individuals may live longer with chronic diseases, as a result of prevention, and may survive long enough to experience unrelated diseases which they would not have experienced otherwise.

• With the exception of fiscal measures, all of the interventions assessed in the economic analysis generate a requirement for additional resources to be made available within the health sector, in other areas of government intervention, or within the private sector. Most interventions appear to be efficient uses of such resources; however, a large part of those resources would need to be made available upfront, while health returns are often delayed. Governments should determine what level of resources (budgets) they are willing and able to assign to prevention, and they may use the findings of our economic analysis to assess what portfolio of interventions would make the best use of such budgets.

117. The cost-effectiveness ratios resulting from the economic analysis are generally favourable, but subject to a certain degree of uncertainty because of the heterogeneity and relatively wide confidence intervals of the estimates of effectiveness used as inputs in the modelling work. Although a range of sensitivity analyses confirmed that model estimates are relatively robust, the range of variation in potential inputs suggests that interventions need to be very carefully designed in order to achieve at least the same levels of effectiveness recorded in the studies referred to in the economic analysis, at no greater cost. Given the degree of heterogeneity observed among interventions documented in the existing literature aimed at tackling the same health-related behaviours in the same settings, and the variation in the outcomes observed, it is likely that the ways in which interventions are designed and implemented may significantly affect their results.
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## ANNEX 1 – EVIDENCE OF THE COST-EFFECTIVENESS OF INTERVENTIONS

