Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

10-Apr-2009
_____
English - Or. English

DIRECTORATE FOR EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
HEALTH COMMITTEE

Expert group -- Economics of Prevention
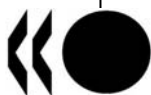
The Economics of Prevention

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
29 April 2009

For further information, please contact Mr Franco SASSI
Tel. + 33 (0)1 45 24 92 39; e-mail: franco.sassi@oecd.org

JT03262884

ABSTRACT

In an attempt to contain rising trends in obesity and associated chronic diseases, many governments have implemented a range of policies to promote healthy lifestyles. These efforts have been hindered by the limited availability of evidence about 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 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 Interventions that are Cost-Effective) approach. The aim of the analysis is to assess the efficiency of a range of policy options to tackle unhealthy lifestyles and related chronic diseases. Additionally, compared to the traditional CHOICE framework, the analysis has assessed the distributional impacts of preventive strategies on costs and health outcomes. Most of the preventive interventions evaluated as part of the project 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 significantly reduce the scale of the obesity problem, if implemented in isolation. Although the most efficient interventions are found 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 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 spend on prevention, and they may use the findings of this economic analysis to assess what portfolio of interventions would make the best use of such budgets.

TABLE OF CONTENTS

Tables

Figures

Boxes

4

SECTION I

TACKLING OBESITY: WHAT DO WE KNOW?

1.1. Introduction

1.   There is a widespread concern in OECD countries about increasingly unhealthy dietary habits and sedentary lifestyles. Concerns have been prompted by rising rates of overweight and obesity and by an increasing burden associated with chronic diseases such as diabetes. In an attempt to control these trends, governments have implemented 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. Many evaluations 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 the efficiency and distributional impact of prevention

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 few 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 (ten studies). In a further 3 studies, economic evaluations were undertaken on the basis of previous trials. Two studies were cost analyses, four 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), six 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, five 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
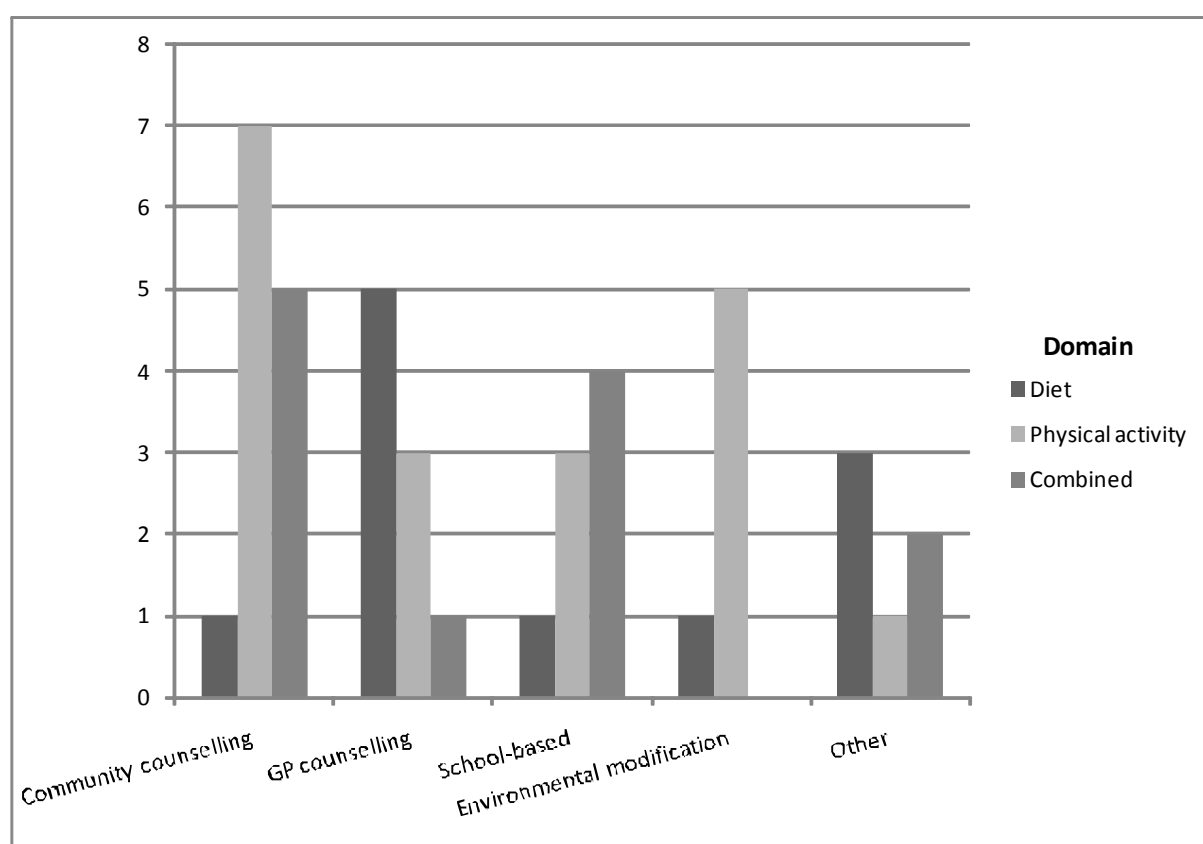
12.   A brief description of the main characteristics and outcomes of each intervention is reported in the table in Annex 1. To facilitate comparisons, all cost values were transformed in 2005 US $ using OECD purchasing power parity conversion rates. In the reminder of this section, we shall present 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 <u>counselling in the community</u> is the 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 per QALY gained varies between $15,259 and $73,227. 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 <u>counselling in general practice</u> 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. Results would suggest that, for example, decreasing the weight of a person of 1 kg would cost about 8 $ while gains both in terms of QALYs or DALYs would cost between 22,000 and 26,000 $.

19.   Compared to other categories, <u>school-based interventions</u> 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.   Six interventions labelled as <u>environmental modifications</u> targeted the environments in which people live in trying to make healthier choices simpler. Since these interventions directly modify environments they target whole communities. Five 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 (<u>other interventions</u>) 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

MODELLING THE IMPACT OF INTERVENTIONS

2.1. Introduction

34.   This section illustrates the methods and the input data used in the assessment of the efficiency and distributional impact of interventions to prevent chronic diseases linked to unhealthy diets and sedentary lifestyles. The analysis was undertaken by developing a micro-simulation model of the health outcomes arising from lifestyle risk factors typically associated with obesity. The model is described in section 2.2. and the key assumptions upon which it rests are discussed in section 2.3. Further details about the structure and characteristics of the epidemiological model are available in Annex 4. Input parameters and the costing approach are described in sections 2.4. and 2.5., while the remainder of the section is devoted to illustrating the characteristics of the preventive interventions assessed in the analysis, as well as the data sources and assumptions used in modelling the effectiveness of those interventions.

2.2. The epidemiological model

35.   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).

36.   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.

37.   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.

38.   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.

Box 1. LifeStyle model

The epidemiological model, named LifeStyle, is a stochastic microsimulation model able to simulate population dynamics. It was written in a C++ pre-compiler called ModGen (http://www.statcan.gc.ca/spsd/Modgen.htm), which is a generic "Model Generator" language created by Statistics Canada for developing and working with microsimulation models. 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.

LifeStyle was jointly developed by the OECD and the WHO as a component of "the Economics of Prevention" project. Interested researchers may apply for access to the model by contacting either Michele Cecchini (michele.cecchini@oecd.org) or Jeremy Lauer (lauerj@who.int).

2.3. Scope of the model and key assumptions

39.   The present version of LifeStyle is able to simulate the dynamics of the European population (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, United Kingdom, Slovenia, Spain, Sweden and Switzerland) and assumes as starting point the year 2000. The population is simulated accounting for its distribution by three dimensions: gender, age (0 to 100) and social class (upper and lower). With some appropriate changes in the distribution of these dimensions and in the epidemiology of risk factors as well as of considered diseases, LifeStyle can be adapted to simulate any specific country or, with some caveats, even other sets of conditions. Analyses presented in the reminder of this paper were calculated by assuming the following:

- A time perspective of 100 years to allow any intervention to get to the steady state and fully show its potential effectiveness.

- A 50% decline in the effectiveness of all interventions starting from the first year after the end of the intervention.

- In line with most current practice in cost-effectiveness analysis, we discounted both future costs and effects at 3%.

- The impact on disability and premature death for the considered diseases is expressed in disability-adjusted life years (DALYs). Age weighting is not used.

- The impact of interventions in terms of health expenditure only accounts for the diseases and the risk factors explicitly included in the model, that is: hypertension, hypercholesterolemia, diabetes, cancer, ischemic heart diseases and stroke.

2.4. 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 status (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 (RRs). The first three reflect the epidemiology of the population as a whole. For example, the incidence of pre-obesity indentifies the fraction of the overall population becoming pre-obese in a given period of time. RRs, instead, reflect either the probability of an individual to fall in one category 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.

42. The last group details the parameters 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 in burden of disease calculations allows to estimate how diseases affect life 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 were 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 disease-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.

		Parameters	References
Diseases	Ischemic heart disease	Prevalence	Lopez *et al.*, 2006
		Incidence hazard	Lopez *et al.*, 2006
		RR of incidence relative to high blood pressure	Lim *et al.*, 2007
		RR of incidence relative to high cholesterol	Lim *et al.*, 2007
		RR of incidence relative to diabetes	van Baal *et al.*, 2008
		RR of incidence relative to obesity	van Baal *et al.*, 2008
		RR of incidence relative to SES	Forssas *et al.*, 2008; Salomaa et al., 2000
		RR of fatality relative to high blood pressure	Hu *et al.*, 2005b; Stevens *et al.*, 2004; Hart *et al.*, 1999
		RR of fatality relative to high cholesterol	Hart *et al.*, 1999; Boshuizen *et al.*, 2007
		RR of fatality relative to diabetes	Hu *et al.*, 2005a; Hu *et al.*, 2006; Hu *et al.*, 2005b; Hart *et al.*, 1999
		RR of fatality relative to obesity	Batty *et al.*, 2006; Pardo Silva *et al.*, 2006
		RR of mortality relative to SES	Haan *et al.*, 1987; Logue *et al.*, 1990; Kaplan *et al.*, 1993
	Stroke	Prevalence	Lopez *et al.*, 2006
		Incidence hazard	Lopez *et al.*, 2006
		RR of incidence relative to high blood pressure	Lim *et al.*, 2007
		RR of incidence relative to high cholesterol	Lim *et al.*, 2007
		RR of incidence relative to diabetes	Lim *et al.*, 2007
		RR of incidence relative to obesity	van Baal *et al.*, 2008
		RR of incidence relative to SES	Hart *et al.*, 2000; Kuper *et al.*, 2007
		RR of fatality relative to high blood pressure	Stevens *et al.*, 2004; Boshuizen *et al.*, 2007; Menotti *et al.*, 2003
		RR of fatality relative to high cholesterol	Boshuizen *et al.*, 2007; Menotti *et al.*, 2003
		RR of fatality relative to diabetes	Hu *et al.*, 2005a; Wannamethee *et al.*, 2004
		RR of fatality relative to obesity	Batty *et al.*, 2006; Pardo Silva *et al.*, 2006
		RR of mortality relative to SES	Arrich *et al.*, 2005; Jakovljević *et al.*, 2001
	Cancer	Incidence hazard	Parkin *et al.*, 2005
		Mortality	IARC/WHO, 2008
		RR of incidence relative to fibre consumption	Lock K *et al.*, 2005
		RR of incidence relative to obesity	van Baal *et al.*, 2008
		RR of incidence relative to SES	van Loon *et al.*, 1995
		RR of fatality relative to fibre consumption	Skuladottir *et al.*, 2006; Pierce *et al.*, 2007; Jansen *et al.*, 1999
		RR of fatality relative to obesity	Calle *et al.*, 2003
		RR of mortality relative to SES	van Loon *et al.*, 1995
proximal risk factors	Cholesterol	prevalence	Lawes *et al.*, 2004b
		mortality	Stamler *et al.*, 2000

15

		Parameters	References
intermediate risk factor	Systolic pressure	RR of high cholesterol relative to obesity	based on Health Survey for England
		prevalence	Lawes *et al.*, 2004a
		mortality	Lawes *et al.*, 2004a
		RR of high systolic blood pressure relative to obesity	based on Health Survey for England
	Diabetes	prevalence	Wild *et al.*, 2004
		mortality	Lopez *et al.*, 2006
		RR of diabetes relative to obesity	van Baal et al., 2008
	Body mass index	prevalence	James *et al.*, 2004
		mortality	Flegal *et al.*, 2005; Ringback, Weitoft *et al.*, 2008
		RR of obesity relative to fat diet	based on the National Health And Nutrition Examination Survey
		RR of obesity relative to physical activity	based on the National Health And Nutrition Examination Survey
		RR of obesity relative to fibre consumption	based on the National Health And Nutrition Examination Survey
distal risk factors	Fat diet	prevalence	FAOSTAT, 2008 and National Health And Nutrition Examination Survey
		RR of fat diet relative to social class	based on the National Health And Nutrition Examination Survey
	Fibre cons	prevalence	Lock *et al.*, 2004
		RR of fibre consumption relative to social class	based on the National Health And Nutrition Examination Survey
	Phys activ	prevalence	Special Eurobarometer 183-6/Wave 58.2
		RR of physical activity relative to social class	based on the National Health And Nutrition Examination Survey
Population, fertility, mortality		starting population distribution	WHO-CHOICE, 2008
		distribution by SES	national health survey datasets
		proportion of newborn males	WHO-CHOICE, 2008
		total mortality	WHO-CHOICE 2008
		RR of mortality relative to SES	Mackenbach *et al.*, 1997
		factors for disability-adjusted life years	Lopez *et al.*, 2006

2.5. 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 (GCEA) 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 across countries, although international comparisons found similar cost-of-illness patterns in several OECD countries (Heijink *et al.*, 2004). As a result, cross country regressions, mainly accounting for country GDP and local characteristics of the supply of health care, 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.

2.6. 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 degree of inaccuracy, they offer the advantage of allowing cross-country comparison. Costs are expressed in 2000 $ Purchasing Power Parities.

2.6.1 Review of the evidence on the effectiveness of interventions

53. A broad review of the existing evidence concerning the effectiveness of interventions to prevent chronic diseases linked to unhealthy diets and sedentary lifestyles was undertaken. This provided a sound basis for determining the characteristics and the likely effects of a range of preventive interventions which were assessed in the analysis. The review revealed that a significant number of studies are available in one area, namely school-based interventions, while substantially smaller bodies of evidence may be gathered on the effectiveness of a range of interventions in other areas, such as worksite interventions, interventions in the health care sector, interventions on the physical environment and transport system, interventions on the broader social and economic environment, etc. The detailed results of the review of existing evidence of the effectiveness of interventions is reported in Annex 5.

2.6.2 Modelled interventions

54. The main characteristics 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.

2.6.2.1 Counselling of at-risk individuals in primary care.

55. 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

	School-based Intervention	Worksite intervention	Mass media Campaign	Fiscal measures	Physician counselling	Physician/ dietician counselling	Food advertising regulation	Self-reg. food advertising
Target								
Age range	8-9	18-65	18+	0+	22-65		2-18	
Restrictions	only school-children	large employers	none	none	BMI≥25or high chol/blood pressure or diabetes		None	
Target as % of the population	2.3%	5.8%	79.4%	100%	7.22%		19.7%	
% Pop. affected at steady-state	91.3%	7.2%	79.4%	100%	9.71%		97.9%	
Effectiveness								
Fruit/vegetables (g/day)	+ 37.6	+ 45.6	+ 18.4	+ 8.6	-	-	-	-
Fat (% of total energy from fat)	- 1.64	- 2.2	-	- 0.77	- 1.6	-9.8	-	-
Physical activity (% of active)	-	+ 11.9	+ 2.4	-	-	-	-	-
BMI (kg/m^2)	-	-	-	-	- 0.83	-2.32	- 0.1 to -0.35	- 0.05 to -0.018
Cholesterol (mmol/l)	-	-	-	-	-0.12	-0.55	-	-
Systolic blood press. (mmHg)	-	-	-	-	- 2.3	-12	-	-
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

56.   Characteristics of the modelled intervention. 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 case (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.

57.   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.

58.   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.

59.   Effects of the intervention. 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.

60.   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.

2.6.2.2 Mass media campaigns.

61.   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.

62.   Characteristics of the modelled intervention. 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.

63.   Effects of the intervention. 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.

64.   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.

2.6.2.3 School-based interventions.

65.   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.

66.   Characteristics of the modelled intervention. 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.

67.   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.

68.   Effects of the intervention. 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.

69.   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.

2.6.2.4 Worksite interventions.

70.   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.

71.   Characteristics of the modelled intervention. 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.

72.   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.

73.   Effects of the intervention. 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.

74.   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.

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

75.   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.

76.   Characteristics of the modelled intervention. 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.

77.   Effects of the intervention. 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.

78.   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.

2.6.2.6 Restrictions on food advertising.

79.   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.

80.   Characteristics of the modelled intervention. 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.

81.   Effects of the intervention. 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.

82.   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.

2.7. Sensitivity analysis

83.   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.

84. 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 1,500 real individuals, for a total of 10 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. Introduction

85.　　Using the methods and data illustrated in Section II, the Lifestyle model was first run to compute the health outcomes associated with a baseline scenario reflecting the epidemiology of the relevant risk factors and chronic diseases in the absence of preventive interventions. Intervention scenarios were then developed, whose health outcomes were compared to those of the baseline scenario. The results of such comparisons are reported in this section in terms of effects on health and longevity (3.1.); intervention costs and effects on health care costs (3.2.); and cost-effectiveness (3.3.). Selected results from a range of sensitivity analyses carried out to assess the robustness of model estimates are reported in section 3.4., while the distributional impact of preventive interventions is discussed in section 3.5.

3.2. The effects of preventive interventions on health and longevity

3.2.1 Effects on obesity

86.　　Most interventions were shown to have only a limited impact on the overall scale of the obesity problem. Figure 2 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.

87.　　The largest results are achieved by intensive primary care counselling (*i.e.* physician/dietician counselling). 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 as people get older.