<table>
<thead>
<tr>
<th>REF</th>
<th>Year of publication</th>
<th>Classification</th>
<th>Domain</th>
<th>Country</th>
<th>Intervention and description</th>
<th>Comparator</th>
<th>Interv/ f-up length</th>
<th>Results</th>
<th>Target population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2001</td>
<td>Community Counseling</td>
<td>Diet</td>
<td>AU</td>
<td>Interactive computer-based telecommunication system</td>
<td>do nothing</td>
<td>26/26</td>
<td>1464 $ for one serve of fruit/veg</td>
<td>Members of a multisite, multispecialty practice</td>
</tr>
<tr>
<td>2</td>
<td>1998</td>
<td>Community Counseling</td>
<td>Physical activity</td>
<td>GB</td>
<td>10 week program</td>
<td>do nothing</td>
<td>10/34</td>
<td>3268$ to move one person to recommended PA level</td>
<td>45-74 y olds inactive people</td>
</tr>
<tr>
<td>3</td>
<td>2000</td>
<td>Community Counseling</td>
<td>Physical activity</td>
<td>US</td>
<td>Small group meetings</td>
<td>month free gym membership</td>
<td>26/104</td>
<td>91$/Kg lost for counseling, 170 $/Kg lost for gym memb at 52 wk; 398 $/Kg lost for counseling, weight increase for gym memb at 104 wk</td>
<td>35-60 y olds &amp; 140% body weight &amp; low expenditure value</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>Community Counseling</td>
<td>Combined</td>
<td>AU</td>
<td>Family-based therapy sessions and follow-up</td>
<td>Current practice</td>
<td>69/life</td>
<td>ICER 2754 $/DALY</td>
<td>families with overweight children</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>Community Counseling</td>
<td>Combined</td>
<td>AU</td>
<td>After-school meetings and exercise sessions</td>
<td>Current practice</td>
<td>32/life</td>
<td>ICER 61985 $/DALY to current practice</td>
<td>Children in school</td>
</tr>
<tr>
<td>6</td>
<td>2004</td>
<td>Community Counseling</td>
<td>Combined</td>
<td>AU</td>
<td>Newsletter, newsletter &amp; small groups</td>
<td>do nothing</td>
<td>16/52</td>
<td>BMI increased, 3586 $/fruit/veg serving increased at 52 wks</td>
<td>cohabiting couples</td>
</tr>
<tr>
<td>7</td>
<td>2001</td>
<td>Community Counseling</td>
<td>Combined</td>
<td>US</td>
<td>Group and individualized treatment</td>
<td>Group treatment</td>
<td>20/32</td>
<td>group treatment -0.016%ow/$, combined treatment -0.006%ow/$</td>
<td>families with overweight children</td>
</tr>
<tr>
<td>Year</td>
<td>Year of intervention</td>
<td>Setting</td>
<td>Nutritional counseling</td>
<td>Type of counseling</td>
<td>Outcome measure</td>
<td>Cost per life year gained</td>
<td>Cost per QALY</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----------------------</td>
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<td>-------</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2005</td>
<td>GP counseling</td>
<td>Diet</td>
<td>GB</td>
<td>Nurse behavioural counseling</td>
<td>Do nothing</td>
<td>2/50</td>
<td>4482$/person changing from &lt;5 fruit/day to &gt;5 fruit/day</td>
<td>18-70 y old low income subj</td>
</tr>
<tr>
<td>9</td>
<td>2005</td>
<td>GP counseling</td>
<td>Diet</td>
<td>AU</td>
<td>Dietician counseling</td>
<td>Current practice</td>
<td>12/0</td>
<td>7.3 $/kg decreased</td>
<td>25-65 y old overweight subj</td>
</tr>
<tr>
<td>9</td>
<td>2005</td>
<td>GP counseling</td>
<td>Diet</td>
<td>AU</td>
<td>Physician and dietician counseling</td>
<td>Current practice</td>
<td>12/0</td>
<td>9.8 $/kg decreased</td>
<td>25-65 y old overweight subj</td>
</tr>
<tr>
<td>10</td>
<td>2005</td>
<td>GP counseling</td>
<td>Diet</td>
<td>DK</td>
<td>General practitioner counseling</td>
<td>Do nothing</td>
<td>52/life</td>
<td>ICER 889 $/life year gained</td>
<td>BMI &gt;30, waist circumference (men &gt;102, women &gt;88 cm), dyslipidemia, type 2 diabetes</td>
</tr>
<tr>
<td>10</td>
<td>2005</td>
<td>GP counseling</td>
<td>Diet</td>
<td>DK</td>
<td>dietician counseling</td>
<td>Do nothing</td>
<td>52/life</td>
<td>dietician 6495 $/life year gained</td>
<td>BMI &gt;30, waist circumference (men &gt;102, women &gt;88 cm), dyslipidemia, type 2 diabetes</td>
</tr>
<tr>
<td>11</td>
<td>1999</td>
<td>GP counseling</td>
<td>Physical activity</td>
<td>AU</td>
<td>PA prescription and counseling</td>
<td>Current practice</td>
<td>-/5</td>
<td>ICER 22605 $/QALY</td>
<td>Inactive patients</td>
</tr>
<tr>
<td>11</td>
<td>1999</td>
<td>GP counseling</td>
<td>Physical activity</td>
<td>AU</td>
<td>Counseling by a physiologist</td>
<td>Informational pamphlet</td>
<td>26/26</td>
<td>ICER 2576$/QALY on 15 years</td>
<td>&gt;60 y old inactive patients</td>
</tr>
<tr>
<td>12</td>
<td>2004</td>
<td>GP counseling</td>
<td>Physical activity</td>
<td>NZ</td>
<td>Verbal and written prescription and follow-up on phone</td>
<td>Do nothing</td>
<td>13/39</td>
<td>7 $/Kcal spent in PA/Kg/day, 1094 $/additional sub became active</td>
<td>40-79 year olds</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>GP counseling</td>
<td>Combined</td>
<td>AU</td>
<td>Family therapy by psychiatrist</td>
<td>Current practice</td>
<td>12/life</td>
<td>ICER 22039 $/DALY</td>
<td>Families with overweight/obese children</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Diet</td>
<td>AU</td>
<td>classes to reduce the consumption of carbonated drinks</td>
<td>Current practice</td>
<td>26/life</td>
<td>ICER 2066 $/DALY on life course</td>
<td>7-11 year olds</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Physical activity</td>
<td>AU</td>
<td>classes to reduce TV viewing</td>
<td>current practice</td>
<td>43/life</td>
<td>ICER 2066 $/DALY on life course</td>
<td>children in primary school (grade 3 and 4)</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Physical activity</td>
<td>AU</td>
<td>school session + events to increase PA *</td>
<td>current practice</td>
<td>4/life</td>
<td>ICER 179068 $/DALY on life course</td>
<td>children in primary school (grade 5 and 6)</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Physical activity</td>
<td>AU</td>
<td>walking school bus *</td>
<td>current practice</td>
<td>43/life</td>
<td>ICER 0.53 M $/DALY on life course</td>
<td>children in primary school</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Combined</td>
<td>AU</td>
<td>classes + increased PA *</td>
<td>current practice</td>
<td>156/life</td>
<td>ICER 4821 $/DALY on life course</td>
<td>children in primary school</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Combined</td>
<td>AU</td>
<td>classes</td>
<td>current practice</td>
<td>104/life</td>
<td>ICER 9642 $/DALY on life course</td>
<td>children in primary school</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>School setting</td>
<td>Combined</td>
<td>AU</td>
<td>classes</td>
<td>current practice</td>
<td>12/life</td>
<td>ICER 2066 $/DALY on life course</td>
<td>Overweight 7-10 year old children</td>
</tr>
<tr>
<td>13</td>
<td>2003</td>
<td>School setting</td>
<td>Combined</td>
<td>US</td>
<td>classes + increased PA *</td>
<td>do nothing</td>
<td>104/life</td>
<td>ICER 4629 $/QALY on life course</td>
<td>pupils in middle school</td>
</tr>
<tr>
<td>4-5</td>
<td>2006</td>
<td>Environment modification</td>
<td>Diet</td>
<td>AU</td>
<td>banning TV advertising</td>
<td>current practice</td>
<td>-/life</td>
<td>ICER 2.5 $/DALY on life course</td>
<td>general pop (&gt;15% audience &lt;14 years old)</td>
</tr>
<tr>
<td>14</td>
<td>2004</td>
<td>Environment modification</td>
<td>Physical activity</td>
<td>US</td>
<td>build/manage a cycle trial</td>
<td>No comparator</td>
<td>1/0</td>
<td>930 $/person cycling with the purpose of losing weight</td>
<td>general pop</td>
</tr>
<tr>
<td>15</td>
<td>2002</td>
<td>Environment modification</td>
<td>Physical activity</td>
<td>NO</td>
<td>build/manage a cycle trial</td>
<td>No comparator</td>
<td>-/-</td>
<td>CB ratio 3:1 to 14:1</td>
<td>general pop</td>
</tr>
<tr>
<td>16</td>
<td>2007</td>
<td>Environment modification</td>
<td>Physical activity</td>
<td>GB</td>
<td>build/manage a cycle trial</td>
<td>No comparator</td>
<td>-/-</td>
<td>CB ratio 1.4:1 to 7:1</td>
<td>general pop</td>
</tr>
<tr>
<td>17</td>
<td>1995</td>
<td>Other</td>
<td>Diet</td>
<td>AU</td>
<td>5 a day campaign</td>
<td>do nothing</td>
<td>156/1040</td>
<td>ICER 36$/QALY</td>
<td>general pop (average age 40 years)</td>
</tr>
<tr>
<td>18</td>
<td>1995</td>
<td>Other</td>
<td>Diet</td>
<td>US</td>
<td>diet regimen with medical check-up</td>
<td>do nothing</td>
<td>76/0</td>
<td>1958 $/lb</td>
<td>obese subj</td>
</tr>
<tr>
<td>19</td>
<td>2005</td>
<td>Other</td>
<td>Diet</td>
<td>US</td>
<td>Low carbohydrate diet</td>
<td>Standard weight loss diet</td>
<td>26/26</td>
<td>No statistical difference</td>
<td>Severely obese subj</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>Country</td>
<td>Activity</td>
<td>Intervention Details</td>
<td>Control Group</td>
<td>Cost/Effect</td>
<td>ICER</td>
<td>Age Group</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>------</td>
<td>---------</td>
<td>----------</td>
<td>----------------------</td>
<td>---------------</td>
<td>-------------</td>
<td>------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>1988</td>
<td>Other</td>
<td>Jogging</td>
<td>do nothing</td>
<td>1560/0</td>
<td>ICER 19273$/QALY</td>
<td>35 y old men</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>2001</td>
<td>Other</td>
<td>Combined</td>
<td>Correspondence behavioral programme</td>
<td>do nothing</td>
<td>11 $/kg lost</td>
<td>general pop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>2006</td>
<td>Other</td>
<td>Combined</td>
<td>Three component intervention of diet, exercise, behaviour modification</td>
<td>Current practice</td>
<td>13800 $/QALY</td>
<td>ow/obese women &gt;35 year olds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEX 2 – LIST OF ARTICLES AND PUBLICATIONS ON THE COST-EFFECTIVENESS AND COST-BENEFIT OF INTERVENTIONS TO TACKLE OVERWEIGHT AND OBESITY THROUGH DIET AND PHYSICAL ACTIVITY

(1) Dalziel K, Segal L, Mortimer D, 2005: Risk factor study: How to reduce the burden of harm from poor nutrition, tobacco smoking, physical inactivity and alcohol misuse: cost-utility analysis of 8 nutrition interventions. Center for Health Economics Research paper 2005(4)


(8) Dalziel K, Segal L, Mortimer D, 2005: Risk factor study: How to reduce the burden of harm from poor nutrition, tobacco smoking, physical inactivity and alcohol misuse: cost-utility analysis of 8 nutrition interventions. Center for Health Economics Research paper 2005(4) pag 90

(9) Dalziel K, Segal L, Mortimer D, 2005: Risk factor study: How to reduce the burden of harm from poor nutrition, tobacco smoking, physical inactivity and alcohol misuse: cost-utility analysis of 8 nutrition interventions. Center for Health Economics Research paper 2005(4) pag 4


(11) Dalziel K, Segal L, Mortimer D, 2005: Risk factor study: How to reduce the burden of harm from poor nutrition, tobacco smoking, physical inactivity and alcohol misuse: cost-utility analysis of 4 physical
inactivity interventions. Center for Health Economics Research paper 2005(3) pag 4 [this reference is used twice]


ARRICH J, LALOUSCHEK W, MÜLLNER M. INFLUENCE OF SOCIOECONOMIC STATUS ON MORTALITY AFTER STROKE: RETROSPECTIVE COHORT STUDY. STROKE. 2005 FEB;36(2):310-4

BATTY GD, SHIPLEY MJ, JARRETT RJ, BREEZE E, MARMOT MG, DAVEY SMITH G. OBESITY AND OVERWEIGHT IN RELATION TO DISEASE-SPECIFIC MORTALITY IN MEN WITH AND WITHOUT EXISTING CORONARY HEART DISEASE IN LONDON: THE ORIGINAL WHITEHALL STUDY. HEART. 2006 JUL;92(7):886-92


BULL FC, ARMSTRONG TP, DIXON T, HAM S, NEIMAN A, PRATT M. PHYSICAL INACTIVITY. IN: EZZATI M, LOPEZ AD, RODGERS A, MURRAY CJL. COMPARATIVE QUANTIFICATION OF HEALTH RISKS. GLOBAL AND REGIONAL BURDEN OF DISEASES ATTRIBUTABLE TO SELECTED MAJOR RISK FACTORS. WORLD HEALTH ORGANIZATION, GENEVA, 2004


FAOSTAT, HTTP://FAOSTAT.FAO.ORG. ACCESSED ON 02/12/2008


FORSSAS EH, KESKIMÄKI IT, REUNANEN AR, KOSKINEN SV. CORONARY HEART DISEASE AMONG DIABETIC AND NONDIABETIC PEOPLE - SOCIOECONOMIC DIFFERENCES IN INCIDENCE, PROGNOSIS AND MORTALITY. JOURNAL OF DIABETES AND ITS COMPLICATIONS. 2008 JAN-FEB;22(1):10-7


HART CL, HOLE DJ, SMITH GD. THE CONTRIBUTION OF RISK FACTORS TO STROKE DIFFERENTIALS, BY SOCIOECONOMIC POSITION IN ADULTHOOD: THE RENFREW/PAISLEY STUDY. AMERICAN JOURNAL OF PUBLIC HEALTH. 2000 NOV;90(11):1788-91
Howarth NC, Huang TT, Roberts SB, McCrory MA. Dietary fiber and fat are associated with excess weight in young and middle-aged US adults. Journal of the American Dietetic Association. 2005 Sep;105(9):1365-72


IARC/WHO. WHO Mortality database on cancer. 2008


ANNEX 4 - STRUCTURE OF THE MICRO-SIMULATION MODEL FOR THE ECONOMIC ANALYSIS

Introduction
The main features of the epidemiological model are described in the main text in section 2.1. In this section, we will describe the risk factors and diseases featuring in various parts of the LifeStyle model. The definition of the risk factors, as well as the thresholds used to identify individuals at risk, is largely based on data provided by the WHO publication “Comparative quantification of health risks” (Ezzati M et al., 2004).

Detailed description of the causal web
Figure 1 shows the overall structure of the Lifestyle model and the interactions (represented by arrows) between risk factors and between risk factors and diseases.

There are a total of eight classes of risk factors. There are three risk factors associated with health-related behaviours (causally distal), one linked with body mass (causally medial) and three related to alterations in physiological parameters (causally proximal). Physical activity and two dimensions of diet are distal risk factors. Body mass is a medial (i.e. intermediate) risk factor. The three proximal risk factors are blood pressure, blood sugar (i.e. diabetes) and blood cholesterol. Three diseases are modelled: stroke, ischaemic heart disease, and colorectal cancer.

For all risk factors and diseases, when there is no interaction, the risk factors/diseases are assumed to be independent. The causal web shown in Figure 1 can be further distinguished by breaking it down into its static and dynamic components.

Static causal web
The static component of the causal web refers to that part of the general causal web shown in Figure 1 that affects an individual's health state before model time is turned on, in other words, at initialization. The initialization of an individual's state refers to the assignment of starting values for all individual level variables: for example, sex, age and risk factor status.

The assignment of risk factor status at initialization is done with reference both to the observed values of risk factor prevalences in the population as well as the assumptions used to specify the interactions in the static causal web. The assignment of risk factor status at initialization thus depends directly on the static causal web. "Static" here refers to the fact that the sort of interaction between risk factors that we have in mind here is not specified with respect to the probability of an individual's making a transition between risk factors (say, moving from a state of low socioeconomic status to a state of low socioeconomic status and low fibre diet) but rather with respect to the probability of an individual's having both risk factors (low socioeconomic status and low fibre diet) at initialization.

The static causal web, in other words, is used to specify the distribution of individuals across risk factor states at the start of the model simulation. Since this distribution refers to a particular point in time (i.e. at simulation start), the parameter values used to implement the static causal web are logically derived from
cross-sectional observations of the population being modelled. It should be kept in mind, however, that the static causal web can be thought of as the cumulative result of dynamic causal web interactions in the past.

The static causal web is represented as a series of boxes denoting the risk factor states included in the model; static interactions are represented by arrows connecting the boxes (Figure A4.1). In the static causal web, the presence of an interaction is equivalent to saying that there is a relative risk, not equal to 1, denoting the factor by which the probability is increased (decreased) of having both the condition at the start of the arrow and the condition at the end of the arrow at the start of the simulation. The actual parameter values used to quantify such factors are derived from observed values of relative risk obtained from epidemiological studies.

The observed values of the population prevalence of the risk factors, together with the values of relative risk that describe their interactions, specify a system of linear equations that determines the joint distribution of the population across risk factor states at model start.

Notice that in Figure A4.1, interactions (represented by arrows) operate in a strictly hierarchical fashion: socioeconomic status affects the probability of having a fat diet, fibre diet and physical activity level at model start. These latter three risk factors in turn affect the probability of having a given body mass status at initialization. Body mass status in turn affects the probability of having diabetes and high blood pressure and high cholesterol levels at time zero.

To initialize an individual's variables, his or her risk factor variables are assigned starting values in accordance with their joint distribution as determined by the observed levels of risk factor prevalences and the observed magnitudes of relative risk.

Dynamic causal web: risk factor transitions and disease events
Risk factors
The dynamic causal web can be, for convenience split into two parts: that part reflecting the interactions between risk factors only and that part reflecting the interaction between risk factors and disease events.