Figure 2. Decrease in obesity rates for 25 and 65 year olds and whole population
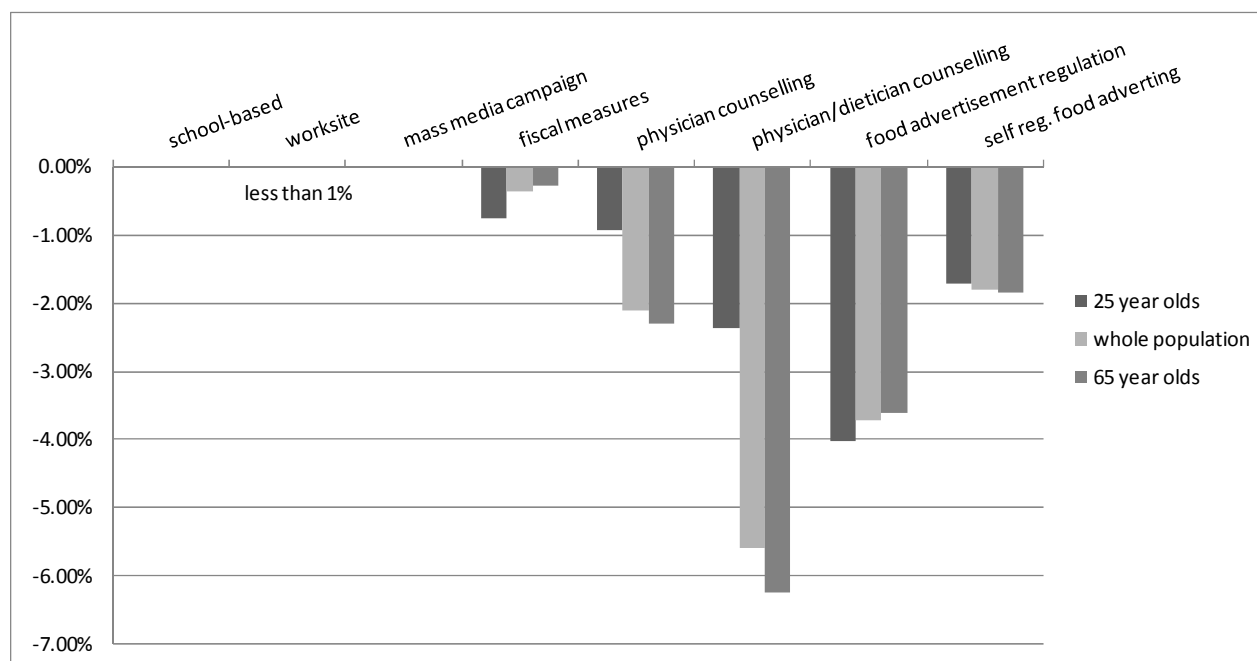
3.2.2 Incidence of chronic diseases

88.   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 3 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 whom the probability of developing a disease is naturally very low.

89.   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. School-based intervention has the highest global effect by decreasing cancer of up to 1.54 % (about 3.2 cases every 100,000 individuals).

Figure 3. Decrease in disease incidence at the population level
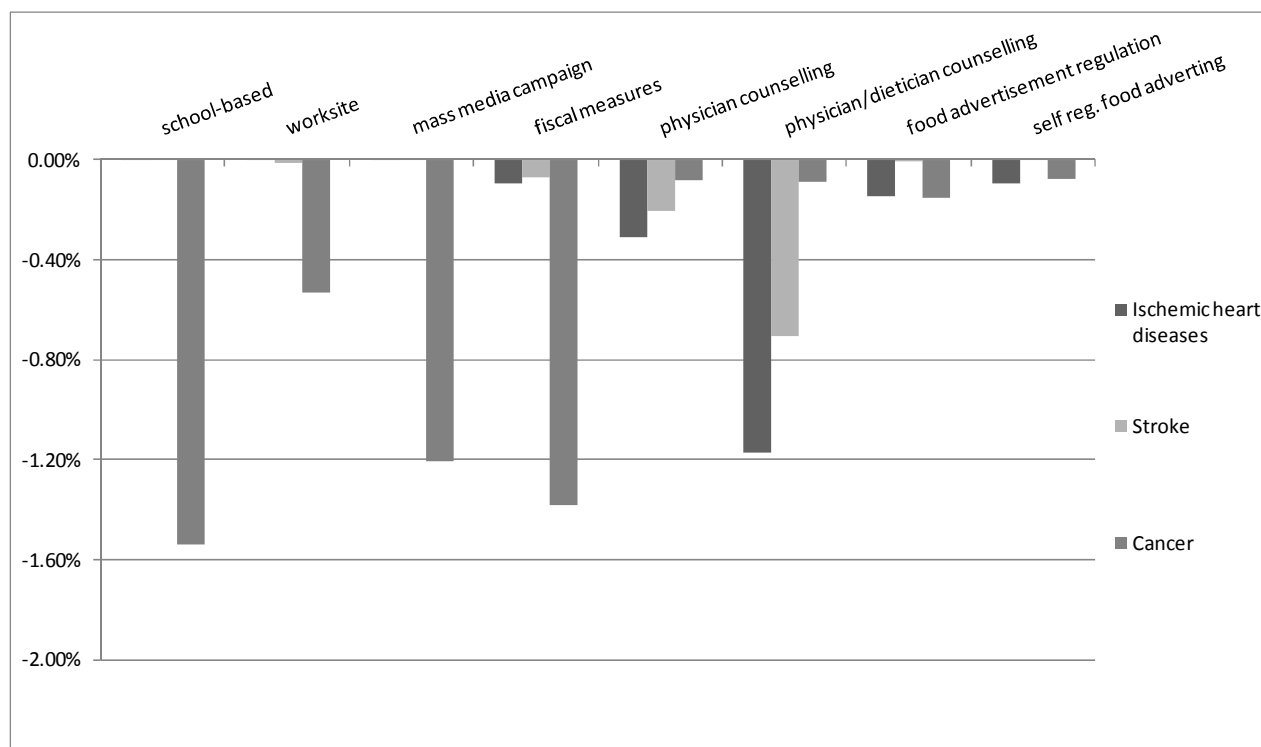
3.2.3 Life years and disability-adjusted life years

90.   Figure 4 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 food advertising, both self-regulated and enforced, for which the gain in disability-adjusted life years is lower than 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.

91.   Intensive primary care counselling is the intervention providing the highest gain both in terms of disability-adjusted life years and life years. Globally, it increases 1 year of life every 19 individuals and 1 year of disability-adjusted life every 14 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 214/507 individuals. While all other programmes present a linear increase in their effectiveness on health outcome, physician/dietician counselling 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 4. Health outcomes at the population level
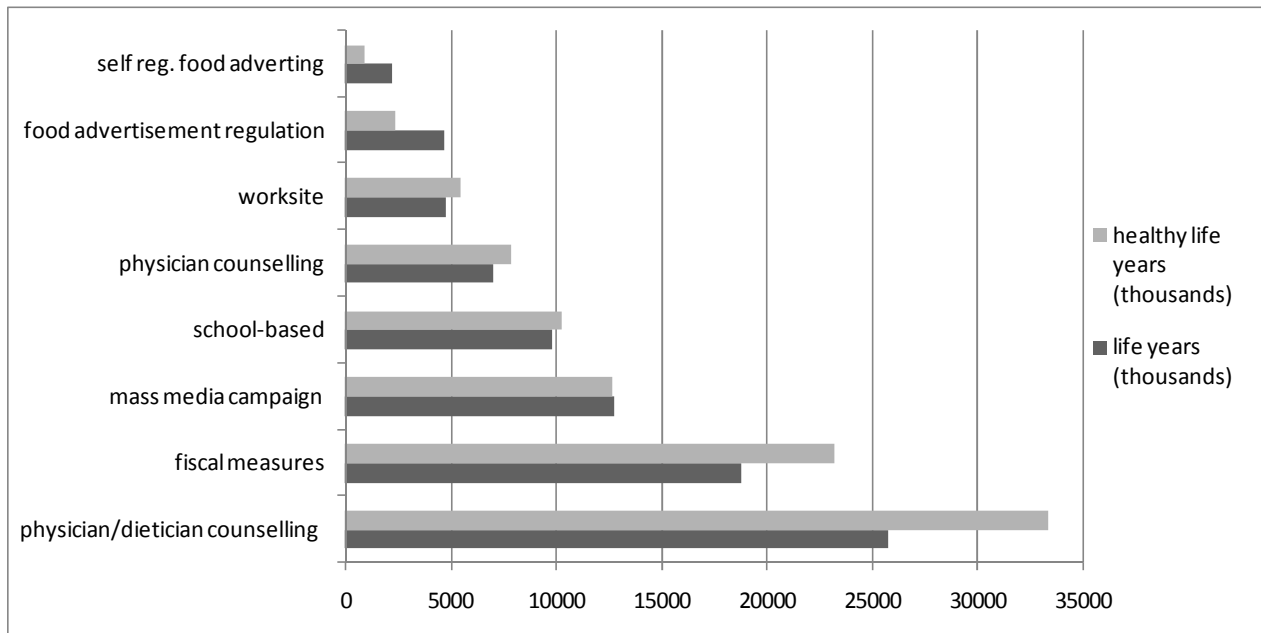
92.   Figure 5 reports the gain in life years and disease adjusted life years by class of age. As expected, interventions show to have almost no effect on people less than 40 year old. Our model incorporates chronic diseases typically affecting middle-aged or old-aged individuals, therefore even if interventions 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.

93.   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 5. Health outcomes of the interventions by age group

School-based

Worksite

Mass media

Fiscal

Primary care

Primary care (intensive)

Food advertising restrictions (enforced)

Food advertising restrictions (self regulated)
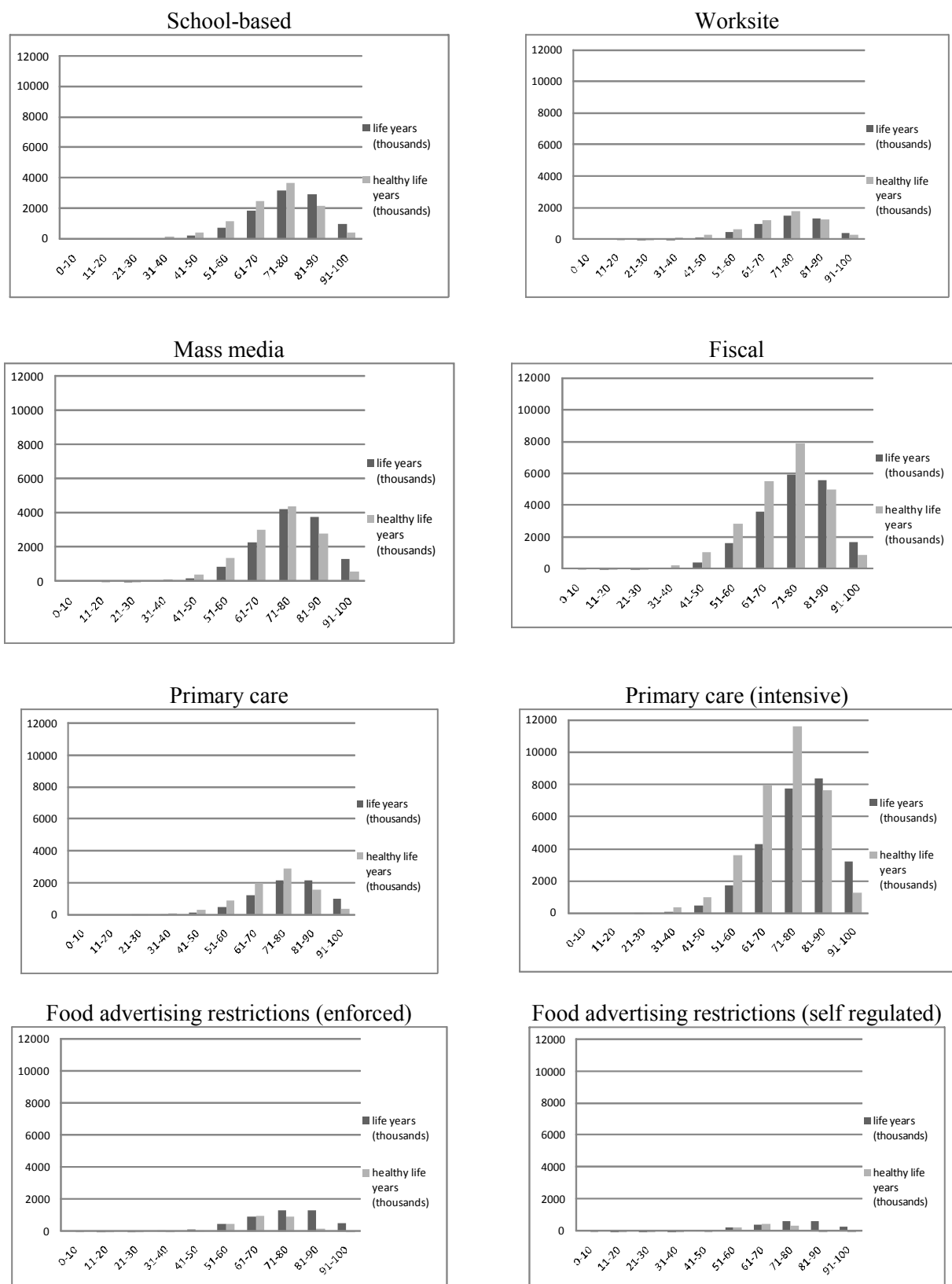
94.	Not all the interventions achieve the steady state at the same time. For example, school-based intervention exclusively targets 8 and 9 year olds. This means that during the first year, only individuals aged 8 and 9 benefit from it while people aged 10 and over show no modification in their behaviours. During the second year, the intervention covers three cohorts: people aged 8 (that in year 1 were 7 year old) and 9 (aged 8 in year 1) take full advantage of it while individuals aged 9 in year 1, and that are now 10, still benefit of the intervention but only at 50%. 91 years after the intervention was first implemented, the cohort of individuals aged 9 in year 1 becomes 100 year old and the intervention shows effects on the whole population. On the contrary, other interventions such as fiscal measures directly target the whole population (0 to 100 year olds) 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 co 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**

Intervention	Average effect (life yrs. per million population)	Coverage	Total effect (life years)	Years to steady state
School-based	535	91.3%	182,407	91
Worksite	2188	7.2%	58,781	35
Mass media	436	79.4%	129,071	1
Primary care	2658	9.7%	96,313	35
Primary care (intense)	11217	9.7%	406,708	35
Enforced food advert restriction	219	97.9%	80,047	82
Self-regulation of food advertising	44	97.9%	16,002	82
Fiscal measures	510	100.0%	190,358	1

95.	Figure 6 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.

96.	Intensive primary care counselling becomes the most effective intervention only starting from the seventeenth year with fiscal measures and mass media campaign having the best performances in the short term. School-based becomes the third most effective intervention after about 70 years 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 out of the eight interventions). Starting from year 50, mass media campaigns and dietician counselling have almost the same annual effect; however the second needs a lot of time to reach the same level. After year 60 enforced

food advertising restrictions become more effective than worksite interventions. Self-regulated advertising restriction is the least effective intervention throughout the whole period.

Figure 6. Disability-adjusted life years gained (thousands) over time
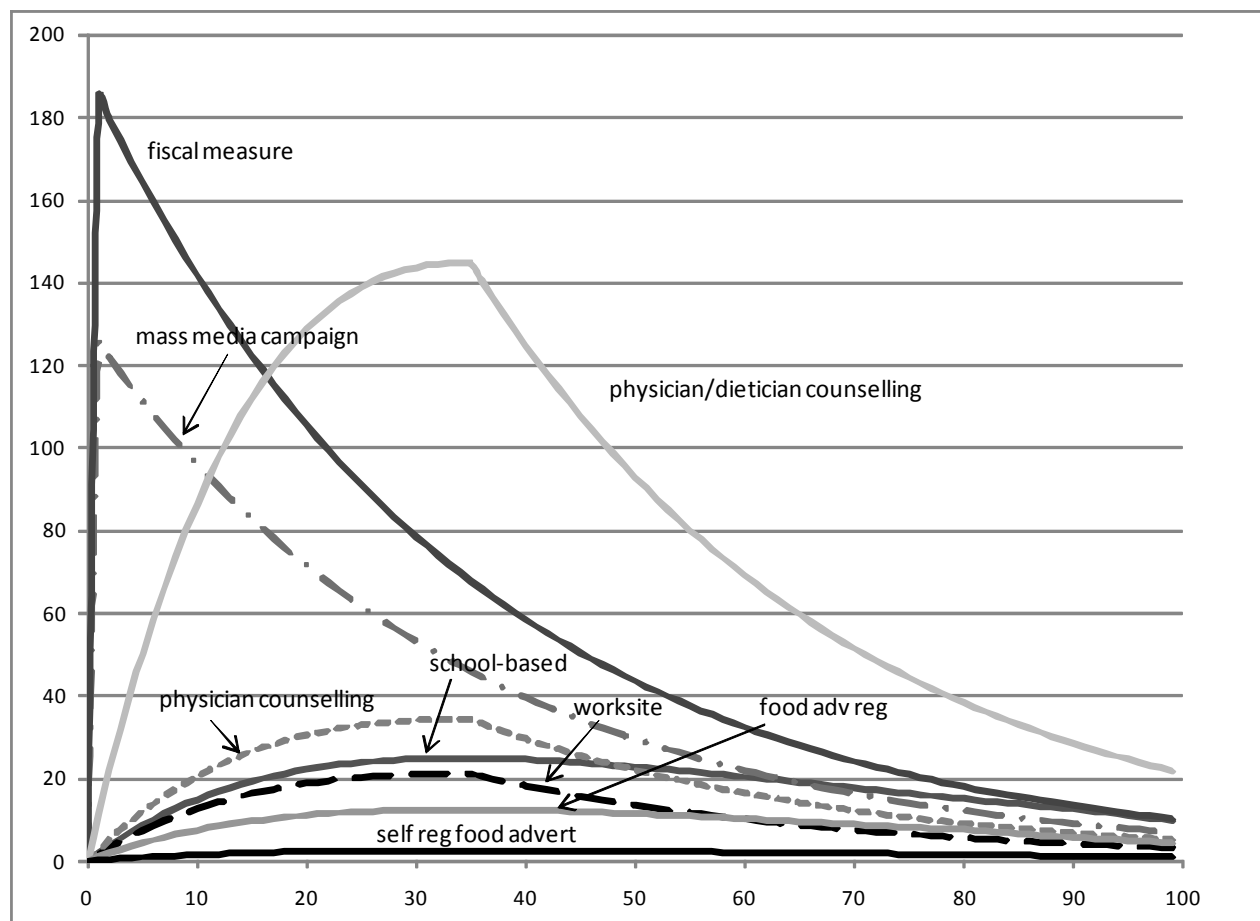
3.3. Total costs

97.   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.

98.   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, as discussed in Section II, for practical reasons all analyses so far were undertaken at the regional level, with reference to a European region broadly reflecting the EUR-A WHO region, and the costs calculated reflect average conditions across the countries that make up that region.

99.   Figure 7 describes the total economic assessment of the interventions. The panel on the left reports the total cost for implementing each intervention for 100 years, while the figure on the right shows the impact on the total health expenditure for the conditions explicitly included in the model (diseases, diabetes, high blood pressure, high cholesterol) due to the interventions. A more detailed breakdown of this, by class of age, can be found in figure 9. Cost reported in figure 8 are expressed in hundreds of millions, 2000 $ Purchasing Power Parity.

100.   Physician/dietician counselling is the most expensive intervention with an expected cost of about 540 billion $ in 100 years, while self-regulated advertisement restriction is the least expensive intervention, costing about 3.7 billion $ in 100 years. The only cost-saving intervention is fiscal measures with estimated savings of about 4.6 billion $.

Figure 7. Total costs and impact on health expenditure* of preventive interventions (hundreds of millions $PPP)

Total costs of preventions   Impact on health expenditure*
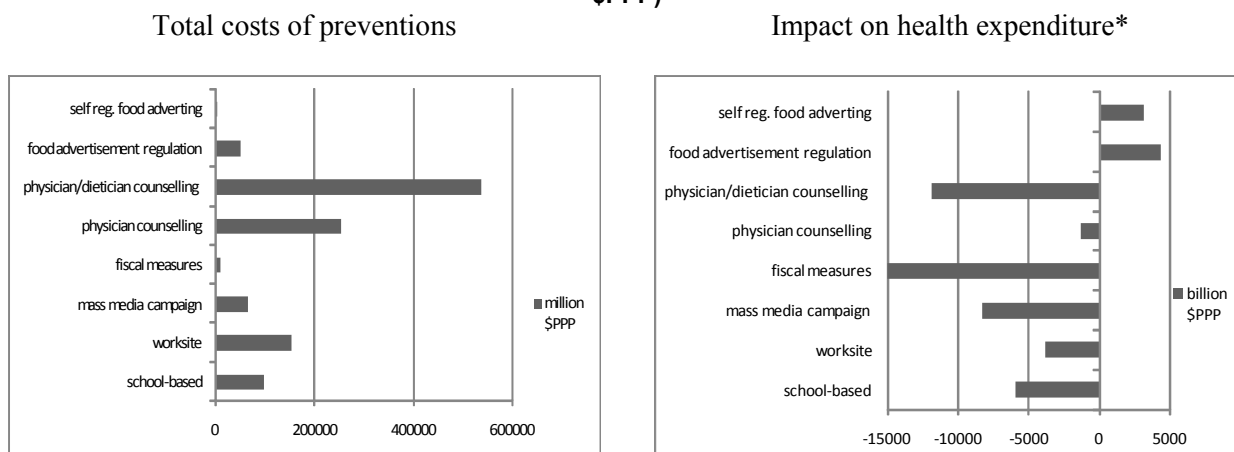
*limited to expenditures for the treatment of diseases included in the model

101.   Figure 8 shows the potential savings due to the interventions in 100 years. Figure 8 can be directly compared with Figure 7 by considering that the sum of all age groups is equal to the result depicted in the right panel of Figure 7. In general, interventions are cost-saving in most age groups but become consistently 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. It is important to emphasise that the costs illustrated in Figure 8 reflect health care resources devoted to the treatment of the diseases and risk factors explicitly included in the model. If a broader definition of health care costs had been assumed, encompassing the treatment of all diseases, it is plausible that overall cost-savings would have been smaller.

Figure 8. Effects of interventions on health care costs by age group

School-based
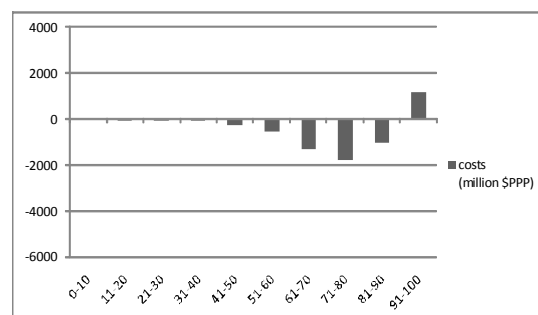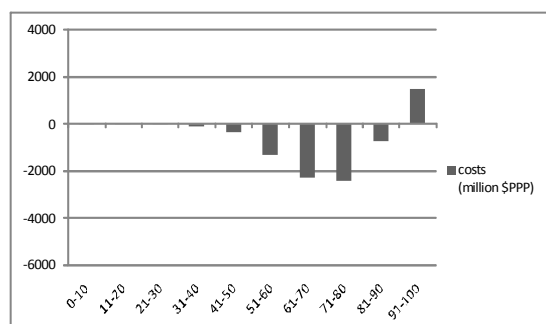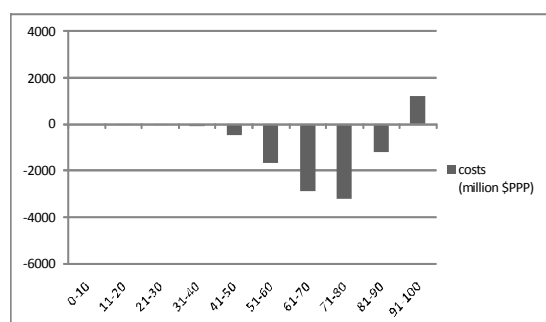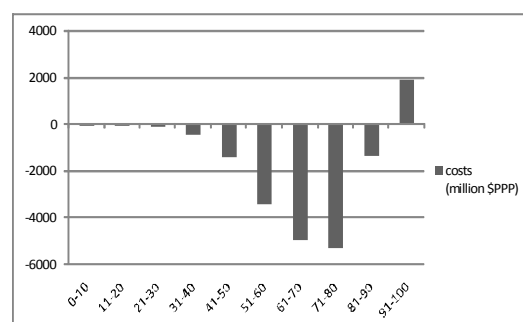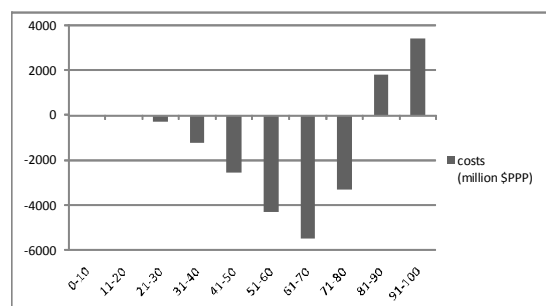
Worksite

Mass media

Fiscal

Primary care

Primary care (intensive)
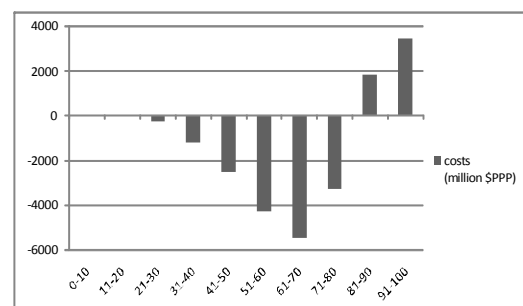
Food advertising restrictions (enforced)
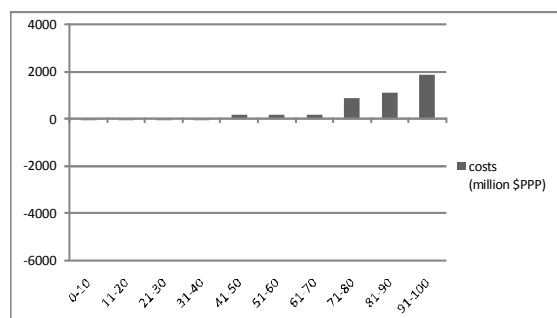
Food advertising restrictions (self regulated)
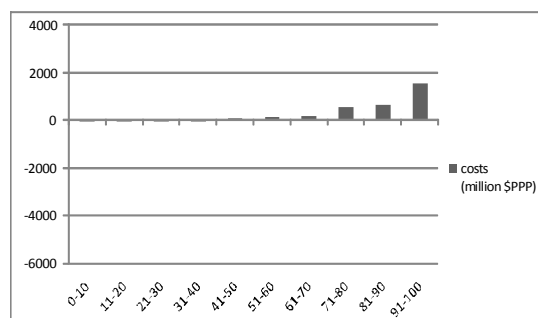
3.4. Cost-effectiveness

102.   Figure 9 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. Self-regulation of food advertisement, fiscal measures and mass media campaigns appear to have very favourable cost-effectiveness ratio from the beginning of their implementation. In fact, these three interventions are characterized by a relatively small cost of implementation, less than 0.3 $ per capita in case of the first two), combined with effects influencing a large share of the population. A second group of interventions: school-based, physician/dietician counselling and enforced food advertisement regulation, meets a threshold of 50.000 $ after 40 years from the actual enforcement of the intervention. The last two interventions: worksite and physician counselling need more than 90 years to meet the same threshold.

Figure 9. Cost-effectiveness of interventions over time ($PPP per DALY)
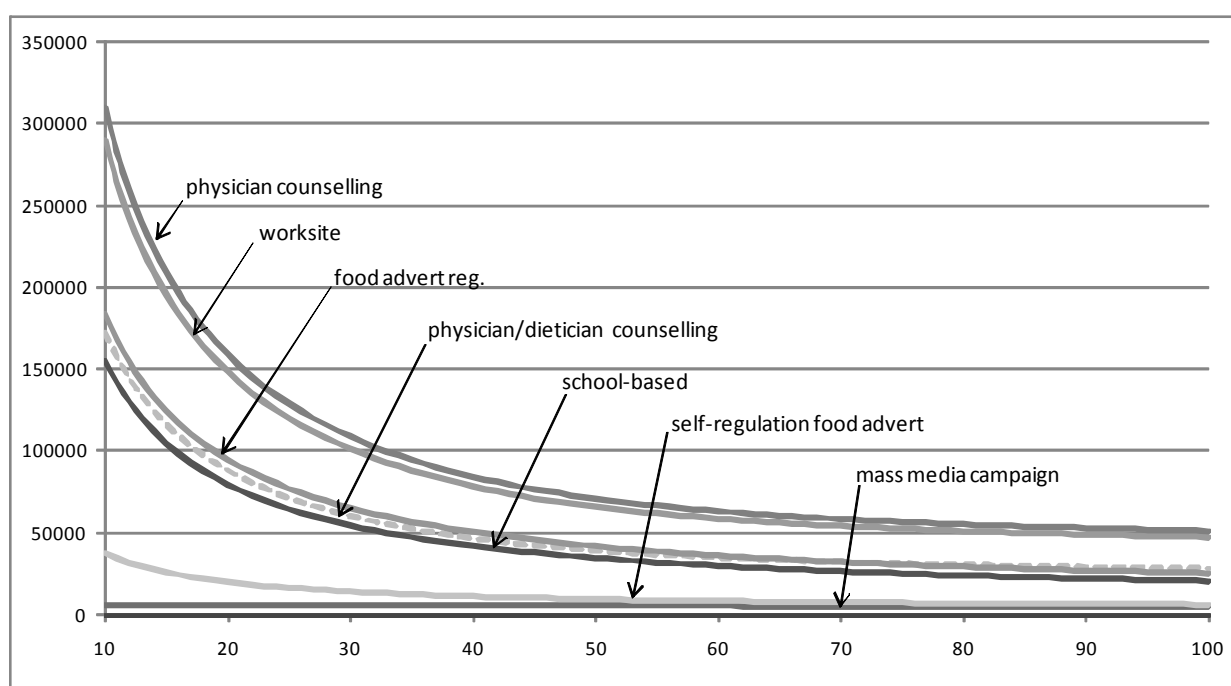
103.   In the first 20-30 years of their implementation cost-effectiveness ratios tend to be extremely high. In general, the scale of the impact of individual interventions is limited by the difficulties involved in reaching a large proportion of the national population, either because only certain age 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.

104.   Figure 10 shows the incremental cost-effectiveness ratio (ICER) per disability adjusted life year once that every intervention reaches the steady state (*i.e.* the intervention affects the maximum possible share of the population). Most of the interventions fall under the category 0 to 35.000 $ with only two interventions, namely physician counselling and worksite intervention, presenting a cost-effectiveness ratio of about 50.000 $ per disability-adjusted life year. Because of the very low costs of implementation, fiscal measures appear to be cost saving.

Figure 10. Incremental cost-effectiveness of interventions at steady state
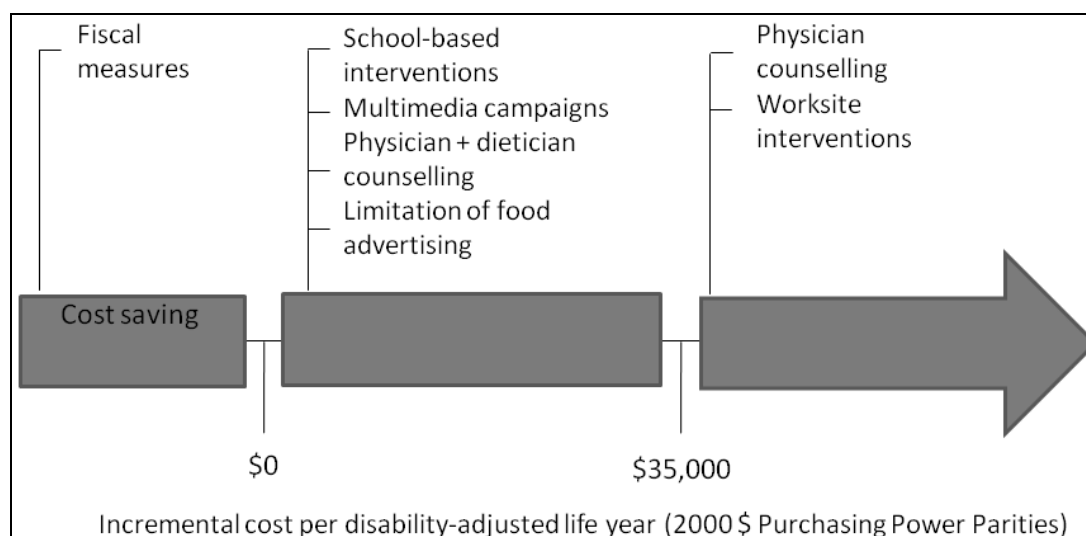
3.5. Sensitivity analysis

105.   Existing evidence suggests that the effectiveness of preventive interventions may vary significantly depending on the settings in which interventions are implemented and on the ways in which they are implemented. Therefore, as part of the sensitivity analysis, we tested the impact of possible variations in the effectiveness of the modelled interventions by first assuming a 30% increase in the effectiveness and coverage of the interventions and then assuming a decrease of the same amount. Columns in Figure 11 represent the effects on health outcomes and health expenditure of the average intervention while the error bars show the results due to the increased/decreased effectiveness. In general, a 30% variation in effectiveness would produce remarkable effects on both health outcomes and health expenditure.

Figure 11. Sensitivity analysis of health outcomes and impact on health expenditure for selected interventions
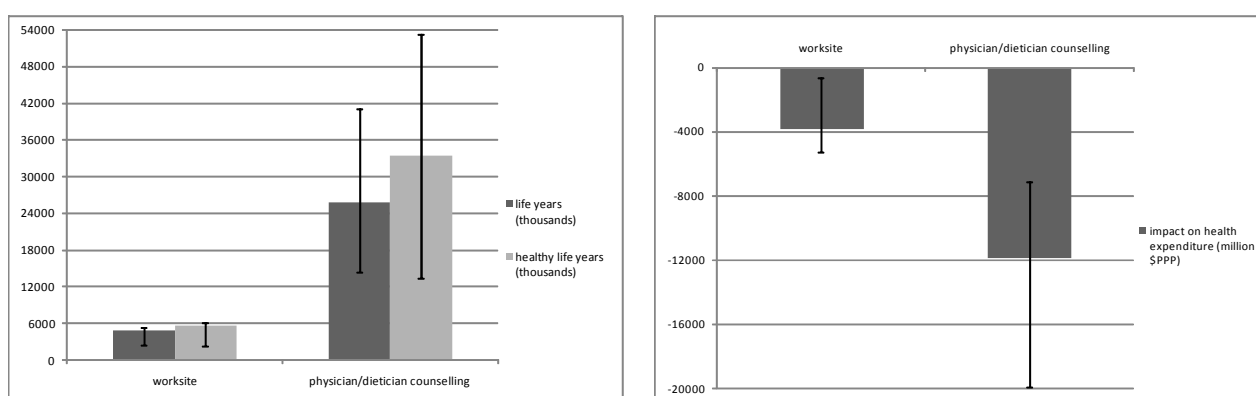
Note: impact on health expenditure is limited to costs for the treatment of diseases explicitly included in the model

106.   Figure 12 reports the results of the sensitivity analysis on cost-effectiveness ratios of a selection of two interventions (intensive counselling in primary care and worksite intervention). The cost-effectiveness ratio of the intervention originally modelled in the analysis is depicted by the solid line, whereas the extreme-value interventions (± 30% of effectiveness) are illustrated by the dashed lines. While

the two interventions had markedly different cost-effectiveness profiles in the original analysis, the picture is less clear after the introduction of the extreme-value bounds. For example, the lower effectiveness bound of the physician/dietician counselling intervention generates a worse cost-effectiveness profile than the original worksite intervention.

Figure 12. Sensitivity analysis: cost-effectiveness of interventions over time ($PPP per DALY)
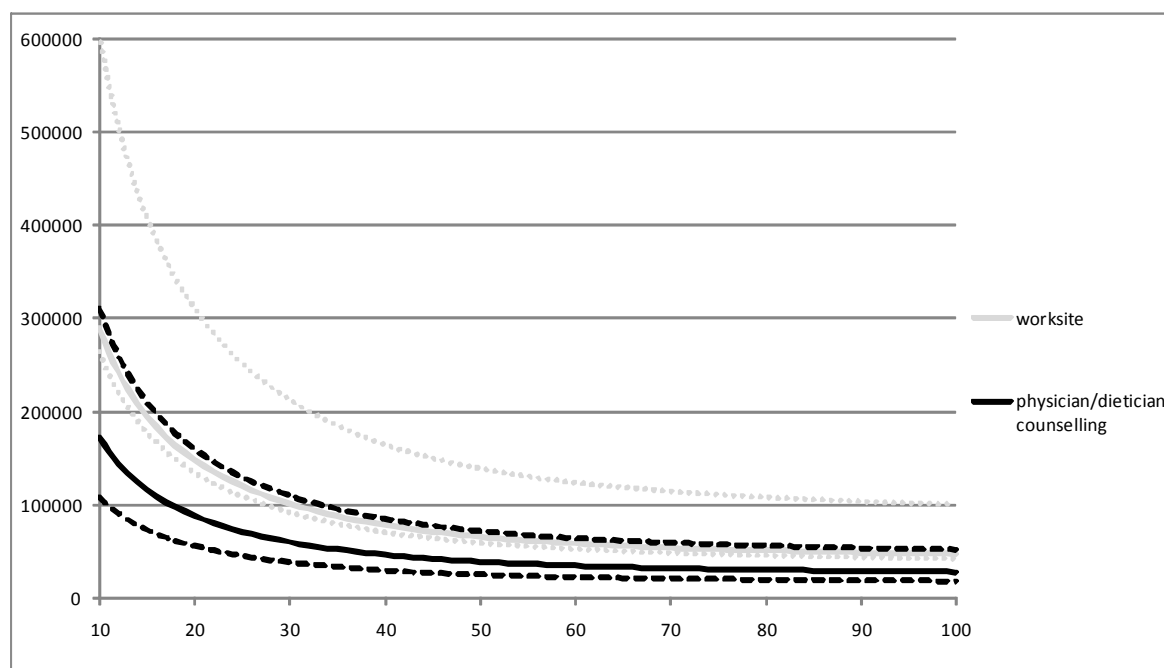
3.6. Distributional impact

107.   Interventions appear to have larger health effects on those in poorer socio-economic circumstances than on their better-off counterparts. This is well illustrated in Figure 13, which depicts the gain in life years produced by fiscal measures and physician/dietician counselling in primary care for different socio economic groups and by class of age. It shows that gains are proportionally larger for all socio-economic groups in older ages and that, in all age groups but one, the less well-off gain proportionally larger numbers of life-years than their better-off counterparts. However, it should be noted that the health outcomes presented in this paper are based on the assumption that the effectiveness and the coverage of interventions is the same across population groups, which may slightly misrepresent the real responsiveness of low-income or high-income groups to some interventions. For instance, in the case of fiscal measures, there is at least some evidence that the two socio-economic groups may have a different reaction to changes in the prices of fruit and vegetables.