The dynamic causal web for risk factors refers to interactions between risk factors that occur within modelled time, in other words, interactions that affect the probability of an individual's making a transition between risk factor states.

The dynamic causal web for risk factors is shown in Figure A4.2. Note that here the strict hierarchical principle is not respected. For example, the fat diet affects both the probability of making a transition between body mass levels and the probability of making a transition between levels of the proximal risk factor diabetes. Similarly, physical activity affects both body mass and proximal risk factors.

These dynamic effects between risk factors are implemented by means of a single parameter for each of the distal risk factors physical activity and fat diet. The use of a single parameter implies that the effect (in relative terms) of, say, the fat diet on diabetes, blood pressure and cholesterol transitions is the same for each of diabetes, blood pressure and cholesterol. The use of a single parameter for each of these two distal risk factor is a simplification that implies the magnitude of its effect on risk factor incidence, on the one hand, and risk factor remission, on the other, are multiplicative inverses. "Multiplicative inverse" means that, if "RR1" is the effect of the risk factor on incidence, the effect of that risk factor on remission is equal to 1/RR1.

Also for simplicity, the interaction between the two distal risk factor effects is assumed to be strictly multiplicative and exponential in levels of the risk factor. "Multiplicative" means that the effect of both the medium fat diet (say, RR1) and the low physical activity level (say, RR2) on the transition between, say,
bodymass levels, is equal to \( RR_1 \times RR_2 \). "Exponential in levels of the risk factor" means that the effect of the fat diet "high fat" is equal to \( RR_1 \times RR_1 \).

Diseases

The dynamic causal web for disease events is shown in Figure A4.3. In this figure, disease states are represented by rectangular boxes while risk factor states are represented by boxes with rounded corners.

Here again, strict hierarchy is not respected: the probability of a disease event (incidence or fatality) related to colorectal cancer is affected by both a distal risk factor fibre diet and by the medial risk factor body mass. Similarly, the probability of a disease event related to stroke or ischaemic heart disease is affected by all three proximal risk factors (diabetes, blood pressure and cholesterol) as well as by body mass.

As opposed to the dynamic causal web for risk factors, the dynamic causal web for diseases allows for either a multiplicative interaction or an additive interaction. As before, "multiplicative" means that the effect of both the medium fat diet (say, \( RR_1 \)) and the low physical activity level (say, \( RR_2 \)) on the incidence of, say, stroke or ischaemic heart disease, is equal to \( RR_1 \times RR_2 \). "Additive" interaction means that the joint effect is equal to \( RR_1 + RR_2 - 1 \) (this is equivalent to "additive in excess risk", where "excess risk" equals the relative risk minus 1).
Physical activity
- \( P_0 \): sufficient physical activity
- \( P_1 \): insufficient physical activity

Body mass index
- \( N \): normal weight
- \( U \): pre-obesity
- \( V \): obesity

Blood pressure
- \( Z_0 \): physiological
- \( Z_1 \): hypertension

Cholesterol
- \( A_0 \): physiological
- \( A_1 \): hypercholesterolemia

Glycaemia
- \( B_0 \): physiological
- \( B_1 \): diabetes

Social class
- \( I_0 \): upper
- \( I_1 \): lower

Fat
- \( F_0 \): sufficient fat intake
- \( F_1 \): insufficient fat intake

Fibre
- \( Y_0 \): sufficient fibre intake
- \( Y_1 \): insufficient fibre intake

Note: states written in italic are considered the reference state (i.e. relative risk equal to 1) in the evaluation of relative risks.
Figure A4.1: The static causal web for risk factor prevalences implemented in the LifeStyle model.
Figure A4.2: The dynamic causal web for risk factor transitions implemented in the LifeStyle model.
Figure A4.3: The dynamic causal web for disease events implemented in the LifeStyle model.

- **Fibre diet**
  - $W_0$: Sufficient fibre
  - $W_1$: Insufficient fibre

- **Body mass**
  - $N$: Normal body mass
  - $U$: Pre-obesity
  - $V$: Obesity

- **Diabetes**
  - $B_0$: Normal blood sugar
  - $B_1$: Diabetes

- **Blood pressure**
  - $A_0$: Normal blood pressure
  - $A_1$: High blood pressure

- **Cholesterol**
  - $Z_0$: Normal cholesterol
  - $Z_1$: High cholesterol

- **Colorectal cancer**

- **Stroke**

- **Ischaemic heart disease**
### ANNEX 5 – EVIDENCE OF THE EFFECTIVENESS OF INTERVENTIONS