Figure 13. Life-year gain for different socio-economic groups

Fiscal measures

Physician and dietician counselling
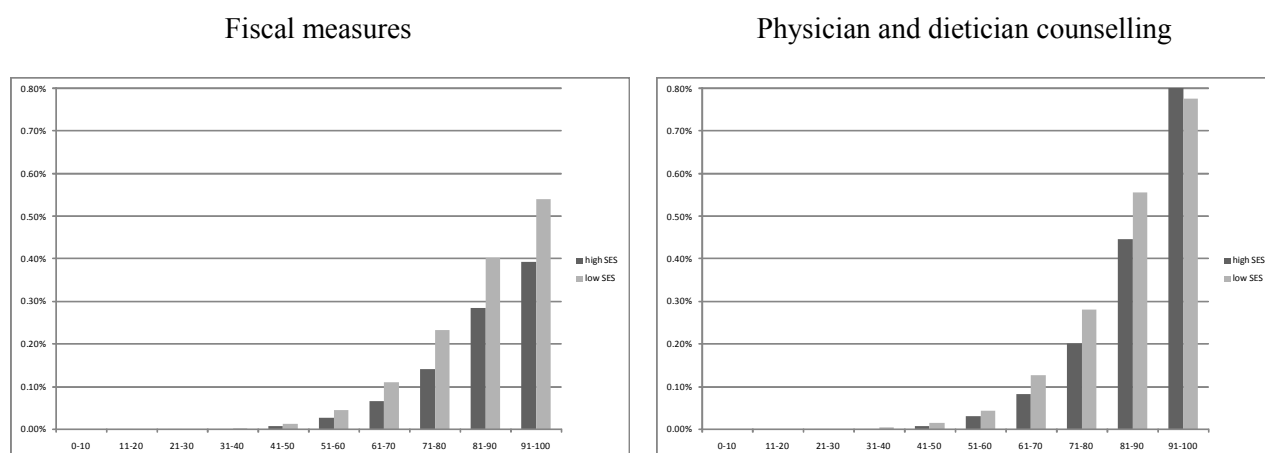
108.   Figure 14 illustrates the effect of interventions on overall inequalities in life expectancy and disability-adjusted life expectancy, measured by the Gini coefficient for life years and healthy life years. All the interventions have a favourable, albeit small, effect on health equity. The figures should be read in the following way: the horizontal axis represents the Gini coefficient for the baseline scenario (*i.e.* no intervention). This means that the Gini coefficient for life years is 0.10222, whereas the one for disability-adjusted life years is 0.10494. The columns show how much each intervention reduces the Gini coefficient. Physician/dietician counselling has the largest effect both when considering life years and healthy life years while, on the contrary, self-regulation of food advertisement produce the lowest decrease of health inequality.

Figure 14. Decrease in the Gini coefficient for life years and disability-adjusted life years due to interventions

Life years

Disability-adjusted life years
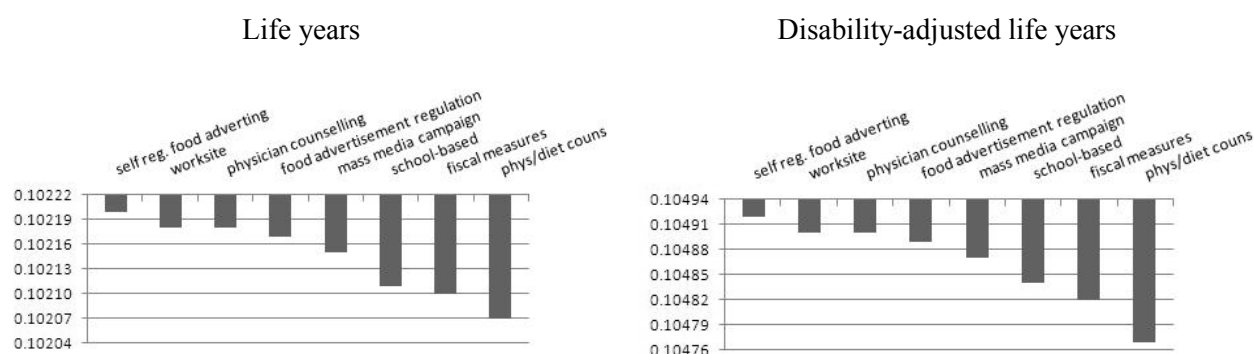
SECTION IV

CONCLUSIONS

109.   Most OECD governments have undertaken actions to curb the recent rise in obesity and related chronic diseases. However, there is only limited evidence concerning the effectiveness and efficiency of doing so. The OECD joined forces with the WHO in an effort to generate new evidence on the efficiency and distributional impact of a range of interventions aimed at preventing chronic diseases linked to unhealthy diets and sedentary lifestyles. A micro-simulation modelling approach was adopted in the analysis, based on the best existing evidence of the epidemiology of the relevant risk factors and chronic diseases, and of the effectiveness of possible actions to modify those risk factors.

110.   The evidence base concerning the efficiency (cost-effectiveness) of interventions to improve diet and increase physical activity prior to this analysis was limited to a relatively small number of studies based on highly heterogeneous methodological approaches and outcome measures. This small body of evidence appears to indicate that interventions in at least four areas may present favourable cost effectiveness ratios: counselling of individuals at risk in a primary care setting; community-based counselling; school-based interventions; interventions on the physical environment.

111.   A modelling approach provides the most reliable means of assessing health interventions that do not lend themselves to testing within experimental settings. However, the advantages offered by a micro-simulation model are inevitably associated with certain limitations, chiefly the need to combine input data from heterogeneous sources and the need to translate all relationships among risk factors, diseases and health outcomes into a mathematical form, with obvious simplifications. Further simplifying assumptions were required due to the nature of the input data available. In particular, the effectiveness of the interventions evaluated had to be assumed constant across individuals of different age, gender, and socio-economic condition. Due to the absence of long-term follow-up data, critical assumptions also had to be made concerning behaviour changes following the completion of interventions.

112.   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 provide the means for a significant reduction of the scale of the obesity problem, if implemented in isolation.

113.   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 their effects 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.

114.   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.

115.   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.

116.   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.

117.   The distributional impact of preventive interventions appears generally favourable, with improvements both in overall inequalities in age at death and in inequalities in life expectancy and healthy life expectancy between socio-economic groups. However, inequalities in age at death appear to be reduced only to a small extent, whereas the extent to which inequalities between socio-economic groups may be reduced depends crucially on possible differences in the effectiveness of interventions between the relevant groups. When equal effectiveness is assumed, interventions generate a greater equality of health outcomes between socio-economic groups, but such assumptions may not always be sound.

ANNEX 1 – EVIDENCE OF THE COST-EFFECTIVENESS OF INTERVENTIONS

REF	Year of publication	Classification	Domain	Country	Intervention and description	Comparator	Interv/ f-up length	Results	Target population
1	2001	Community Counseling	Diet	AU	Interactive computer-based telecommunication system	do nothing	26/26	1464 $ for one serve of fruit/veg	Members of a multisite, multispecialty practice
2	1998	Community Counseling	Physical activity	GB	10 week program	do nothing	10/34	3268$ to move one person to recommended PA level	45-74 y olds inactive people
3	2000	Community Counseling	Physical activity	US	Small group meetings	month free gym membership	26/104	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	35-60 y olds & 140% body weight & low expenditure value
23	2008	community counseling	physical activity	US	promotion of walking using media	do nothing	life/life	ICER 15259 $/QALY	25-64 in good health
23	2008	community counseling	physical activity	US	training sessions and phone calls to increase walking	do nothing	life/life	ICER 29238 $/QALY	25-64 in good health
23	2008	community counseling	physical activity	US	personal trainers and counseling sessions	do nothing	life/life	ICER 31786 $/QALY	25-64 in good health
23	2008	community counseling	physical activity	US	newsletter and group activities	do nothing	life/life	ICER 42394 $/QALY	25-64 in good health

REF	Year of publication	Classification	Domain	Country	Intervention and description	Comparator	Interv/ f-up length	Results	Target population
23	2008	community counseling	physical activity	US	health education through media	do nothing	life/life	ICER 73227 $/QALY	25-64 in good health
23	2008	community counseling	combined	US	group/individual sessions, written material	do nothing	life/life	ICER 50110 $/QALY	25-64 in good health
4-5	2006	Community Counseling	Combined	AU	Family-based therapy sessions and follow-up	Current practice	69/life	ICER 2754 $/DALY	families with overweight children
4-5	2006	Community Counseling	Combined	AU	After-school meetings and exercise sessions	Current practice	32/life	ICER 61985 $/DALY to current practice	Children in school
6	2004	Community Counseling	Combined	AU	Newsletter, newsletter & small groups	do nothing	16/52	BMI increased, 3586 $/fruit/veg serving increased at 52 wks	cohabiting couples
7	2001	Community Counseling	Combined	US	Group and individualized treatment	Group treatment	20/32	group treatment -0.016%ow/$, combined treatment -0.006%ow/$	families with overweight children
8	2005	GP counseling	Diet	GB	Nurse behavioural counseling	Do nothing	2/50	4482$/person changing from<5 fruit/day to >5 fruit/day	18-70 y old low income subj
9	2005	GP counseling	Diet	AU	Dietician counseling	Current practice	12/0	7.3 $/kg decreased	25-65 y old overweight subj
9	2005	GP counseling	Diet	AU	Physician and dietician counseling	Current practice	12/0	9.8 $/kg decreased	25-65 y old overweight subj

REF	Year of publication	Classification	Domain	Country	Intervention and description	Comparator	Interv/ f-up length	Results	Target population
10	2005	GP counseling	Diet	DK	General practitioner counseling	Do nothing	52/life	ICER 889 $/life year gained	BMI>30, waist circumference (men>102, women >88 cm), dyslipidemia, type 2 diabetes
10	2005	GP counseling	Diet	DK	dietician counseling	Do nothing	52/life	dietician 6495 $/life year gained	BMI>30, waist circumference (men>102, women >88 cm),
11	1999	GP counseling	Physical activity	AU	PA prescription and counseling	Current practice	-/5	ICER 22605 $/QALY	Inactive patients
11	1999	GP counseling	Physical activity	AU	Counseling by a physiologist	Informational pamphlet	26/26	ICER 2576$/QALY on 15 years	>60 y old inactive patients
12	2004	GP counseling	Physical activity	NZ	Verbal and written prescription and follow-up on phone	Do nothing	13/39	7 $/Kcal spent in PA/Kg/day, 1094 $/additional sub became active	40-79 year olds
4-5	2006	GP counseling	Combined	AU	Family therapy by psychiatrist	Current practice	12/life	ICER 22039 $/DALY	Families with overweight/obese children
4-5	2006	School setting	Diet	AU	classes to reduce the consumption of carbonated drinks	current practice	26/life	ICER 2066 $/DALY on life course	7-11 year olds

REF	Year of publication	Classification	Domain	Country	Intervention and description	Comparator	Interv/ f-up length	Results	Target population
4-5	2006	School setting	Physical activity	AU	classes to reduce TV viewing	current practice	43/life	ICER 2066 $/DALY on life course	children in primary school (grade 3 and 4)
4-5	2006	School setting	Physical activity	AU	school session + events to increase PA *	current practice	4/life	ICER 179068 $/DALY on life course	children in primary school (grade 5 and 6)
4-5	2006	School setting	Physical activity	AU	walking school bus *	current practice	43/life	ICER 0.53 M $/DALY on life course	children in primary school
4-5	2006	School setting	Combined	AU	classes + increased PA *	current practice	156/life	ICER 4821 $/DALY on life course	children in primary school
4-5	2006	School setting	Combined	AU	classes	current practice	104/life	ICER 9642 $/DALY on life course	children in primary school
4-5	2006	School setting	Combined	AU	classes	current practice	12/life	ICER 2066 $/DALY on life course	Overweight 7-10 year old children
13	2003	School setting	Combined	US	classes + increased PA *	do nothing	104/life	ICER 4629 $/QALY on life course	pupils in middle school
4-5	2006	Environment modification	Diet	AU	banning TV advertising	current practice	-/life	ICER 2.5 $/DALY on life course	general pop (>15% audience <14 years old)
14	2004	Environment modification	Physical activity	US	build/manage a cycle trial	No comparator	1/0	930 $/person cycling with the purpose of losing weight	general pop
15	2002	Environment modification	Physical activity	NO	build/manage a cycle trial	No comparator	-/-	CB ratio 3:1 to 14:1	general pop
16	2007	Environment modification	Physical activity	GB	build/manage a cycle trial	No comparator	-/-	CB ratio 1.4:1 to 7:1	general pop

REF	Year of publication	Classification	Domain	Country	Intervention and description	Comparator	Interv/ f-up length	Results	Target population
23	2008	environmental modifications	physical activity	US	bike paths, fitness facilities, events	do nothing	life/life	ICER 30493 $/QALY	25-64 in good health
24	2008	environmental modifications	physical activity	US	sponsored access to fitness centers	do nothing	2/0	-534 $ in total health care costs	>65 year olds
17	1995	Other	Diet	AU	5 a day campaign	do nothing	156/1040	ICER 36$/QALY	general pop (average age 40 years)
18	1995	Other	Diet	US	diet regimen with medical check-up	do nothing	76/0	1958 $/lb	obese subj
19	2005	Other	Diet	US	Low carbohydrate diet	Standard weight loss diet	26/26	No statistical difference	Severely obese subj
20	1988	Other	Physical activity	US	jogging	do nothing	1560/0	ICER 19273$/QALY	35 y old men
21	2001	Other	Combined	US	correspondence behavioral programme	do nothing	-/-	11 $/kg lost	general pop
22	2006	Other	Combined	US	Three component intervention of diet, exercise, behaviour modification *	current practice	52/life	13800 $/QALY	ow/obese women >35 year olds

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. *et al.* (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).

(2) Stevens, W. *et al.* (1998), "Cost-effectiveness of a Primary Care Based Physical Activity Intervention in 45-74-year-old Men and Women: a Randomized Controlled Trial. Br J Sports Med 1998; 32:236-241

(3) Sevick MA, Dunn AL, Morrow MS, Marcus BH, Chen GJ, Blair SN, 2000: Cost-effectiveness of lifestyle and structured exercise interventions in sedentary adults. Am J Prev Med. 2000;19(1):1-8

(4) ACE 2006, Haby MM, Vos T, Carte, R, Moodie M, Markwick A, Magnus A, Tay-Teo K-S, Swinburn B, 2006: Pediatric new perspective: A new approach to assessing the health benefit from obesity interventions in children and adolescents: the assessing cost-effectiveness in obesity project. International Journal of Obesity. 2006

(5) ACE-Obesity 2006: Assessing Cost-effectiveness of obesity interventions in children and adolescents Summary of results

(6) Dzator JA, Hendrie D, Burke V, Gianguilio N, Gillam HF, Beilin LJ, Houghton S, 2004: A randomized trial of interactive group sessions achieved greater improvements in nutrition and physical activity at a tiny increase in cost. Journal of Clinical Epidemiology 2004;57:610-619

(7) Goldfied GS, Epstein LH, Kilanowski CK, Paluch RA, Kogut-Bossler B, 2001: Cost-effectiveness of group and mixed family-based treatment for childhood obesity. International Journal of Obesity 2001; 25:1843-1849

(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) p. 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) p. 4

(10) Olsen J, Willaing I, Ladelund S, Jørgensen T, Gundgaard J, Sørensen J, 2005: Cost-effectiveness of nutritional counselling for obese patients and patients at risk of ischemic heart disease. International Journal of Technology Assessment in Health Care 2005; 21(2):194-202

(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) p. 4 [this reference is used twice]

(12) Elley R, Kerse N, Arroll B, Swinburn B, Ashton T, Robinson E, 2004: Cost-Effectiveness of physical counselling in general practice. The New Zealand Medical Journal. 2004 Dec;117(1207)

(13) Wang LY, Yang Q, Lowry R, Wechsler H, 2003: Economic Analysis of a school-based obesity prevention program. Obes Res. 2003;11:1313-1324

(14) Wang G, Macera CA, Scudder-Soucie B, Schmid T, Pratt M, Buchner D, 2004: Cost effectiveness of a bicycle/pedestrian trail development in health promotion. Preventive Medicine. 2004;38:237-242

(15) Saelesminde K, 2002: Walking and cycling track networks in Norwegian cities - Cost-benefit analyses including health effects and external costs of road traffic. TØI report 2002

(16) Rutter H, 2007: Valuing the benefits of cycling: A report to Cycling England. 2007 May

(17) 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) p. 99

(18) Martin LF, Tan TL, Horn JR Bixler EO, Kauffman GL, Becker DA, Hunter SM, 1995: Comparison of the costs associated with medical and surgical treatment of obesity. Surgery. 1995;118:599-607

(19) Tsai AG, Glick HA, Shera D, Stern L, Samaha FF, 2005: Cost-effectiveness of a low-carbohydrate diet and a standard diet in severe obesity. Obesity Research. 2005 Oct;13(10)

(20) Hatziandreu EI, Koplan JP, Weinstein MC, Caspersen CJ, Warner KE, 1988: A cost-effectiveness analysis of exercise as a health promotion activity. Am J Public Health. 1988;78:1417-1421

(21) Latner JD, 2001: Self-help in the long-term treatment of obesity. Obesity Reviews. 2001;2:87-97

(22) Roux L, Kuntz KM, Donaldson C, Goldie SJ, 2006: Economic evaluation of weight loss interventions in overweight and obese women. Obesity. 2006 June;14(6):1093-1103

(23) Roux L, Pratt M, Tengs TO, Yore MM, Yanagawa TL, Van Den Bos J, Rutt C, Brownson RC, Powell KE, Heath G, Kohl HW 3rd, Teutsch S, Cawley J, Lee IM, West L, Buchner DM. Cost effectiveness of community-based physical activity interventions. Am J Prev Med. 2008 Dec;35(6):578-88.

(24) Nguyen HQ, Ackermann RT, Maciejewski M, Berke E, Patrick M, Williams B, LoGerfo JP. Managed-Medicare health club benefit and reduced health care costs among older adults. Prev Chronic Dis. 2008 Jan;5(1):A14. Epub 2007 Dec 15.

ANNEX 3 – LIST OF ARTICLES AND PUBLICATIONS ON PARAMETERS OF THE EPIDEMIOLOGICAL MODEL

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

Boshuizen HC, Lanti M, Menotti A, Moschandreas J, Tolonen H, Nissinen A, Nedeljkovic S, Kafatos A, Kromhout D. Effects of past and recent blood pressure and cholesterol level on coronary heart disease and stroke mortality, accounting for measurement error. American Journal of Epidemiology. 2007 Feb 15;165(4):398-409

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

Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. New England Journal of Medicine 2003 Apr 24;348(17):1625-38

FAOSTAT, http://faostat.fao.org. Accessed on 02/12/2008

Flegal KM, Graubard BI, Williamson DF. Cause-specific excess deaths associated with underweight, overweight, and obesity. The Journal of American Medical Association 2005,293(15):1861

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

Haan M, Kaplan GA, Camacho T. Poverty and health. Prospective evidence from the Alameda County Study. American Journal of Epidemiology. 1987 Jun;125(6):989-98.

Hart CL, Hole DJ, Smith GD. Risk factors and 20-year stroke mortality in men and women in the Renfrew/Paisley study in Scotland. Stroke. 1999 Oct;30(10):1999-2007

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

Hu G, Jousilahti P, Qiao Q, Katoh S, Tuomilehto J. Sex differences in cardiovascular and total mortality among diabetic and non-diabetic individuals with or without history of myocardial infarction. Diabetologia. 2005a May;48(5):856-61

Hu G, Jousilahti P, Sarti C, Antikainen R, Tuomilehto J. The effect of diabetes and stroke at baseline and during follow-up on stroke mortality. Diabetologia. 2006 Oct;49(10):2309-16

Hu G, Sarti C, Jousilahti P, Peltonen M, Qiao Q, Antikainen R, Tuomilehto J. The impact of history of hypertension and type 2 diabetes at baseline on the incidence of stroke and stroke mortality. Stroke. 2005b Dec;36(12):2538-43

IARC/WHO. WHO Mortality database on cancer. 2008

Jakovljević D, Sarti C, Sivenius J, Torppa J, Mähönen M, Immonen-Räihä P, Kaarsalo E, Alhainen K, Kuulasmaa K, Tuomilehto J, Puska P, Salomaa V. Socioeconomic status and ischemic stroke: The FINMONICA Stroke Register. Stroke. 2001 Jul;32(7):1492-8

James WPT, Jackson-Leach R, Mhurchu CN, Kalamara E, Shayeghi M, Rigby NJ, Nishida C, Rodgers A. Overweight and Obesity (High body mass index). 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

Jansen MC, Bueno-de-Mesquita HB, Buzina R, Fidanza F, Menotti A, Blackburn H, Nissinen AM, Kok FJ, Kromhout D. Dietary fiber and plant foods in relation to colorectal cancer mortality: the Seven Countries Study. International Journal of Cancer. 1999 Apr 12;81(2):174-9

Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. Circulation 1993 Oct;88(4 Pt 1):1973-98

Kuper H, Adami HO, Theorell T, Weiderpass E. The socioeconomic gradient in the incidence of stroke: a prospective study in middle-aged women in Sweden. Stroke. 2007 Jan;38(1):27-33

Lawes CMM, Vander Horn S, Law MR, Elliot P, Mac Mahon S, Rodgers A. High blood pressure. 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 Healt Organization, Geneva, 2004a

Lawes CMM, Vander Horn S, Law MR, Rodgers A. High Cholesterol. 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, 2004b

Lim SS, Gaziano TA, Gakidou E, Reddy KS, Farzadfar F, Lozano R, Rodgers A. Prevention of cardiovascular disease in high-risk individuals in low-income and middle-income countries: health effects and costs. Lancet. 2007 Dec 15;370(9604):2054-62.

Lock K, Pomerleau J, Causer L, McKee M. Low fruit and vegetable consumption. 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

Lock K, Pomerleau J, Causer L, Altmann DR, McKee M. The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. Bulletin of the World Health Organization. 2005 Feb;83(2):100-8

Logue EE, Jarjoura D. Modeling heart disease mortality with census tract rates and social class mixtures. Social Science & Medicine. 1990;31(5):545-50

Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL. Global Burden of Disease and risk factors.

Oxford University Press/the World Bank. New York, 2006

Mackenbach JP, Kunst AE, Cavelaars AE, Groenhof F, Geurts JJ. Socioeconomic inequalities in morbidity and mortality in western Europe. The EU Working Group on Socioeconomic Inequalities in Health. Lancet. 1997 Jun 7;349(9066):1655-9

Menotti A, Lanti M. Coronary risk factors predicting early and late coronary deaths. Heart. 2003 Jan;89(1):19-24

Pardo Silva MC, De Laet C, Nusselder WJ, Mamun AA, Peeters A. Adult obesity and number of years lived with and without cardiovascular disease. Obesity (Silver Spring). 2006 Jul;14(7):1264-73

Parkin DM, Whelan SL, Ferlay J, Storm H. Cancer Incidence in Five Continents, vol VIII updated. IARC CancerBase. Lyon, 2005

Pierce JP, Natarajan L, Caan BJ, Parker BA, Greenberg ER, Flatt SW, Rock CL, Kealey S, Al-Delaimy WK, Bardwell WA, Carlson RW, Emond JA, Faerber S, Gold EB, Hajek RA, Hollenbach K, Jones LA, Karanja N, Madlensky L, Marshall J, Newman VA, Ritenbaugh C, Thomson CA, Wasserman L, Stefanick ML. Influence of a diet very high in vegetables, fruit, and fiber and low in fat on prognosis following treatment for breast cancer: the Women's Healthy Eating and Living (WHEL) randomized trial. Journal of the American Medical Association. 2007 Jul 18;298(3):289-98

Ringback Weitoft G, Eliasson M, Rosen M. Underweight, overweight and obesity as risk factors for mortality and hospitalization. Scandinavian Journal of Public Health 2008,36(2):169-76

Skuladottir H, Tjoenneland A, Overvad K, Stripp C, Olsen JH. Does high intake of fruit and vegetables improve lung cancer survival? Lung Cancer 2006 Mar;51(3):267-73

Salomaa V, Niemelä M, Miettinen H, Ketonen M, Immonen-Räihä P, Koskinen S, Mähönen M, Lehto S, Vuorenmaa T, Palomäki P, Mustaniemi H, Kaarsalo E, Arstila M, Torppa J, Kuulasmaa K, Puska P, Pyörälä K, Tuomilehto J. Relationship of socioeconomic status to the incidence and prehospital, 28-day, and 1-year mortality rates of acute coronary events in the FINMONICA myocardial infarction register study. Circulation 2000 Apr 25;101(16):1913-8

Stamler J, Daviglus ML, Garside DB, Dyer AR, Greenland P, Neaton JD. Relationship of baseline serum cholesterol levels in 3 large cohorts of younger men to long-term coronary, cardiovascular, and all-cause mortality and to longevity. Journal of the American Medical Association. 2000;284(3):311-318

Stevens RJ, Coleman RL, Adler AI, Stratton IM, Matthews DR, Holman RR. Risk factors for myocardial infarction case fatality and stroke case fatality in type 2 diabetes: UKPDS 66. Diabetes Care. 2004 Jan;27(1):201-7

van Baal PH, Polder JJ, de Wit GA, Hoogenveen RT, Feenstra TL, Boshuizen HC, Engelfriet PM, Brouwer WB. Lifetime medical costs of obesity: prevention no cure for increasing health expenditure. PLoS Medicine 2008 Feb;5(2):e29

van Loon AJ, Brug J, Goldbohm RA, van den Brandt PA. Differences in cancer incidence and mortality among socio-economic groups. Scandinavian Journal of Social Medicine. 1995 Jun;23(2):110-2

Wannamethee SG, Shaper AG, Lennon L. Cardiovascular disease incidence and mortality in older men with diabetes and in men with coronary heart disease. Heart. 2004 Dec;90(12):1398-403

WHO-CHOICE website, www.who.int/choice. Accessed on 2/12/08

Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004 May;27(5):1047-53

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

Introduction

118.   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 *et al.*, 2004).

Detailed description of the causal web

119.   Figure A4.1 shows the overall structure of the Lifestyle model and the interactions (represented by arrows) between risk factors and between risk factors and diseases.

120.   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.

121.   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

122.   The static component of the causal web refers to that part of the general causal web shown in Figure A4.1 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.

123.   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.

124.   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.

125.   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.

126.   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.

127.   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.

128.   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

129.   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.

130.   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.

131.   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.

132.   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.

133.   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 RR1 x RR2. "Exponential in levels of the risk factor" means that the effect of the fat diet "high fat" is equal to RR1 x RR1.

Diseases

134.   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.

135.   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.

136.   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, RR1) and the low physical activity level (say, RR2) on the incidence of, say, stroke or ischaemic heart disease, is equal to RR1 x RR2. "Additive" interaction means that the joint effect is equal to RR1 + RR2 − 1 (this is equivalent to "additive in excess risk", where "excess risk" equals the relative risk minus 1).

Figure A4.1: The static causal web for risk factor prevalences implemented in the LifeStyle model.
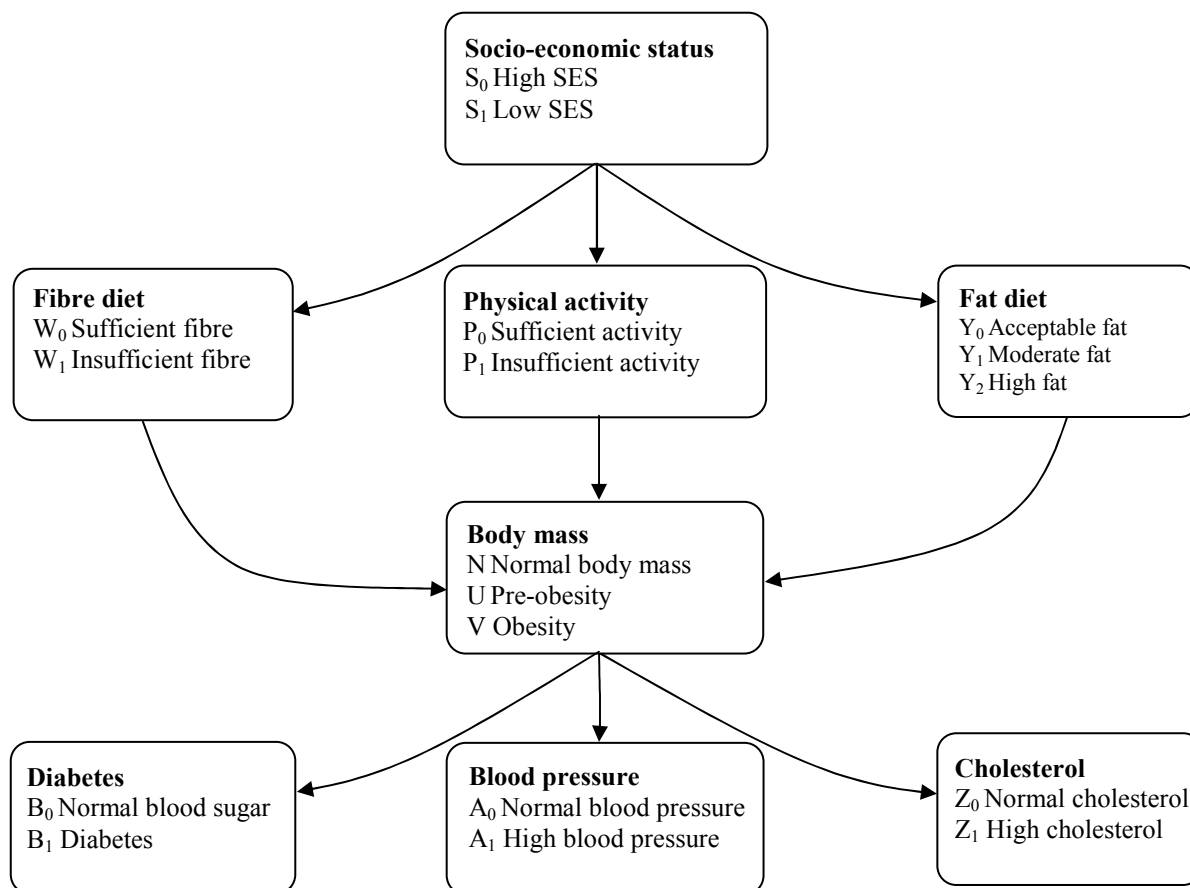
Figure A4.2: The dynamic causal web for risk factor transitions implemented in the LifeStyle model.
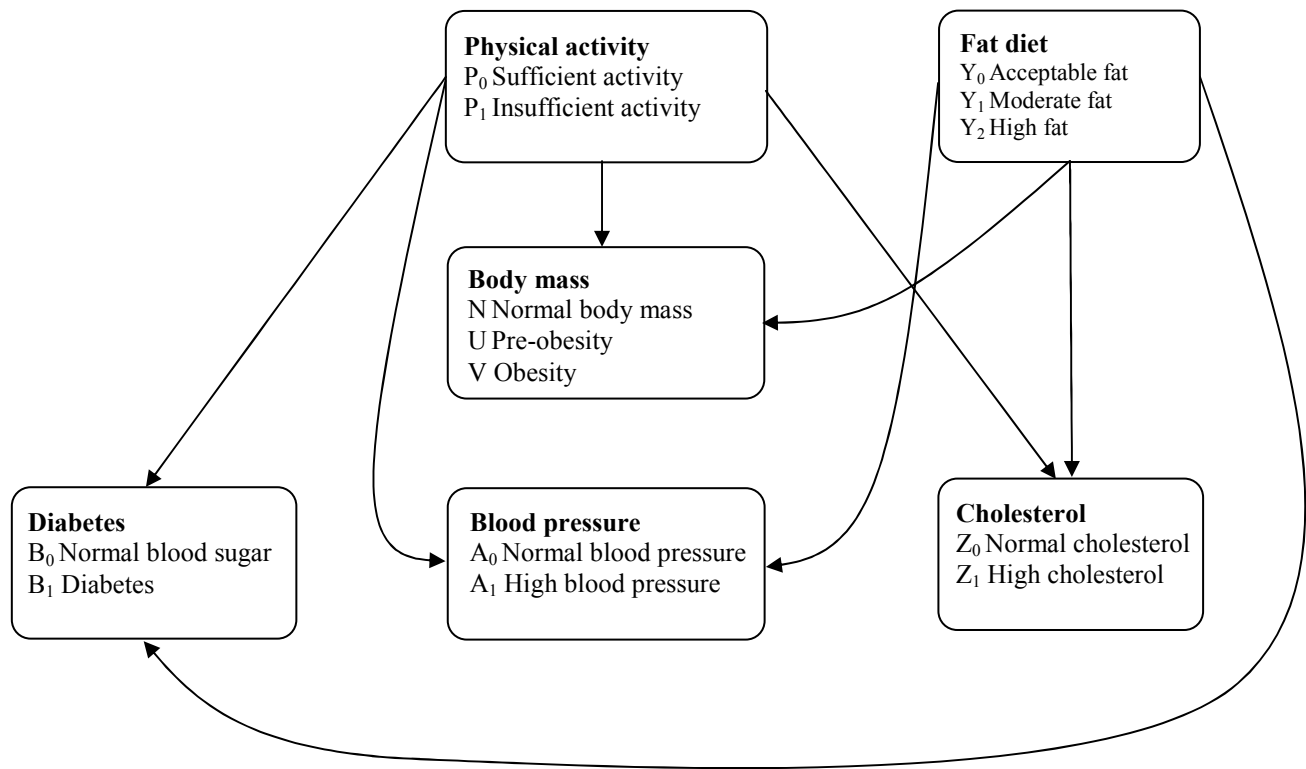
Figure A4.3: The dynamic causal web for disease events implemented in the LifeStyle model.

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
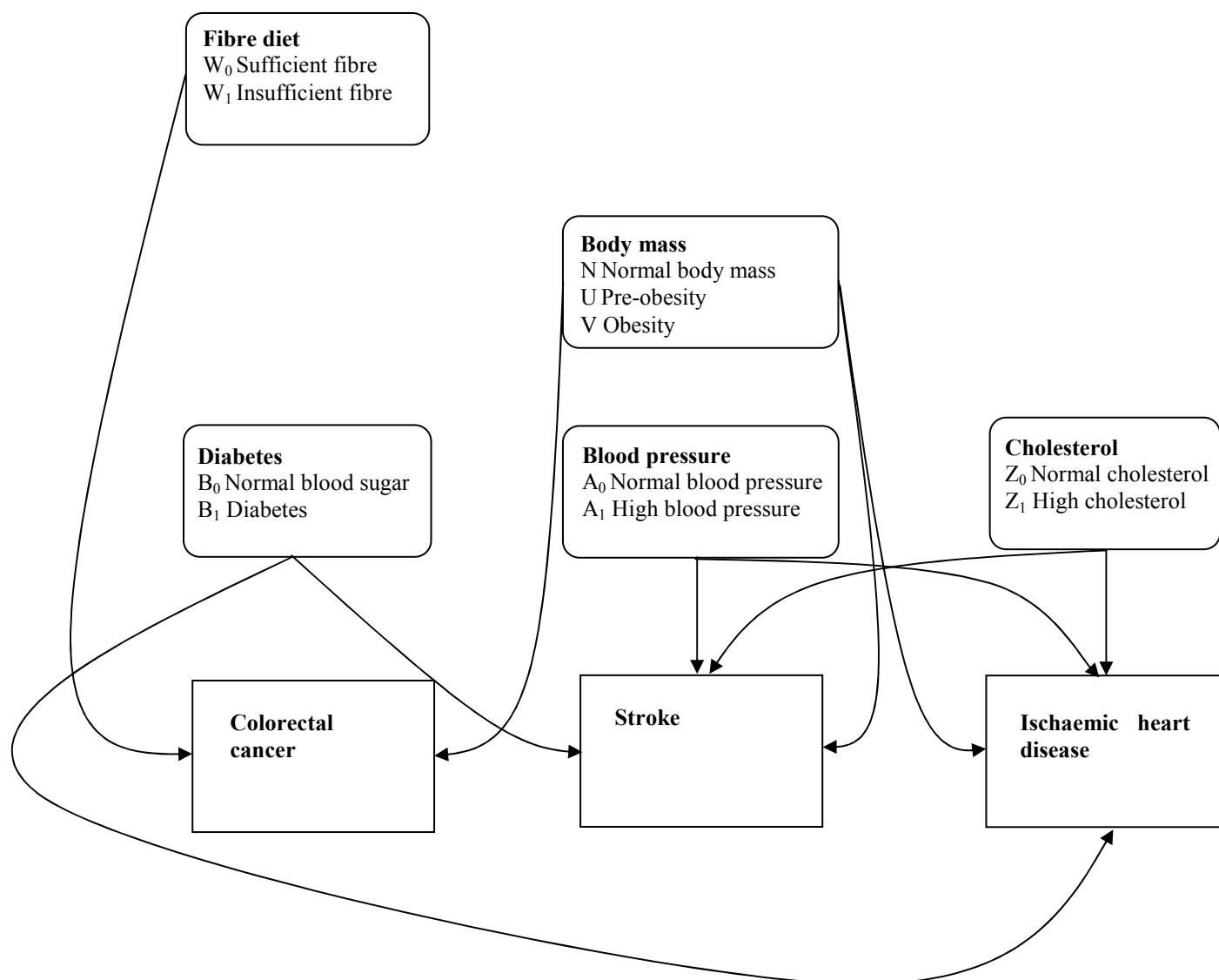
ANNEX 5 – EVIDENCE OF THE EFFECTIVENESS OF INTERVENTIONS

137.   The main source in our search for effectiveness evaluations was a comprehensive review undertaken by the WHO, to be published under the title of "Interventions on diet and physical activity: what works". This is one of the planned outputs of the WHO global strategy on diet, physical activity & health and is designed to provide a framework of "best practice" interventions for diet and physical activity, aimed at reducing risks of chronic non-communicable diseases. The studies included in the WHO 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 settings. 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.