<table>
<thead>
<tr>
<th>OECD class</th>
<th>Domain</th>
<th>Country</th>
<th>Intervention and description</th>
<th>Intervention Length / Follow-up length</th>
<th>Results</th>
<th>Target population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention on the broader economic and social environment</td>
<td>Diet</td>
<td>US</td>
<td>policy of free fruit/vegetable at home</td>
<td>22/0</td>
<td>increase of 1.04 servings of fruit/veg, % of elderly having &gt;5 servings a day from 22% to 39%</td>
<td>low income seniors</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Physical activity</td>
<td>US</td>
<td>evaluation of the use of walking trials</td>
<td>-/-</td>
<td>beneficial in promoting PA in some groups</td>
<td>gen pop</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Physical activity</td>
<td>Colombia</td>
<td>influence on PA of sport events</td>
<td>-/-</td>
<td>women who participate in ciclovia are 7 times more likely to be physically active</td>
<td>women 18-69</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Physical activity</td>
<td>Finland</td>
<td>evaluation of the benefits of walking/biking to work</td>
<td>20/0</td>
<td>VO2 max +4.5%, cycle time +10.5%, HDL +5%; heart rate -2.5% compared to control</td>
<td>employee</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Physical activity</td>
<td>US</td>
<td>improving safety in walk/cycle trials</td>
<td>104/-</td>
<td>number of students walking +64%, biking +114%, car use -39%, carpooling +91%</td>
<td>school pupils</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Physical activity</td>
<td>Australia</td>
<td>organization of community walking events, campaign on PA, multimedia</td>
<td>104/-</td>
<td>inactive women decreased (22% vs. 15%)</td>
<td>20-50 y old women</td>
</tr>
<tr>
<td>Intervention on the physical environment and transport system</td>
<td>Combined</td>
<td>US</td>
<td>funding the establishment of community garden</td>
<td>-/0</td>
<td>fruit/veg +0.34 servings/day, PA +0.3 sessions/week</td>
<td>gen pop</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Education + multimedia + environment modification</td>
<td>52/52</td>
<td>fruit/veg intake +0.3 servings/day total, +0.16 servings/day in cafeterias</td>
<td>workers</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>Belgium</td>
<td>Education + multimedia + environment modification</td>
<td>13/-</td>
<td>BMI +0.258, energy intake -142 Kcal/day, cholesterol intake -16.5 mg/day</td>
<td>male workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>Denmark</td>
<td>Canteen staff better present fruits/vegetables</td>
<td>34/17</td>
<td>average increase 95g/customer of fruit/veg</td>
<td>workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Prevention + environmental changes + education vs. education + multimedia vs. family involvement</td>
<td>86/-</td>
<td>fruit/veg intake +19% in group 3, +7% in group 2</td>
<td>low-income workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Education + environment modification</td>
<td>104/-</td>
<td>energy from fat -2.3% Kcal vs. -1.5% in control, fruit/veg intake +10% vs. +4% in control</td>
<td>workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Environmental mod at work vs. peer groups</td>
<td>77/26</td>
<td>fruit/veg intake +0.41 servings/day</td>
<td>low-income workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Education + environment modification</td>
<td>104/-</td>
<td>energy from fat -0.37% Kcal, fiber intake +0.13 g/1000 Kcal, fruit/veg intake +0.18 serv/day</td>
<td>workers</td>
</tr>
<tr>
<td>Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>Use of a pedometer + education</td>
<td>12/-</td>
<td>decrease BMI, weight, heart rate, +3451 steps/day</td>
<td>sedentary workers</td>
</tr>
<tr>
<td>Interventions on supply of lifestyle commodities</td>
<td>Diet</td>
<td>Mauritius</td>
<td>Reduction palm oil and increase soy oil</td>
<td>260/0</td>
<td>Total cholesterol fell by 0.79mmol/L in men &amp; 0.82 in women (p&lt;0.001), Estimated intake of saturated fats decreased by 3.5% &amp; 3.6% in men &amp; women, respectively</td>
<td>gen pop</td>
</tr>
<tr>
<td>Interventions on supply of lifestyle commodities</td>
<td>Physical activity</td>
<td>South Africa</td>
<td>Exercise classes</td>
<td>20/-</td>
<td>Systolic pressure decr (147.8 vs. 143.9 gr 1) (143.0 vs. 137.4 gr 2)</td>
<td>elderlies in low socioeconomic conditions</td>
</tr>
<tr>
<td>Interventions on supply of lifestyle commodities</td>
<td>Physical activity</td>
<td>UK</td>
<td>Free supervised PA sessions</td>
<td>104/-</td>
<td>ICER 17174 £??/QALY</td>
<td>general old pop</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>UK</td>
<td>Education, increased provision, newsletter, etc</td>
<td>39/-</td>
<td>50g/day increase in fruit/veg intake</td>
<td>6-7 &amp; 10-11 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>Behaviour education</td>
<td>4/52</td>
<td>drop of 6.5% in cholesterol after 12 months</td>
<td>voluntary workers</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>multimedia computer program printouts</td>
<td>4/9</td>
<td>increased use of fruit/veg (results are difficult to be read)</td>
<td>workers with cholesterol &gt;200 m</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>group/individual sessions</td>
<td>13/13</td>
<td>no signif differences in weight or BMI, cal/day from 1099.9 to 1089.5, cal from fat from 35.9% to 32.3%</td>
<td>25-55 y olds women with BMI&gt;27</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>counseling on diet change</td>
<td>26/-</td>
<td>fiber +4.2 g and reduced monthly expenditure</td>
<td>&gt;18 women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>group and individual sessions healthy diet</td>
<td>104/77</td>
<td>fat intake from 39.7% energy to 26.4%, frui+0.53 portion/daily, veg +0.27 port/daily at 18 months</td>
<td>postmenopausal women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>education and activities in groups</td>
<td>6/-</td>
<td>1.6 times more likely to eat fruit/veg, 0.44 more likely to eat at least 5 servings/day fruit/veg</td>
<td>low income women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>Canada</td>
<td>group and individual sessions healthy diet</td>
<td>12/0</td>
<td>cholesterol no difference, waist circum -1.3 cm, BMI -0.2, weight -0.4 kg</td>
<td>women in charge for purchasing and preparing meals</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>personal visits, newsletters, group meetings</td>
<td>52/-</td>
<td>fruit/veg +0.53 por/day</td>
<td>low socioeconomic Afro-American parents</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>sessions low fat healthy diet</td>
<td>8/-</td>
<td>no changes in total cholesterol</td>
<td>low-educated and limited income</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>Sessions + printed material + tailored letters</td>
<td>26/26</td>
<td>serving/day of fruit/veg +0.73 at the end</td>
<td>low income &gt;18 y old women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>UK</td>
<td>tailored information</td>
<td>1hour/6</td>
<td>1.06 increase fruit/veg servings/day, people eating &gt;=5 servings/day of fruit/veg increased to 42% from 25%</td>
<td>55-64 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>advising by dieticians, phone calls</td>
<td>22/52</td>
<td>% of energy from fat decreased by 1.2%</td>
<td>postmenopausal women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>intensive and maintenance sessions + diettitan for non-compliants</td>
<td>416/-</td>
<td>intervention -0.5 kg compared to control at year 9, different data on weight/BMI also by ethnicity, intervention +1 serving fruit/veg /day compared to control</td>
<td>50-79 y old menopausal women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>phone-delivered advising, tailored material</td>
<td>4/34</td>
<td>no difference between control and intervention for fruit/veg intake</td>
<td>40-75 y old with adenomatous colon</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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<tr>
<td>Education</td>
<td>Diet</td>
<td>UK</td>
<td>brief advising</td>
<td>25min/26</td>
<td>increase of 1.4 servings of fruit/veg/day, no difference in plasmatic flavonol (lower coronary mortality)</td>
<td>polyps</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>Australia</td>
<td>advising of doctor + dietician vs. dietician</td>
<td>52/-</td>
<td>doctor+diet -6.7 kg, dietitian -5.6 kg, blood pressure improved</td>
<td>adults with BMI&gt;25/hypertension/diabetes</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>Italy</td>
<td>advising, written information</td>
<td>15min/52</td>
<td>BMI decreased by 0.41, fruit/veg +1.31 servings/week</td>
<td>18-65 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>counseling end of a service on cancer+ mails</td>
<td>2/52</td>
<td>0.43 servings/day at 12 months</td>
<td>&gt;18 y olds calling the cancer information service</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>partially computer-assisted sessions +telephone contacts</td>
<td>6-9/52</td>
<td>non-signif change in cholesterol, self-reported fruit/veg +0.93 por/day compared to control, fat intake -16 g/day</td>
<td>40-70 y old women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>intensive and maintenance sessions + dietician for non- compliants</td>
<td>416/-</td>
<td>intervention reduced fat by 24.3 g/day compared to control: 9.1 g from added fat, 4.6 g from meat and 3.9 from dessert; patterns for different ethnicities</td>
<td>50-79 y old menopausal women</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>personalised mails, phone advising</td>
<td>4/52</td>
<td>improvement in fat and fiber intake</td>
<td>low socioeconomic low education adults</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>UK</td>
<td>individual nurse advising, phone follow-up, mail material</td>
<td>26/-</td>
<td>fruit/veg +1.4 por/day, total cholesterol -0.018 mmol/l, blood pressure -2 mmHg</td>
<td>25-64 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>UK</td>
<td>nurse advising</td>
<td>2/52</td>