138.   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.

139.   The reminder 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.

140.   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 A5.2. Educational interventions are clearly the ones that have been investigated the most. However, this group may be divided into two sub-groups 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.

Figure A5.2. Numbers of interventions per area and domain
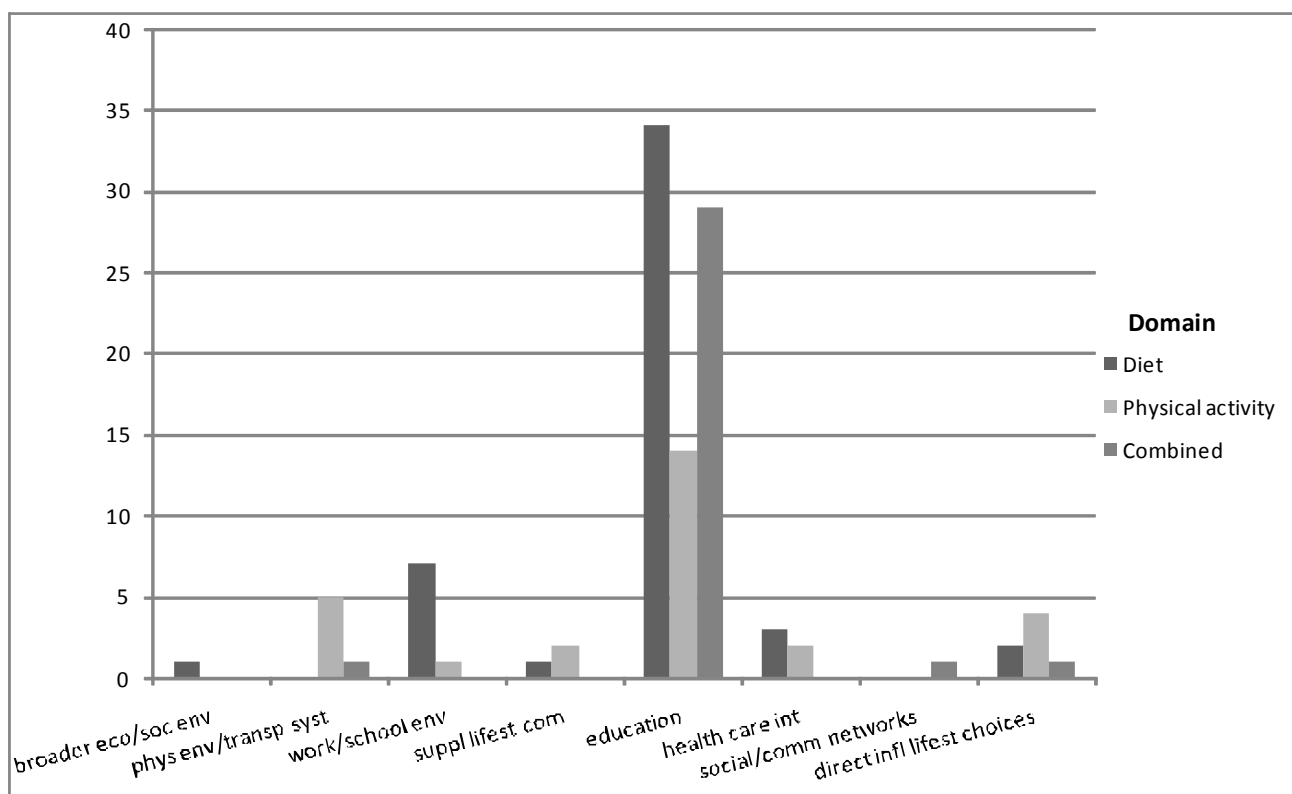
141.   The group defined as "interventions on the broader economic and social environment" gathers all those interventions implying modification of policies at national (*e.g.* general fiscal policies) and international (*e.g.* international trade agreements) level. In the only study falling in this 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.

142.   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%).

143.   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

58

environmental changes. Interventions generally targeted workers, with some additionally focusing on sub-groups 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.

144.   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.

145.   "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 the table below 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.

146.   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.

147.   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.

148.   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.

149.   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.

150.   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).

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Intervention on the broader economic and social environment	Diet	US	policy of free fruit/vegetable at home	22/0	increase of 1.04 servings of fruit/veg, % of elderly having >5 servings a day from 22% to 39%	low income seniors
Intervention on the physical environment and transport system	Physical activity	US	evaluation of the use of walking trials	-/-	beneficial in promoting PA in some groups	gen pop
Intervention on the physical environment and transport system	Physical activity	Colombia	influence on PA of sport events	-/-	women who participate in ciclovia are 7 times more likely to be physically active	women 18-69
Intervention on the physical environment and transport system	Physical activity	Finland	evaluation of the benefits of walking/biking to work	20/0	VO2 max +4.5%, cycle time +10.5%, HDL +5%; heart rate -2.5% compared to control	employee
Intervention on the physical environment and transport system	Physical activity	US	improving safety in walk/cycle trials	104/-	number of students walking +64%, biking +114%, car use -39%, carpooling +91%	school pupils
Intervention on the physical environment and transport system	Physical activity	Australia	organization of community walking events, campaign on PA, multimedia	104/-	inactive women decreased (22% vs. 15%)	20-50 y old women
Intervention on the physical environment and transport system	Combined	US	funding the establishment of community garden	-/0	fruit/veg +0.34 servings/day, PA +0.3 sessions/week	gen pop
Interventions on the work, or school, environment	Diet	US	Education + multimedia + environment modification	52/52	fruit/veg intake +0.3 servings/day total, +0.16 servings/day in cafeterias	workers
Interventions on the work, or school, environment	Diet	Belgium	Education + multimedia + environment modification	13/-	BMI +0.258, energy intake -142 Kcal/day, cholesterol intake -16.5 mg/day	male workers
Interventions on the work, or school, environment	Diet	Denmark	canteen staff better present fruits/vegetables	34/17	average increase 95g/customer of fruit/veg	workers
Interventions on the work, or school, environment	Diet	US	Prevention + environmental changes + education vs. education + multimedia vs. family involvement	86/-	fruit/veg intake +19% in group 3, +7% in group 2	low-income workers

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Interventions on the work, or school, environment	Diet	US	Education + environment modification	104/-	energy from fat -2.3% Kcal vs. -1.5% in control, fruit/veg intake +10% vs. +4% in control	workers
Interventions on the work, or school, environment	Diet	US	environmental mod at work vs. peer groups	77/26	fruit/veg intake +0.41 servings/day	low-income workers
Interventions on the work, or school, environment	Diet	US	Education + environment modification	104/-	energy from fat -0.37% Kcal, fiber intake +0.13 g/1000 Kcal, fruit/veg intake +0.18 serv/day	workers
Interventions on the work, or school, environment	Physical activity	Canada	Use of a pedometer + education	12/-	decrease BMI, weight, heart rate, +3451 steps/day	sedentary workers
Interventions on supply of lifestyle commodities	Diet	Mauritius	reduction palm oil and increase soy oil	260/0	Total cholesterol fell by 0.79mmol/L in men & 0.82 in women (p<0.001). Estimated intake of saturated fats decreased by 3.5% & 3.6% in men & women, respectively	gen pop
Interventions on supply of lifestyle commodities	Physical activity	South Africa	exercise classes	20/-	systolic pressure decr (147.8 vs. 143.9 gr 1) (143.0 vs. 137.4 gr 2)	elderlies in low socioeconomic conditions
Interventions on supply of lifestyle commodities	Physical activity	UK	free supervised PA sessions	104/-	ICER 17174 £??/QALY	general old pop
Education	Diet	UK	education, increased provision, newsletter, etc	39/-	50g/day increase in fruit/veg intake	6-7 & 10-11 y olds
Education	Diet	US	behaviour education	4/52	drop of 6.5% in cholesterol after 12 months	voluntary workers with cholesterol >200 m
Education	Diet	US	multimedia computer program printouts	4/9	increased use of fruit/veg (results are difficult to be read)	workers
Education	Diet	US	group/individual sessions	13/13	no signif differences in weight or BMI, cal/day from 1099.9 to 1089.5, cal from fat from 35.9% to 32.3%	25-55 y olds women with BMI>27
Education	Diet	US	counseling on diet change	26/-	fiber +4.2 g and reduced monthly expenditure	>18 women
Education	Diet	US	group and individual	104/77	fat intake from 39.7% energy to 26.4% , frui+0.53	postmenopausal

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
			sessions healthy diet		portion/daily, veg +0.27 port/daily at 18 months	women
Education	Diet	US	education and activities in groups	6/-	1.6 times more likely to eat fruit/veg, 0.44 more likely to eat at least 5 servings/day fruit/veg	low income women
Education	Diet	Canada	group and individual sessions healthy diet	12/0	cholesterol no difference, waist circum -1.3 cm, BMI -0.2, weight -0.4 kg	women in charge for purchasing and preparing meals
Education	Diet	US	personal visits, newsletters, group meetings	52/-	fruit/veg +0.53 por/day	low socioeconomic Afro-American parents
Education	Diet	US	sessions low fat healthy diet	8/-	no changes in total cholesterol	low-educated and limited income
Education	Diet	US	Sessions + printed material + tailored letters	26/26	serving/day of fruit/veg +0.73 at the end	low income >18 y old women
Education	Diet	UK	tailored information	1hour/6	1.06 increase fruit/veg servings/day, people eating >=5 servings/day of fruit/veg increased to 42% from 25%	55-64 y olds
Education	Diet	US	advising by dieticians, phone calls	22/52	% of energy from fat decreased by 1.2%	postmenopausal women
Education	Diet	US	intensive and maintenance sessions + dietitian for non-compliants	416/-	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	50-79 y old menopausal women
Education	Diet	US	phone-delivered advising, tailored material	4/34	no difference between control and intervention for fruit/veg intake	40-75 y old with adenomatous colon polyps
Education	Diet	UK	brief advising	25min/26	increase of 1.4 servings of fruit/veg/day, no difference in plasmatic flavonol (lower coronary mortality)	25-64 y olds
Education	Diet	Australia	advising of doctor + dietician vs. dietician	52/-	doctor+diet -6.7 kg, dietitian -5.6 kg, blood pressure improved	adults with BMI>25/hypertension/diabetes
Education	Diet	Italy	advising, written information	15min/52	BMI decreased by 0.41, fruit/veg +1.31 servings/week	18-65 y olds

OCD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Education	Diet	US	counseling end of a service on cancer+ mails	2/52	0.43 servings/day at 12 months	>18 y olds calling the cancer information service
Education	Diet	US	partially computer-assisted sessions +telephone contacts	6-9/52	non-signif change in cholesterol, self-reported fruit/veg +0.93 por/day compared to control, fat intake -16 g/day	40-70 y old women
Education	Diet	US	intensive and maintenance sessions + dietician for non- compliants	416/-	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	50-79 y old menopausal women
Education	Diet	US	personalised mails, phone advising	4/52	improvement in fat and fiber intake	low socioeconomic low education adults
Education	Diet	UK	individual nurse advising, phone follow-up, mail material	26/-	fruit/veg +1.4 por/day, total cholesterol -0.018 mmol/l,blood pressure -2 mmHg	25-64 y olds
Education	Diet	UK	nurse advising	2/52	no differences in BMI, cholesterol, blood pressure, +1.5 fruit/veg portions/day, +42% people eating 5 portions/day	low income adults
Education	Diet	US	written personalized counseling	13/9	interv gr increased fruit/veg intake of 0.6 compared to control	>18 y olds
Education	Physical activity	Brazil	multimedia campaign	208/-	people knowing the healthy message are more active	gen pop with focus on students, collars and elderly
Education	Physical activity	Brazil	multimedia campaign walk	416/-	cost saving (but do not state the comparison)	student and gen pop
Education	Physical activity	New Zealand	multimedia campaign PA	260/-	no changes in PA level, 1999:38.6% active, 2000:44.5%, 2002:38.0%	gen pop
Education	Physical activity	Australia	TV/magazine campaign regular exercise	17/0	target group recalling the media campaign was 2.08 times more likely to increase its PA	25-60 year olds motivated but insufficiently active
Education	Physical activity	Canada	campaign: walk and use of pedometer	52/-	awareness of the campaign was associated with a 13% higher odds of sufficient level of weekly	>18 y olds

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
					walking	
Education	Physical activity	US	multimedia campaign to be more PA	52/-	significant relationship between awareness of the message and PA +34%, high effect in at-risk group (low baseline)	9-13 y olds
Education	Physical activity	US	campaign to promote 30 min daily walking	8/0	23% increase in walkers, 32% increase of the baseline sedentary pop meeting the recommendation	sedentary 50-65 y olds
Education	Physical activity	US	campaign to promote 30 min daily walking	8/4	16% from non-active to active (non-signif compared to control), 47% increased total walking time (significant compared)	sedentary 40-65 y olds
Education	Physical activity	US	advising before a routine visit	5min/5	52% adopted regular activity, 37 min/week increase in walking	>18 y old sedentary patients
Education	Physical activity	US	counseling educational material + phone calls	13/26	increased amount of PA measured as a score	20-64 y olds exercising <15 min/day
Education	Physical activity	US	personalised counseling, fitness program	52/-	% of inactive decreased (38 vs. 56)	older people
Education	Physical activity	US	personal / group counseling, newsletter, phone calls	52/-	687 kcal/week increase in energy spent in PA	65-90 y old inactive people
Education	Physical activity	US	counseling, telephone-based program vs. group-based program	26 vs. 20/-	both groups had a decrease in BMI	elderlies
Education	Combined	US	counseling nurse behaviour	26/26	cholesterol decreased by 11.5 mg/dl, systolic blood pressure by 3.6 mmHg, BMI by 0.5, weight by 2.8 lb at 12 month, % active increased by 5.9% at 7 months. Values no significative compared to control	>50 y old low income women with at least 1 CVD risk factor
Education	Combined	UK	TV campaign with booklet	7/22	obese decreased by 6%, fruit/veg intake increased by 0.8 port/day, 39% participants increased PA	gen pop with focus on overw/obese
Education	Combined	UK	TV campaign with booklet	7/13	awareness of the campaign was high in all socio-econ groups, memory for the message was poorer in those with lower level of edu and ethnic minority	gen pop with focus on overw/obese

DELSA/HEA/EP(2009)1

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Education	Combined	UK	lessons	20/-	no changes in overweight/obesity, increase in consumption of fruit/veg	5-7 y olds
Education	Combined	US	multimedia, information distribution, group sessions & interactive activity	130/-	increase in fruit/veg intake no in fat%; increase in exercising	workers
Education	Combined	US	encouragements to change behaviours, activity	12/-	62% reported weight loss, 50% increased fruit/veg cons, 40% decreased TV view	volunteer workers
Education	Combined	US	education course	4/6	interv gr decreased weight and % body fat significantly compared to control, veg servings and total steps increased significantly	>18 y olds
Education	Combined	US	counseling, interactive sessions	12/-	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)	gen pop (high % Spanish)
Education	Combined	US	workbook vs. workbook+comp vs. work+comp+staff	52/-	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	adults with BMI>25
Education	Combined	US	education course	4/0	weight -7.9 lb, women -6.4 lb, LDL -19.1 men, women -10, also others parameters decreased	upper-middle class >40 y olds with risk of CAD
Education	Combined	Australia	mail information vs. 1/2 mail+1/2 group vs. nothing	17/52	no sign differ in BMI, LDL fell signif, HDL did not change	couples living together for less than 2 yrs
Education	Combined	US	sessions on healthy behavior, diet plan	260/-	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 increased more in the control	44-50 y old premenopausal women
Education	Combined	New Zealand	oral advising+phone calls+newsletter on PA	52/-	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	40-79 y olds
Education + Interventions on the work, or school,	Diet	Sweden	environment modification (fish in schools)	52/-	increased consumption of fish	14 y olds

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
environment						
Education + Interventions on the work, or school, environment	Diet	US	environment, newsletters, education	104/-	no stat difference	students
Education + Interventions on the work, or school, environment	Diet	US	education+school environm+parental involv	208/-	daily fruit/veg servings increased by 0.35	14-15 y olds
Education + Interventions on the work, or school, environment	Diet	US	education+environmental (food in school)+parental involvement+industry involvement	52/-	increase of 0.58 serving of fruit intake, decrease of 1.81 % of total kcal by fat	4-5 grade children
Education + Interventions on the work, or school, environment	Diet	US	education+environmental (food in school)+parental involvement	52/52	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 & saturated fat smaller in treatment	8-9 y olds
Education + Interventions on the work, or school, environment	Diet	Canada	education+family involvement+environmental (snacks in school)+peer involvement	52/-	BMI increased by 0.95, body fat increased by 1.2%, fiber intake increase by 1.8%	7-14 y old Native Americans
Education + Interventions on the work, or school, environment	Diet	US	education+environmental (food in school)	129/-	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	food service staff
Education + Interventions on the work, or school, environment	Diet	US	education+environment (food in school), parent involvement	104/-	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	2-5 y olds
Education + Interventions on the work, or school, environment	Physical activity	France	sport, debate on PA, social support	208/-	6% decrease of children spending >3h/day in sedentary activity (at 6 months)	11 y olds

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Education + Interventions on the work, or school, environment	Combined	US	PA program, nutrition, information	12/0	adults: BMI decreased by 0.5, % body fat 1, children decrease in systolic blood pressure. Both increase in fruit servings	African American parents/studs
Education + Interventions on the work, or school, environment	Combined	Ireland	education+aerobic exercise regime	10/13	increased intake of fruit/veg, decreased consumption of salty snacks	8-10 y olds
Education + Interventions on the work, or school, environment	Combined	US	education+exercise+environmental	104/-	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	students (91% African American)
Education + Interventions on the work, or school, environment	Combined	US	education+PA program	8/-	no difference between classroom-based intervention and risk-based intervention	7-12 y olds
Education + Interventions on the work, or school, environment	Combined	US	education+creation of a fitness centre	208/-	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	16-18 y old Native Americans
Education + Interventions on the work, or school, environment	Combined	US	education+environment (food in school, after school club), incentives	30/-	fasting glucose level decreased by 0.12 mmol/l, no difference in % body fat, increase fiber intake by 1 g/day	4th grade low income Mexican American children
Education + Interventions on the work, or school, environment	Combined	US	health fair, group activities, newsletters, vending machines	52/-	employees were 2 times less likely to lose work days due to health reasons	workers
Education + Interventions on the work, or school, environment	Combined	Greece	education+PA program+parental involvement	156/-	improvements in fitness, skinfold measure and BMI	1st grade students
Education + Interventions on the	Combined	US	education and activity	11/-	cholesterol decreases of 16 mg/dl and 5 point increase in fitness (VO2 max) in females, no stat	students