<td>no differences in BMI, cholesterol, blood pressure, +1.5 fruit/veg portions/day, +42% people eating 5 portions/day</td>
<td>low income adults</td>
</tr>
<tr>
<td>Education</td>
<td>Diet</td>
<td>US</td>
<td>written personalized counseling</td>
<td>13/9</td>
<td>interv gr increased fruit/veg intake of 0.6 compared to control</td>
<td>&gt;18 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>Brazil</td>
<td>multimedia campaign</td>
<td>208/-</td>
<td>people knowing the healthy message are more active</td>
<td>gen pop with focus on students, collars and elderly</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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<tr>
<td>Education</td>
<td>Physical activity</td>
<td>Brazil</td>
<td>multimedia campaign walk</td>
<td>416/-</td>
<td>cost saving (but do not state the comparison)</td>
<td>student and gen pop</td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>New Zealand</td>
<td>multimedia campaign PA</td>
<td>260/-</td>
<td>no changes in PA level, 1999:38.6% active, 2000:44.5%, 2002:38.0%</td>
<td>gen pop</td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>Australia</td>
<td>TV/magazine campaign</td>
<td>17/0</td>
<td>target group recalling the media campaign was</td>
<td>25-60 year olds motivated but insufficiently active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>regular exercise</td>
<td></td>
<td>2.08 times more likely to increase its PA</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>Canada</td>
<td>campaign: walk and use of</td>
<td>52/-</td>
<td>awareness of the campaign was associated with a 13% higher odds of</td>
<td>&gt;18 y olds</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>pedometer</td>
<td></td>
<td>sufficient level of weekly walking</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>multimedia campaign to be</td>
<td>52/-</td>
<td>significant relationship between awareness of the message and PA +34%</td>
<td>9-13 y olds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>more PA</td>
<td></td>
<td>high effect in at-risk group (low baseline)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>campaign to promote 30 min</td>
<td>8/0</td>
<td>23% increase in walkers, 32% increase of the baseline sedentary pop</td>
<td>sedentary 50-65 y olds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>daily walking</td>
<td></td>
<td>meeting the recommendation</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>campaign to promote 30 min</td>
<td>8/4</td>
<td>16% from non-active to active (non-signif compared to control), 47%</td>
<td>sedentary 40-65 y olds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>daily walking</td>
<td></td>
<td>increased total walking time (significant compared)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>advising before a routine</td>
<td>5min/5</td>
<td>52% adopted regular activity, 37 min/week increase in walking</td>
<td>&gt;18 y old sedentary patients</td>
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<td></td>
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<td></td>
<td>visit</td>
<td></td>
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<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>counseling educational</td>
<td>13/26</td>
<td>increased amount of PA measured as a score</td>
<td>20-64 y olds exercising &lt;15 min/day</td>
</tr>
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<td></td>
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<td>material + phone calls</td>
<td></td>
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<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>personalised counseling,</td>
<td>52/-</td>
<td>% of inactive decreased (38 vs. 56)</td>
<td>older people</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>fitness program</td>
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<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>personal / group</td>
<td>52/-</td>
<td>687 kcal/week increase in energy spent in PA</td>
<td>65-90 y old inactive people</td>
</tr>
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<td></td>
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<td>counseling, newsletter, phone</td>
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<td></td>
<td>calls</td>
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<tr>
<td>Education</td>
<td>Physical activity</td>
<td>US</td>
<td>counseling, telephone-based</td>
<td>26 vs. 20/-</td>
<td>both groups had a decrease in BMI</td>
<td>elderlies</td>
</tr>
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<td></td>
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<td>program vs. group-based</td>
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<td></td>
<td>program</td>
<td></td>
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</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>counseling nurse behaviour</td>
<td>26/26</td>
<td>cholesterol decreased by 11.5 mg/dl, systolic blood pressure by 3.6</td>
<td>&gt;50 y old low income women with</td>
</tr>
<tr>
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<td></td>
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<td></td>
<td>mmHg, BMI by 0.5, weight</td>
<td></td>
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<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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<tr>
<td>Education</td>
<td>Combined</td>
<td>UK</td>
<td>TV campaign with booklet</td>
<td>7/22</td>
<td>obese decreased by 6%, fruit/veg intake increased by 0.8 port/day, 39% participants increased PA</td>
<td>gen pop with focus on overw/obese</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>UK</td>
<td>TV campaign with booklet</td>
<td>7/13</td>
<td>awareness of the campaign was high in all socio-econ groups, memory for the message was poorer in those with lower level of educ and ethnic minority</td>
<td>gen pop with focus on overw/obese</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>UK</td>
<td>lessons</td>
<td>20/-</td>
<td>no changes in overweight/obesity, increase in consumption of fruit/veg</td>
<td>5-7 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>multimedia, information distribution, group sessions &amp; interactive activity</td>
<td>130/-</td>
<td>increase in fruit/veg intake no in fat%; increase in exercising</td>
<td>workers</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>encouragements to change behaviours, activity</td>
<td>12/-</td>
<td>62% reported weight loss, 50% increased fruit/veg cons, 40% decreased TV view</td>
<td>volunteer workers</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>education course</td>
<td>4/6</td>
<td>interv gr decreased weight and % body fat significantly compared to control, veg servings and total steps increased significantly</td>
<td>&gt;18 y olds</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>counseling, interactive sessions</td>
<td>12/-</td>
<td>increase in fast walking (108.9 min/week vs. 77.5), mod walk (138.1 min vs. 73.7). Decr soda servings/week (2.6 vs. 1.4)</td>
<td>gen pop (high % Spanish)</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>workbook vs. workbook+comp vs. work+comp+staff</td>
<td>52/-</td>
<td>weight -2.2, -4.7, -7.4 lb at 1 year, BMI -0.4 -0.9 - 1.2, self-rep calories -398 -283 -324, % kcal from fat -4.3 -2.9 -4.4, blocks walked/day +5.9 +5.1 +3.9</td>
<td>adults with BMI&gt;25</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>education course</td>
<td>4/0</td>
<td>weight -7.9 lb, women -6.4 lb, LDL -19.1 men, women -10, also others parameters decreased</td>
<td>upper-middle class &gt;40 y olds with risk of CAD</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>Australia</td>
<td>mail information vs. 1/2 mail+1/2 group vs. nothing</td>
<td>17/52</td>
<td>no sign differ in BMI, LDL fell signif, HDL did not change</td>
<td>couples living together for less than 2 ys</td>
</tr>
<tr>
<td>Education</td>
<td>Combined</td>
<td>US</td>
<td>sessions on healthy behavior, diet plan</td>
<td>260/-</td>
<td>at 54 months: weight decreased by 0.2 lb vs. increase by 5.2 lb in control, LDL increased by 3.5 mg/dl vs. 8.9 in control, triglycerides and glucose</td>
<td>44-50 y old premenopausal women</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
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<tr>
<td>Education</td>
<td>Combined</td>
<td>New Zealand</td>
<td>oral advising+phone calls+newsletter on PA</td>
<td>52/-</td>
<td>mean tot energy expenditure increased by 9.4 Kcal/kg/week and leisure exercise by 34 min/week more in intervention than control, no difference in blood pressure</td>
<td>40-79 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>Sweden</td>
<td>environment modification (fish in schools)</td>
<td>52/-</td>
<td>increased consumption of fish</td>
<td>14 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>environment, newsletters, education</td>
<td>104/-</td>
<td>no stat difference</td>
<td>students</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>education+school environm+parental involv</td>
<td>208/-</td>
<td>daily fruit/veg servings increased by 0.35</td>
<td>14-15 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>education+environmental (food in school)+parental involvement+industry involvement</td>
<td>52/-</td>
<td>increase of 0.58 serving of fruit intake, decrease of 1.81 % of total kcal by fat</td>
<td>4-5 grade children</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>education+environmental (food in school)+parental involvement</td>
<td>52/52</td>
<td>to baseline increase of fruit/veg consumption of 1.35 serving at 1 year and 0.59 servings at 2 years, % of cal from fat &amp; saturated fat smaller in treatment</td>
<td>8-9 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>Canada</td>
<td>education+family involvement+environmental (snacks in school)+peer involvement</td>
<td>52/-</td>
<td>BMI increased by 0.95, body fat increased by 1.2%, fiber intake increase by 1.8%</td>
<td>7-14 y old Native Americans</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>education+environmental (food in school)</td>
<td>129/-</td>
<td>decrease of 4.1% in calories from total fat, decrease of 1.3-1.6% in calories from saturated fat. At 5 years 50% of canteens met guidelines</td>
<td>food service staff</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
</tr>
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</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Diet</td>
<td>US</td>
<td>education+environment (food in school), parent involvement</td>
<td>104/-</td>
<td>saturated fat from meals decreased by 3%, total fat decreased by 6%, serum cholesterol decreased by 6 mg/dl, 30% reduction in risk of elevated cholesterol</td>
<td>2-5 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Physical activity</td>
<td>France</td>
<td>sport, debate on PA, social support</td>
<td>208/-</td>
<td>6% decrease of children spending &gt;3h/day in sedentary activity (at 6 months)</td>
<td>11 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>PA program, nutrition, information</td>
<td>12/0</td>
<td>adults: BMI decreased by 0.5, % body fat 1, children decrease in systolic blood pressure. Both increase in fruit servings</td>
<td>African American parents/studs</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>Ireland</td>
<td>education+aerobic exercise regime</td>
<td>10/13</td>
<td>increased intake of fruit/veg, decreased consumption of salty snacks</td>
<td>8-10 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>education+exercise+environmental</td>
<td>104/-</td>
<td>decrease of 1.4% of % total energy from fat, increase of 0.76 servings/day of fruit/veg, decrease of 0.55 h/day in TV viewing</td>
<td>students (91% African American)</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>education+PA program</td>
<td>8/-</td>
<td>no difference between classroom-based intervention and risk-based intervention</td>
<td>7-12 y olds</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>education+creation of a fitness centre</td>
<td>208/-</td>
<td>decrease of 4.8 ounces/day/student of sugared soft drinks, no differences in plasma glucose level, decline in the fasting and 30 min level insulin</td>
<td>16-18 y old Native Americans</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>education+environment (food in school, after school club), incentives</td>
<td>30/-</td>
<td>fasting glucose level decreased by 0.12 mmol/l, no difference in % body fat, increase fiber intake by 1 g/day</td>
<td>4th grade low income Mexican American children</td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>health fair, group activities, newsletters, vending</td>
<td>52/-</td>
<td>employees were 2 times less likely to lose work days due to health reasons</td>
<td>workers</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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</tr>
<tr>
<td>work, or school, environment</td>
<td></td>
<td></td>
<td>machines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>Greece</td>
<td>education+PA program+parental involvement</td>
<td>156/-</td>
<td>improvements in fitness, skinfold measure and BMI</td>
<td>1st grade students</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>education and activity</td>
<td>11/-</td>
<td>cholesterol decreases of 16 mg/dl and 5 point increase in fitness (VO2 max) in females, no stat sign in males</td>
<td>students</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>education+PA program+parental involvement</td>
<td>312/-</td>
<td>smaller BMI increase compared to control, total cholesterol decreased by 0.27 mmol/l and LDL by 0.13mmol/l</td>
<td>5.5-11.5 y olds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>education+community activities+mass media+environmental (food in school)</td>
<td>416/-</td>
<td>no substantial differences in BMI and TV watching. Decrease in fruit/veg intake</td>
<td>6-11 y old aboriginals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>educatio+PA program+environment (food in school)</td>
<td>52/-</td>
<td>no signif results</td>
<td>7-11 y olds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>education+PA program+environmental (food in school)+parental involvement</td>
<td>156/-</td>
<td>decrease in dietary energy -265 kcal and % of energy from fat -2.5, no change in BMI and body fat</td>
<td>8-11 y old Native Americans</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>education+PA program+environmental (food in school)</td>
<td>129/-</td>
<td>total cholesterol fell by 1.3 mg/dl (no signif compared to non-interv), energy from tot fat decreased by 2.4% and from saturated fat by 1.4%, no changes in fruit/veg intake, no changes in obesity</td>
<td>3th grade student</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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</tr>
<tr>
<td>Education + Interventions on the work, or school, environment</td>
<td>Combined</td>
<td>US</td>
<td>CVD program: contests, groups, media, schools</td>
<td>312/-</td>
<td>significant adverse trends for HDL and triglycerides, non-significant reduction in sedentary lifestyle, BMI increased</td>
<td>gen pop</td>
</tr>
<tr>
<td>Education + Intervention aimed at directly influencing lifestyle choices</td>
<td>Combined</td>
<td>Australia</td>
<td>store management policy changes, health promotion activities, and nutrition education</td>
<td>208/-</td>
<td>reduction in the prev of hypercholesterolemia from 31% baseline to 15% at 4 years. Increase in alpha-tocopherol, lutein, zeaxanthin, beta-carotene, homocysteine decreased by 3 umol/l</td>
<td>aboriginals with high CVD/diabetes risk</td>
</tr>
<tr>
<td>Education + Intervention on the broader economic and social environment</td>
<td>Diet</td>
<td>US</td>
<td>information campaign vs. coupons for vegetables</td>
<td>-9</td>
<td>coupon has direct effect increasing the purchase of veg, info had indirect effect through attitude. Best results when combined</td>
<td>low income women</td>
</tr>
<tr>
<td>Health care interventions</td>
<td>Diet</td>
<td>Australia</td>
<td>cholesterol check, advising, written information</td>
<td>5min/17</td>
<td>13.5% cholesterol decrease (0.84 mmol/l), no BMI changes</td>
<td>18-60 y old with cholesterol between 5.5-7.9 mmol/l</td>
</tr>
<tr>
<td>Health care interventions</td>
<td>Diet</td>
<td>UK</td>
<td>initial health check, follow-up checks and advising</td>
<td>156/-</td>
<td>compared to control cholesterol -0.19 mmol/l, BMI -1.4%, blood pressure -1.9%</td>
<td>35-64 y olds</td>
</tr>
<tr>
<td>Health care interventions</td>
<td>Diet</td>
<td>US</td>
<td>clinician visit, advising, phone counseling, information material</td>
<td>22/34</td>
<td>0.29 servings fruit/veg/day increase, 3.3% of part increased fruit/veg servings to at least 5/day</td>
<td>18-75 y old low income adults</td>
</tr>
<tr>
<td>Health care interventions</td>
<td>Physical activity</td>
<td>Finland</td>
<td>prescription of PA</td>
<td>30/26</td>
<td>increase of 0.9 session of PA/week at 6 months</td>
<td>20-65 y olds</td>
</tr>
<tr>
<td>Health care interventions</td>
<td>Physical activity</td>
<td>US</td>
<td>education+visits+PA program</td>
<td>52/52</td>
<td>LDL decreased by 0.53 mmol/l, systolic blood pressure by 9 mmHG, no difference in BMI</td>
<td>&lt;60 y old siblings of black patients hospitalized for CHD</td>
</tr>
<tr>
<td>Interventions on social and community networks</td>
<td>Combined</td>
<td>Iran</td>
<td>media, community, health system involvement, policy, improve health behaviors</td>
<td>312/-</td>
<td>no results</td>
<td>&gt;19 y olds with focus on groups</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Diet</td>
<td>US</td>
<td>environment modification reduction high fat choices</td>
<td>52/-</td>
<td>to increase the rate of selection of low/moderate fat entrees one have to both increase their availability and decrease the availability of high-fat entrees; the first alone is not sufficient</td>
<td>elementary school students</td>
</tr>
<tr>
<td>Intervention aimed at</td>
<td>Diet</td>
<td>US</td>
<td>environment modification</td>
<td>104/-</td>
<td>10% increase in selling of low-fat food in year 1,</td>
<td>secondary school</td>
</tr>
<tr>
<td>OECD class</td>
<td>Domain</td>
<td>Country</td>
<td>Intervention and description</td>
<td>Intervention Length / Follow-up length</td>
<td>Results</td>
<td>Target population</td>
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<tr>
<td>directly influencing lifestyle choices</td>
<td></td>
<td></td>
<td>low fat food+peer promotion</td>
<td></td>
<td>year 2: 33.6% of sale of low-fat food in intervention compared to 22.1% in control</td>
<td>students</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Physical activity</td>
<td>US</td>
<td>environment modification stairs in a bank, airport, office, university</td>
<td>26/-</td>
<td>star use increased</td>
<td>Hispanic gene pop</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Physical activity</td>
<td>US</td>
<td>environment modification stairs in a mall</td>
<td>13/0</td>
<td>star use increased overall, white more than black and older more than younger</td>
<td>&gt;18 y olds</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Physical activity</td>
<td>Australia</td>
<td>environment modification stairs in a hospital</td>
<td>4/3</td>
<td>stair used increased with the first interv then decreased during the f-up then did not significantly changed during the second interv and decreased below the baseline in the second f-up</td>
<td>hosp workers</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Physical activity</td>
<td>US</td>
<td>environment modification stairs in an airport</td>
<td>3/-</td>
<td>stair using increased</td>
<td>gen pop</td>
</tr>
<tr>
<td>Intervention aimed at directly influencing lifestyle choices</td>
<td>Combined</td>
<td>Canada</td>
<td>environment modification increase health choices at school and outside</td>
<td>47/-</td>
<td>9% decrease of low active children, 7-25% increase in steps/day</td>
<td>elementary school students</td>
</tr>
</tbody>
</table>
ANNEX 6 – LIST OF ARTICLES AND PUBLICATIONS ON THE EFFECTIVENESS OF INTERVENTIONS TO TACKLE OVERWEIGHT AND OBESITY THROUGH DIET AND PHYSICAL ACTIVITY