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
work, or school, environment					sign in males	
Education + Interventions on the work, or school, environment	Combined	Greece	education+PA program+parental involvement	312/-	smaller BMI increase compared to control, total cholesterol decreased by 0.27 mmol/l and LDL by 0.13mmol/l	5.5-11.5 y olds
Education + Interventions on the work, or school, environment	Combined	Canada	education+community activities+mass media+environmental (food in school)	416/-	no substantial differences in BMI and TV watching. Decrease in fruit/veg intake	6-11 y old aboriginals
Education + Interventions on the work, or school, environment	Combined	UK	educatio+PA program+environment (food in school)	52/-	no signif results	7-11 y olds
Education + Interventions on the work, or school, environment	Combined	US	education+PA program+environmental (food in school)+parental involvement	156/-	decrease in dietary energy -265 kcal and % of energy from fat -2.5, no change in BMI and body fat	8-11 y old Native Americans
Education + Interventions on the work, or school, environment	Combined	US	education+PA program+environmental (food in school)	129/-	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	3th grade student
Education + Interventions on the work, or school, environment	Combined	US	CVD program: contests, groups, media, schools	312/-	significant adverse trends for HDL and triglycerides, non-significant reduction in sedentary lifestyle, BMI increased	gen pop
Education + Intervention aimed at directly influencing lifestyle choices	Combined	Australia	store management policy changes, health promotion activities, and nutrition education	208/-	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	aboriginals with high CVD/diabetes risk
Education + Intervention on the broader economic and social environment	Diet	US	information campaign vs. coupons for vegetables	-/9	coupon has direct effect increasing the purchase of veg, info had indirect effect through attitude. Best results when combined	low income women

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
Health care interventions	Diet	Australia	cholesterol check, advising, written information	5min/17	13.5% cholesterol decrease (0.84 mmol/l), no BMI changes	18-60 y old with cholesterol between 5.5-7.9 mmol/l
Health care interventions	Diet	UK	initial health check, follow-up checks and advising	156/-	compared to control cholesterol -0.19 mmol/l, BMI -1.4%, blood pressure -1.9%	35-64 y olds
Health care interventions	Diet	US	clinician visit, advising, phone counseling, information material	22/34	0.29 servings fruit/veg/day increase, 3.3% of part increased fruit/veg servings to at least 5/day	18-75 y old low income adults
Health care interventions	Physical activity	Finland	prescription of PA	30/26	increase of 0.9 session of PA/week at 6 months	20-65 y olds
Health care interventions	Physical activity	US	education+visits+PA program	52/52	LDL decreased by 0.53 mmol/l, systolic blood pressure by 9 mmHG, no difference in BMI	<60 y old siblings of black patients hospitalized for CHD
Interventions on social and community networks	Combined	Iran	media, community, health system involvement, policy, improve health behaviors	312/-	no results	>19 y olds with focus on groups
Intervention aimed at directly influencing lifestyle choices	Diet	US	environment modification reduction high fat choices	52/-	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	elementary school students
Intervention aimed at directly influencing lifestyle choices	Diet	US	environment modification low fat food+peer promotion	104/-	10% increase in selling of low-fat food in year 1, year 2: 33.6% of sale of low-fat food in intervention compared to 22.1% in control	secondary school students
Intervention aimed at directly influencing lifestyle choices	Physical activity	US	environment modification stairs in a bank, airport, office, university	26/-	star use increased	Hispanic gene pop
Intervention aimed at directly influencing lifestyle choices	Physical activity	US	environment modification stairs in a mall	13/0	star use increased overall, white more than black and older more than younger	>18 y olds
Intervention aimed at directly influencing lifestyle choices	Physical activity	Australia	environment modification stairs in a hospital	4/3	stair used increased with the first interv then decreased during the f-up then did not significantly changed during the second interv and decreased	hosp workers

OECD class	Domain	Country	Intervention and description	Intervention Length / Follow-up length	Results	Target population
					below the baseline in the second f-up	
Intervention aimed at directly influencing lifestyle choices	Physical activity	US	environment modification stairs in a airport	3/-	stair using increased	gen pop
Intervention aimed at directly influencing lifestyle choices	Combined	Canada	environment modification increase health choices at school and outside	47/-	9% decrease of low active children, 7-25% increase in steps/day	elementary school students

ANNEX 6 – LIST OF ARTICLES AND PUBLICATIONS ON THE EFFECTIVENESS OF INTERVENTIONS TO TACKLE OVERWEIGHT AND OBESITY THROUGH DIET AND PHYSICAL ACTIVITY

(1) Johnson DB, Beaudoin S, Smith LT, Beresford SA, LoGerfo JP. Increasing fruit and vegetable intake in homebound elders: The Seattle Seniors Farmers' Market Nutrition Pilot Program. Preventing Chronic Disease Public Health Research, Practice, and Policy 2004; 1(1):1-9. 369

(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

(3) Brownson RC, Housemann RA, Brown DR et al. Promoting physical activity in rural communities: walking trail access, use, and effects. Am J Prev Med. 2000;18(3):235-241. 17

(4) Gomez LF, Mateus JC, Cabrera G. Leisure-time physical activity among women in a neighbourhood in Bogota, Colombia: prevalence and socio-demographic correlates. Cad Saude Publica. 2004;20(4):1103-1109.(http://www.scielo.br/pdf/csp/v20n4/26.pdf) . 10

(5) Oja P, Vuori I, Paronen O. Daily walking and cycling to work: their utility as health-enhancing physical activity. Patient Educ Couns. 1998;33(1 Suppl):S87-S94. 18

(6) Staunton CE, Hubsmith D, Kallins W. Promoting safe walking and biking to school: the Marin County success story. Am J Public Health. 2003;93(9):1431-1434. 19

(7) Wen LM, Thomas M, Jones H, Orr N, Mreton R, King L, Hawe P, Bindon J, Humphries J, Schnicht K, Corne S, Bauman A. Promoting physical activity in women: evaluation of a 2-year community-based intervention in Sydney, Australia. Health Promotion International 2002; 17(2): 127-137. 54

(8) Twiss J, Dickinson J, Duma S et al. Community gardens: lessons learned from California Healthy Cities and Communities. Am J Public Health. 2003;93(9):1435-1438. 16

(9) Beresford SA, Thompson B, Feng Z, Christianson A, McLerran D, Patrick DL. Seattle 5-a-Day Worksite Program to increase fruit and vegetable consumption. Prev Med 2001; 32(3):230-238. 262

(10) Braeckman L, De Bacquer D, Maes L, De Backer G. Effects of a low-intensity worksite-based nutrition intervention. Occup Med (Lond) 1999; 49(8):549-555. 259

(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

(12) Sorensen G, Stoddard A, Peterson K, Cohen N, Hunt MK, Stein E, Palombo R, Lederman R. Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study. Am J Public Health 1999; 89(1):54-60.239

(13) Sorensen G, Stoddard A, Hunt MK, Hebert JR, Ockene JK, Avrunin JS, et al. The effects of a health promotion-health protection intervention on behavior change: the WellWorks Study. Am J Public Health 1998; 88(11):1685-1690. 249

(14) Buller DB, Morrill C, Taren D, Aickin M, Sennott-Miller L, Buller MK, et al. Randomized trial testing the effect of peer education at increasing fruit and vegetable intake. J Natl Cancer Inst 1999; 91(17):1491-1500. 251

(15) Buller D, Buller MK, Larkey L, Sennott-Miller L, Taren D, Aickin M, et al. Implementing a 5-a-day peer health educator program for public sector labor and trades employees. Health Educ Behav 2000; 27(2):232-240. 252

(16) Sorensen G, Thompson B, Glanz K, Feng Z, et al. Work site-based cancer prevention: primary results from Working Well Trial. Am J Public Health 1996; 86(7):939-947. 244

(17) Biener L, Glanz K, McLerran D, Sorensen G, Thompson B, Basen-Engquist K et al. Impact of the Working Well Trial on the worksite smoking and nutrition environment. Health Educ Behav 1999; 26(4):478-494. 245

(18) Patterson RE, Kristak AR, Glanz K, McLerran DF, Herbert JR, Heimendinger J, et al. Components of the Working Well Trial intervention associated with adoption of healthful diets. Am J Prev Med 1997; 13(4):271-276. 246

(19) Chan CB, Ryan DA and Tudor-Locke C. Health benefits of a pedometer-based physical activity intervention in sedentary workers. Prev Med 39: 1215-1222, 2004 277

(20) Uusitalo U, Feskens EJM, Tuomilehto J, Dowse G, Haw U, Fareed D, Hemraj F, Gareeboo H, Alberti MM, Zimmet P. Fall in total cholesterol concentration over five years in association with changes in fatty acid composition of cooking oil in Mauritius: Cross sectional survey. Br Med J 1996; 313(7064):1044-1046.

(21) Kolbe-Alexander TL, Lambert EV and Charlton KE. Effectiveness of a community based low intensity exercise program for older adults. J Nutr Health Aging 10: 21-29, 2006. 352

(22) Munro JF, Nicholl JP, Brazier JE, Davey R and Cochrane T. Cost-effectiveness of a community based exercise programme in over 65 year olds: cluster randomised trial. J Epidemiol Community Health 58: 1004-1010, 2004. 356

(23) Anderson AS, Porteous LE, Foster E, Higgins C, Stead M, Hetherington M et al. The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables. Public Health Nutr 2005; 8(6):650-656. 148

(24) Byers T, Mullis R, Anderson J, Dusenbury L, Gorsky R, Kimber C et al. The costs and effects of a nutritional education program following work-site cholesterol screening. Am J Public Health 1995; 85(5):650-655.240

(25) Irvine AB, Ary DV, Grove DA, Gilfillan-Morton L. The effectiveness of an interactive multimedia program to influence eating habits. Health Educ Res 2004; 19(3): 290-305. 272

(26) Auslander W, Haire-Joshu D, Houston C, Rhee CW, Williams JH. A controlled evaluation of staging dietary patterns to reduce the risk of diabetes in African-American Women. Diabetes Care 2002; 25(5):809-814.320

(27) Burney J, Haughton B. EFNEP: A nutrition education program that demonstrates cost-benefit. J Am Diet Assoc 2002; 102(1):39-45. 9

(28) Coates RJ, Bowen DJ, Kristal AR, Feng Z, Oberman A, Hall WD et al. The Women's Health Trial Feasibility Study in Minority Populations: Changes in dietary intakes. Am J Epidemiol 1999; 149(12):1104-1112. 312

(29) Devine CM, Farrell TJ, Hartman R. Sisters in health: experiential program emphasizing social interaction increases fruit and vegetable intake among low-income adults. J Nutr Educ Behav 2005; 37(5):265-270. 334

(30) Goulet J, Lamarche B, Nadeau G, Lemieux S. Effect of a nutritional intervention promoting the Mediterranean food pattern on plasma lipids, lipoproteins and body weight in healthy French-Canadian women. Atherosclerosis 2003; 170(1):115-124. 323

(31) Haire-Joshu D, Brownson RC, Nanney MS, Houston C, Steger-May K, Schechtman K, Auslander W. Improving dietary behavior in African Americans: the Parents As Teachers High 5, Low Fat Program. Prev Med 2003; 36(6):684-691. 325

(32) Hartman TJ, McCarthy PR, Park RJ, Schuster E, Kushi LH. Results of a community-based low-literacy nutrition education program. J Community Health 1997; 22(5):325-341. 7

(33) Havas S, Treiman K, Langenberg P, Ballesteros M, Anliker J, Damron D, Feldman R. Factors associated with fruit and vegetable consumption among women participating in WIC. J Am Diet Assoc 1998; 98(10):1141-1148.4

(34) Baker AH, Wardle J. Increasing fruit and vegetable intake among adults attending colorectal cancer screening: the efficacy of a brief tailored intervention. Cancer Epidemiol Biomarkers Prev 2002; 11(2):203-206. 191

(35) Bowen DB, Ehret C, Pedersen M, Snetselaar L, Johnson M, Tinker L et al. Results of an adjunct dietary intervention program in the Women's Health Initiative. J Am Diet Assoc 2002; 102(11):1631-1637. 192

(36) Howard BV, Manson JE, Stefanick ML, Beresford SA, Frank G, Jones B et al. Low fat dietary pattern and risk of colorectal cancer: the Women's Health Initiative Randomised Controlled Dietary Modification Trial. JAMA 2006: 295 (6):639-49. 204

(37) Emmons KM, McBride CM, Puleo E, Pollak KI, Clipp E, Kuntz K et al. Project PREVENT: a randomized trial to reduce multiple behavioral risk factors for colon cancer. Cancer epidemiology, biomarkers & prevention: a publication of the American Association for Cancer Research, co-sponsored by the American Society of Preventive Oncology 2005; 14(6):1453-1459. 209

(38) Huxley RR, Lean M, Crozier A, John JH, Neil HA. Effect of dietary advice to increase fruit and vegetable consumption on plasma flavonol concentrations: results from a randomised controlled intervention trial. J Epidemiol Community Health 2004; 58(4):288-289. 206

(39) Pritchard DA, Hyndman J, Taba F. Nutritional counselling in general practice: a cost-effective analysis. J Epidemiol. Community Health 1999;53:311-316. 180

(40) Sacerdote C, Fiorini L, Rosato R, Audenino M, Valpreda M, Vineis P. Randomized controlled trial: Effect of nutritional counselling in general practice. International Journal of Epidemiology 2006; 35(2):409-415. 215

(41) Marcus AC, Heimendinger J, Wolfe P, Rimer BK, Morra M, Cox D et al. Increasing fruit and vegetable consumption among callers to the CIS: results from a randomized trial. Prev Med 1998; 27(5 Pt 2):S16-S28. 309

(42) Marcus AC, Heimendinger J, Wolfe P, Fairclough D, Rimer BK, Morra M et al. A randomized trial of a brief intervention to increase fruit and vegetable intake: a replication study among callers to the CIS. Prev Med 2001; 33(3):204-216.310

(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

(44) Stevens VJ, Glasgow RE, Toobert DJ, Karanja N, Smith KS. One-year results from a brief, computer-assisted intervention to decrease consumption of fat and increase consumption of fruits and vegetables. Prev Med 2003; 36(5):594-600. 322

(45) Patterson RE, Kristal A, Rodabough R, Caan B, Lillington L, Mossavar-Rahmani Y et al. Changes in food sources of dietary fat in response to an intensive low fat dietary intervention: early results from the Women's Health Initiative. J Am Diet Assoc 2003; 103(4):454-460. 193

(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

(47) Hopkins S, Burrows E, Bowen DJ, Tinker LF. Differences in eating pattern labels between maintainers and nonmaintainers in the women's health initiative. J Nutr Educ Behav 2001; 33(5):278-283. 195

(48) Langer RD, White E, Lewis CE, Kotchen JM, Hendrix SL, Trevisan M. The women's health initiative observational study: Baseline characteristics of participants and reliability of baseline measures. Annals of Epidemiology 2003; 13(9SUPPL.):S107-S121. 196

(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(9SUPPL.):S87-S97. 197

(50) Anderson GL, Manson J, Wallace R, Lund B, Hall D, Davis S et al. Implementation of the Women's Health Initiative study design. Annals of Epidemiology 2003; 13(9 SUPPL.):S5-S17. 198

(51) Fries E, Edinboro P, McClish D, Manion L, Bowen D, Beresford SAA et al. Randomized trial of a low-intensity dietary intervention in rural residents: The rural physician cancer prevention project. American Journal of Preventive Medicine 2005;28(2):162-168. 210

(52) Fries E, Edinboro P, McClish D, Murff HJ. A self-help intervention to change patient dietary behavior in rural communities. Journal of Clinical Outcomes Management 2005; 12(4):180-183. 211

(53) John JH, Ziebland S, Yudkin PL, Roe L, Neil HA. Effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure: a randomised controlled trial. The Lancet 2002; 359:1969-1974. 168

(54) John JH, Yudkin PL, Neil HAW, Ziebland S. Does stage of change predict outcome in a primary-care intervention to encourage an increase in fruit and vegetable consumption? Health Education Research 2003; 18(4):429-438. 189

(55) John JH, Ziebland S. Reported barriers to eating more fruit and vegetables before and after participation in a randomised controlled trial: a qualitative study. Health Education Research 2004; 19(2):165-174. 190

(56) Steptoe A, Doherty S, Rink E, Kerry S, Kendrick T, Hilton S. Behavioural counselling in general practice for the promotion of healthy behaviour among adults at increased risk of coronary heart disease: randomised trial. BMJ 1999;319(7215):943-947. 181

(57) Steptoe A, Perkins-Porras L, McKay C, Rink E, Hilton S, Cappuccio FP. Behavioural counselling to increase consumption of fruit and vegetables in low income adults: randomized trial. British Medical Journal 2003; 326(7394):855. 182

(58) Steptoe A, Kerry S, Rink E, Hilton S. The impact of behavioral counseling on stage of change in fat intake, physical activity, and cigarette smoking in adults at increased risk of coronary heart disease. Am J Public Health 2001; 91(2):265-269. 183

(59) Delichatsios H, Hunt M, Lobb R, Emmons K, Gillman MW. EatSmart: Efficacy of a multifaceted preventive nutrition intervention in clinical practice. Preventive Medicine 2001; 33(2):91-98. 185

(60) Hunt MK, Lobb R, Delichatsios HK, Stone C, et al. Process evaluation of a clinical preventative nutrition intervention. Prev Med. 2001; 33(2 Pt 1):82-90. 186

(61) Matsudo V, Matsudo S, Andrade D, Araujo T, Andrade E, de Oliveira C, Braggion G. Promotion of physical activity in a developing country: the Agita Sao Paulo experience. Publ Health Nutr 2001; 5(1A): 1-10. 38

(62) Matsudo S, Matsudo V, Andrade D, Araujo T, Andrade E, de Oliveira C, Braggion G. Physical activity promotion: Experiences and evaluation of the Agita Sao Paulo Program using the ecological mobile model. Journal of Physical Activity and Health 2004; 1: 81-97. 39

(63) Bauman A, McLean G, Hurdle D, Walker S, Boyd J, van Aalst I, Carr H. Evaluation of the national 'Push Play' campaign in New Zealand-creating population awareness of physical activity. N Z Med J. 2003 Aug 8;116(1179):U534. 52

(64) Bauman AE, Bellew B, Owen N, Vita P. Impact of an Australian Mass Media Campaign Targeting Physical Activity in 1998. Am J Prev Med 2001;21(1):41–47. 37

(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

(66) Huhman M, Potter LD, Wong FL, Banspach SW, Duke JC, Heitzler CD. Effects of a mass media campaign to increase physical activity among children: Year-1 results of the VERB campaign. Pediatrics 2005; 116(2): 277-284. 41

(67) Reger B, Cooper L, Booth-Butterfield S, Smith H, Bauman A, Wootan M, Middlestadt S, Marcus B, Greer F. Wheeling Walks: A community campaign using paid media to encourage walking among sedentary older adults. Prev Med 2002; 35:285-292. 50¨

(68) Reger-Nash, B, Fell P, Spicer D, Fisher BD, Cooper L, Chey T, Bauman A. BC Walks: Replication of a Communitywide Physical Activity Campaign. Prev Chronic Disease 2006; 3: [serial online] 2006 Jul [date cited]. Available from: URL:http://www.cdc.gov/pcd/ issues/2006/jul/05_0138.htm. 51

(69) Calfas KJ, Long BJ, Sallis JF et al. A controlled trial of physician counseling to promote the adoption of physical activity. SO: Preventive medicine. 1996;25(3):225-233. 223