(2) Smith LT, Johnson DB, Beaudoin S, Monsen ER, LoGerfo JP. Qualitative assessment of participant utilization and satisfaction with the Seattle Senior Farmers' Market Nutrition Pilot Program. Prev Chronic Dis 2004; 1(1):A06. 370 Intervention on the physical environment and transport system


(11) Lassen A, Thorsen AV, Trolle E, Elsig M, Ovesen L. Successful strategies to increase the consumption of fruits and vegetables: results from the Danish '6 a day' Work-site Canteen Model Study. Public Health Nutr 2004; 7(2):263-270. 270


(43) Stevens VJ, Glasgow RE, Toobert DJ, Karanja N, Smith KS. Randomized trial of a brief dietary intervention to decrease consumption of fat and increase consumption of fruits and vegetables. Am J Health Promot 2002; 16(3):129-134. 321


(46) Kearney MH, Rosal MC, Ockene JK, Churchill LC. Influences on older women's adherence to a low fat diet in the Women's Health Initiative. Psychosomatic Medicine 2002; 64(3):450-457. 194


(49) Ritenbaugh C, Patterson RE, Chlebowski RT, Caan B, Fels-Tinker L, Howard B et al. The Women's Health Initiative dietary modification trial: Overview and baseline characteristics of participants. Annals of Epidemiology 2003; 13(9 SUPPL.):S87-S97. 197


(65) Craig CL, Tudor-Locke C, Bauman A. Twelve-month effects of Canada on the Move: a population-wide campaign to promote pedometer use and walking. Health Education Research. 2006; Epub, October 10, 2006. 45


(75) Miles A, Rapoport L, Wardle J, Afuape T, Duman M. Using the mass-media to target obesity: an analysis of the characteristics and reported behaviour change of participants in the BBC’s ‘Fighting Fat, Fighting Fit’ campaign. Health


(86) Simkin-Silverman LR, Wing RR, Boraz MA, Kuller LH. Lifestyle intervention can prevent weight gain during menopause: results from a 5-year randomized clinical trial. Ann Behav Med 2003; 26(3):212-220; 305