(70) Green BB, McAfee T, Hindmarsh M et al. Effectiveness of telephone support in increasing physical activity levels in primary care patients. Am J Prev Med. 2002;22(3):177-183.220

(71) Phelan EA, Williams B, Leveille S, Snyder S, Wagner EH and LoGerfo JP. Outcomes of a community-based dissemination of the health enhancement program. J Am Geriatr Soc 50: 1519-1524, 2002. 355

(72) Stewart AL, Verboncoeur CJ, McLellan BY, Gillis DE, Rush S, Mills KM, King AC, Ritter P, Brown BW, Jr. and Bortz WM. Physical activity outcomes of CHAMPS II: a physical activity promotion program for older adults. J Gerontol A Biol Sci Med Sci 56: M465-M470, 2001. 351

(73) Wilcox S, Griffin SF, Rheaume C, et al., Results of the first year of active for life: translation of 2 evidence-based physical activity programs for older adults into community settings 2006; Am J Public Health 96(7): 354

(74) Rosamond WD, Ammerman A, Holliday JL, Tawney KW, Hunt KJ, Keyserling T et al. Cardiovascular disease risk factor intervention in low-income women: The North Carolina WISEWOMAN Project. Preventive Medicine 2000; 31: 370-379. 184

(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

(76) Wardle J, Rapoport L, Miles A, Afuape T and Duman M. Mass education for obesity prevention: the penetration of the BBC's 'Fighting Fat, Fighting Fit' campaign. Health Education Research 2001; 16(3): 343-355. 46

(77) Warren JM, Henry CJ, Lightowler HJ, Bradshaw SM, Perwaiz S. Evaluation of a pilot school programme aimed at the prevention of obesity in children. Health Promot Int 2003; 18(4):287-296. 134

(78) Emmons KM, Linnan LA, Shadel WG, Marcus B, Abrams DB. The Working Healthy Project: a worksite health-promotion trial targeting physical activity, diet and smoking. J Occup Environ Med 1999; 41(7):545-555. 258

(79) Polacsek M, O'Brien L, Lagasse W, Hammar N. Move & Improve: A Worksite Wellness Program in Maine. Prev Chronic Dis 2006; www.cdc.gov/pcd/issues/2006/jul/05_0123.htm 278

(80) Aldana SG, Greenlaw RL, Diehl HA, Salberg A, Merrill RM, Ohmine S, Thomas C. Effects of an intensive diet and physical activity modification program on the health risks of adults. J Am Diet Assoc 2005; 105(3):371-381. 335

(81) Staten LK, Scheu LL, Bronson D, Pena V, Elenes J Pasos Adelante: the effectiveness of a community-based chronic disease prevention program Prev Chronic Dis. 2005 Jan;2(1):A18. Epub 2004 Dec 15 341

(82) Wylie-Rosett J, Swencionis C, Ginsberg M, Cimino C, Wassertheil-Smoller S, Caban A, Segal-Isaacson CJ, Martin T, Lewis J. Computerized weight loss intervention optimizes staff time: the clinical and cost results of a controlled clinical trial conducted in a managed care setting. J Am Diet Assoc 2001; 101:1155-62. 316

(83) Englert et al., Prev Med. 2004 Apr;38(4):432-41.Rationale and design of the Rockford CHIP, a community-based coronary risk reduction program: results of a pilot phase.

(84) Burke V, Giangiulio N, Gillam HF, Beilin LJ, Houghton S. Physical activity and nutrition programs for couples: a randomized controlled trial. J Clin Epidemiol 2003; 56(5):421-432. 326

(85) Burke V, Giangiulio N, Gillam HF, Beilin LJ, Houghton S. Changes in cognitive measures in a randomized controlled trial of a health promotion program for couples targeting diet and physical activity. Am J Health Promot 2004; 18(4):300-311. 327

(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

(87) Kuller LH, Simkin-Silverman LR, Wing RR, Meilahn EN, Ives DG. Women's Healthy Lifestyle Project: A randomised clinical Trial. Circulation. 2001; 103:32-44. 307

(88) Elley CR, Kerse N, Arroll B, Robinson E. Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial. BMJ. 2003;326(7393):793. 216

(89) Green Prescription online - http://www.sparc.org.nz/getting-active/green-prescription/overview 236

(90) Prell HC, Berg MC, Jonsson LM, Lissner L. A school-based intervention to promote dietary change. J Adolesc Health 2005; 36(6):515-529. 137

(91) Lytle LA, Kubik MY, Perry C, Story M, Birnbaum AS, Murray DM. Influencing healthful food choices in school and home environments: Results from the TEENS study. Prev Med 2006; 43: 8-13. 97

(92) Nicklas TA, Johnson CC, Farris R, Rice R, Lyon L, Shi R. Development of a school-based nutrition intervention for high school students: Gimme 5. Am J Health Promot 1997; 11(5):315-322. 86

(93) Perry CL, Bishop DB, Taylor G, Murray DM, Mays RW, Dudovitz BS et al. Changing fruit and vegetable consumption among children: the 5-a-Day Power Plus program in St. Paul, Minnesota. Am J Public Health 1998; 88(4):603-609 93

(94) Reynolds KD, Franklin FA, Binkley D, Raczynski JM, Harrington KF, Kirk KA, Person S. Increasing the fruit and vegetable consumption of fourth-graders: results from the high 5 project. Prev Med 2000; 30(4):309-319. 90

(95) Saksvig BI, Gittelsohn J, Harris SB, Hanley AJ, Valente TW, Zinman B. A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for native Canadian children. J Nutr 2005;135(10):2392-2398. 126

(96) Osganian SK, Ebzery MK, Montgomery DH, Nicklas TA, Evans MA, Mitchell PD et al. Changes in the nutrient content of school lunches: results from the CATCH Eat Smart Food service Intervention. Prev Med 1996; 25(4):400-412. 78

(97) Dwyer JT, Hewes LV, Mitchell PD, Nicklas TA, Montgomery DH, Lytle LA et al. Improving school breakfasts: effects of the CATCH Eat Smart program on the nutrient content of school breakfasts. Prev Med 1996; 25(4):413-422. 79

(98) Williams CL, Bollella MC, Strobino BA, Spark A, Nicklas TA, Tolosi LB, Pittman BP. "Healthy-start": outcome of an intervention to promote a heart healthy diet in preschool children. J Am Coll Nutr 2002; 21(1):62-71. 101

(99) Williams CL, Strobino BA, Bollella C, Brotanek J. Cardiovascular risk reduction in preschool children: The "Healthy Start" project. J Am Coll Nutr 2004; 23(2): 117-123. 102

(100) Simon C, Wagner A, Platat C, Arveiler D, Schweitzer B, Schlienger JL, Triby E. ICAPS: a multilevel program to improve physical activity in adolescents. Diabetes Metab. 2006 Feb;32(1):41-9

(101) Simon C, Wagner A, DiVita C, Rauscher E, Klein-Platat C, Arveiler D, Schweitzer B, Triby E. Intervention centred on adolescents' physical activity and sedentary behaviour (ICAPS): concept and 6-month results. Int J Obes Relat Metab Disord. 2004 Nov;28 Suppl 3:S96-S103. X.

(102) Engels HJ, Gretebeck RJ, Gretebeck KA, Jimenez L. Promoting healthful diets and exercise: efficacy of a 12-week after-school program in urban African Americans. J Am Diet Assoc 2005; 105(3):455-459. 114

(103) Friel S, Kelleher C, Campbell P, Nolan G. Evaluation of the Nutrition Education at Primary School (NEAPS) programme. Public Health Nutr 1999; 2(4):549-555. 125

(104) Gortmaker SL, Cheung LW, Peterson KE, Chomitz G, Cradle JH, Dart H et al. Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children: eat well and keep moving. Arch Pediatr Adolesc Med 1999; 153(9):975-983. 100

(105) Harrell JS, McMurray RG, Gansky SA, Bangdiwala SI, Bradley CB. A public health vs. a risk-based intervention to improve cardiovascular health in elementary school children: The cardiovascular health in children study. Am J Public Health 1999; 89:1529-1535. 113

(106) Trevino RP, Yin Z, Hernandez A, Hale DE, Garcia OA, Mobley C. Impact of the Bienestar school-based diabetes mellitus prevention program on fasting capillary glucose levels: a randomized controlled trial. Arch Pediatr Adolesc Med 2004; 158(9):911-917. 124

(107) Pegus C, Bazzarre TL, Brown JS, Menzin J. Effect of the Heart At Work program on awareness of risk factors, self-efficacy, and health behaviours. J Occup Environ Med 2002; 44(3):228-236. 268

(108) Manios Y, Kafatos A, Mamalakis G. The effects of a health education intervention initiated at first grade over a 3 year period: physical activity and fitness indices. Health Ed Res 1998; 13: 593-606.

(109) Fardy PS, White RE, Haltiwanger-Schmitz K, Magel JR, McDermott KJ, Clark LT, Hurster MM. Coronary disease risk factor reduction and behavior modification in minority adolescents: the PATH program. J Adolesc Health 1996; 18(4):247-253. 109

(110) Bayne-Smith M, Fardy PS, Azzollini A, Magel J, Schmitz KH, Agin D. Improvements in heart health behaviors and reduction in coronary artery disease risk factors in urban teenaged girls through a school-based intervention: the PATH program. Am J Public Health 2004; 94(9):1538-1543. 110

(111) Manios Y, Kafatos A. Health and nutrition education in elementary schools: changes in health knowledge, nutrient intakes and physical activity over a six year period. Public Health Nutr 1999; 2(3A):445-448; 62

(112) Manios Y, Moschandreas J, Hatzis C, Kafatos A. Evaluation of a health and nutrition education program in primary school children of Crete over a three-year period. Prev Med 1999; 28(2):149-159. 98

(113) Manios Y, Moschandreas J, Hatzis C, Kafatos A. Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. Br J Nutr 2002; 88(3):315-324. 99

(114) Paradis G, Levesque L, Macaulay AC, Cargo M, McComber A, Kirby R et al. Impact of a diabetes prevention program in body size, physical activity, and diet among Kanien'keha:ka (Mohawk) children 6 to 11 years old: 8 year results from the Kahnawake Schools Diabetes Prevention Project. Pediatrics 2005; 115(2):333-339. 130

(115) Jimenez MM, Receveur O, Trifonopoulos M, Kuhnlein H, Paradis G, Macaulay AC. Comparison of the dietary intakes of two different groups of children (grades 4 to 6) before and after the Kahnawake Schools Diabetes Prevention Project. J Am Diet Assoc 2003; 103(9):1191-1194. 131

(116) Macaulay AC, Paradis G, Potvin L, Cross EJ, Saad-Haddad C, McComber A et al. The Kahnawake Schools Diabetes Prevention Project: intervention, evaluation, and baseline results of a diabetes primary prevention program with a native community in Canada. Prev Med 1997; 26(6):779-790. 132

(117) Sahota P, Rudolf MC, Dixey R, Hill AJ, Barth JH, Cade J. Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. Br Med J 2001; 323(7320):1029-1032. 68

(118) Sahota P, Rudolf MC, Dixey R, Hill AJ, Barth JH, Cade J. Evaluation of implementation and effect of primary school based intervention to reduce risk factors for obesity. Br Med J 2001; 323(7320):1027-1029. 69

(119) Caballero B, Clay T, Davis SM, Ethelbah B, Rock BH, Lohman T et al. Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. Am J Clin Nutr 2003; 78(5):1030-1038. 64

(120) Davis SM, Clay T, Smyth M, Gittelsohn J, Arviso V, Flint-Wagner H et al. Pathways curriculum and family interventions to promote healthful eating and physical activity in American Indian schoolchildren. Prev Med 2003; 37: S24-S34. 65

(121) Stevens J, Story M, Ring K, Murray DM, Cornell CE, Juhaeri , Gittelsohn J. The impact of the Pathways intervention on psychosocial variables related to diet and physical activity in American Indian schoolchildren. Prev Med 2003; 37(6):S70-S79. 66

(122) Steckler A, Ethelbah B, Martin CJ, Stewart D, Pardilla M, Gittelsohn J et al. Pathways process evaluation results: a school-based prevention trial to promote healthful diet and physical activity in American Indian third, fourth and fifth grade students. Prev Med 2003; 37(6):S80-S90. 67

(123) Aldana SG, Greenlaw RL, Diehl HA, Salberg A, Merrill RM, Ohmine S. The effects of a worksite chronic disease prevention program. J Occup Environ Med 2005; 47(6):558-564. 275

(124) Armitage CJ, Conner M. Efficacy of a minimal intervention to reduce fat intake. Soc Sci Med 2001; 52(10):1517-1524. 263

(125) Webber LS, Osganian SK, Feldman HA, Wu M, McKenzie TL, Nichaman M et al. Cardiovascular risk factors among children after a 2 1/2- -year intervention - The CATCH study. Prev Med 1996; 25:432-441. 70

(126) Edmundson E, Parcel GS, Feldman HA, Elder J, Perry CL, Johnson CC et al. The effects of the child and adolescent trial for cardiovascular health upon psychosocial determinants of diet and physical activity behavior. Prev Med 1996; 25(4):442-454. 71

(127) Lytle LA, Stone EJ, Nichaman MZ, Perry CL, Montgomery DH, Nicklas TA et al. Changes in nutrient intakes of elementary school children following a school-based intervention: results from the CATCH Study. Prev Med 1996; 25(4):465-477. 72

(128) Nader PR, Sellers DE, Johnson CC, Perry CL, Stone EJ, Cook KC et al. The effect of adult participation in a school-based family intervention to improve children's diet and physical activity: the child and adolescent trial for cardiovascular health. Prev Med 1996; 25(4):455-464. 73

(129) Nader PR, Stone EJ, Lytle LA, Perry CL, Osganian SK, Kelder S et al. Three-year maintenance of improved diet and physical activity: The CATCH cohort. Arch Pediatr Adolesc Med 1999; 153(7):695-704. 74

(130) Hoelscher DM, Feldman HA, Johnson CC, Lytle LA, Osganian SK, Parcel GS et al. School-based health education programs can be maintained over time: results from CATCH Institutionalization study. Prev Med 2004; 38(5):594-606. 75

(131) Luepker RV, Perry CL, Osganian V, Nader PR, Parcel GS, Stone EJ, Webber LS. The child and adolescent trial for cardiovascular health (CATCH). J Nutr Biochem 1998; 9: 525-534. 76

(132) Perry CL, Lytle L, Feldman H, Nicklas T, Stone E, Zive M. Effects of the Child and Adolescent Trial for Cardiovascular Health (CATCH) on fruit and vegetable intake. J Nutr 1998; 30(6):354-360. 77

(133) Nafziger AN, Erb TA, Jenkins PL, Lewis C, Pearson TA. The Otsego-Schoharie healthy heart program: prevention of cardiovascular disease in the rural US. Scand J Public Health Suppl. 2001;56:21-32. 56

(134) Rowley KG, Su Q, Cincotta M, Skinner M, Skinner K, Pindan B, White GA, O'Dea K. Improvements in circulating cholesterol, antioxidants, and homocysteine after dietary intervention in an Australian Aboriginal community. Am J Clin Nutr 2001; 74(4):442-448. 319

(135) Anderson JV, Bybee DI, Brown RM, McLean DF, Garcia EM, Breer ML, Schillo A. 5-a-Day fruit and vegetable intervention improves consumption in a low income population. J Am Diet Assoc 2001; 101(2):195-202. 6

(136) Redman S, Sanson FR, Kreft S, Fleming J, Dickinson J. Is the Australian National Heart Foundation programme effective in reducing cholesterol levels among general practice patients? Health Promotion International 1995; 10(4):293-303.174

(137) Anon. Effectiveness of health checks conducted by nurses in primary care: final results of the OXCHECK study. Imperial Cancer Research Fund OXCHECK Study Group. BMJ 1995; 310(6987):1099-1104. 169

(138) Field K, Thorogood M, Silagy C, Normand C. O'Neill, Muir J. Strategies for reducing coronary risk factors in Primary care: which is most cost-effective? BMJ 1995; 310:1109-1112. 170

(139) Langham S, Thorgood M, Normand C, Muir J, Jones L, Fowler G. Costs and cost effectiveness of health checks conducted by nurses in primary care: the Oxcheck study. BMJ 1996; 312: 1265-68. 171

(140) Emmons KM, Stoddard AM, Fletcher R, Gutheil C, Suarez EG, Lobb R et al. Cancer prevention among working class, multiethnic adults: results of the healthy directions-health centers study. Am J Public Health 2005; 95(7):1200-1205. 207

(141) Lobb R, Gonzalez SE, Fay ME, Gutheil CM, Hunt MK, Fletcher RH et al. Implementation of a cancer prevention program for working class, multiethnic populations. Prev Med 2004; 38(6):766-776 208

(142) Aittasalo M, Miilunpalo S, Kukkonen-Harjula K, Pasanen M. A randomized intervention of physical activity promotion and patient self-monitoring in primary health care. Preventive Medicine. 2006;42(1):40-46. 226

(143) Becker DM, Yanek LR, Johnson WR, Jr., Garrett D, Moy TF, Reynolds SS et al. Impact of a community-based multiple risk factor intervention on cardiovascular risk in black families with a history of premature coronary disease. Circulation 2005;111(10):1298-1304. 214

(144) Sarraf-Zadgan N, Sadri G, Afzali HM, et al., Isfahan Healthy Heart Program: A comprehensive integrated community-based program for cardiovascular disease prevention and control. Acta Cardiol 2003; 58(4): 309-20. 61

(145) Bartholomew JB, Jowers EM. Increasing frequency of lower-fat entrees offered at school lunch: an environmental change strategy to increase healthful selections. J Am Diet Assoc 2006;106(2): 248-252. 144

(146) French SA, Story M, Fulkerson JA, Hannan P. An environmental intervention to promote lower-fat food choices in secondary schools: outcomes of the TACOS Study. American journal of public health 2004; 94(9):1507-1512. 128 375

(147) Coleman, KJ & Gonzalez EC. Promoting Stair Use in a US-Mexico Border Community Am J Public Health, 2001;91(12):2007-2009. 21

(148) Andersen RE, Franckowiak SC, Snyder J et al. Can inexpensive signs encourage the use of stairs? Results from a community intervention. Ann Intern Med.1998;129(5):363-369. 12

(149) Marshall AL., Bauman AE., Patch C., Wilson J., Chen J. Can motivational signs prompt increases in accidental physical activity in an Australian health-care facility? Health Education Research (17), 6: 743-749, 2002 280

(150) Russell WD, Hutchinson J. Comparison of health promotion and deterrent prompts in increasing use of stairs over escalators. Percept Mot Skills. 2000;91(1):55-61. 22

(151) Naylor PJ, Macdonald HM, Reed KE, McKay HA. Action Schools! BC: A socio-ecological approach to modifying chronic disease risk factors in elementary school children. Preventing Chronic Disease: Public Health Research, Practice and Policy 2006; 3(2) 156

(152) Naylor PJ, MacDonald HM, Zebedee JA, McKay HA. Lessons learned from Action Schools! BC- an 'active school' model to promote physical activity in elementary schools. J Sci Med Sport 2006; 9(5): 413-23. 157

REFERENCES

Adam, T., D.B. Evans and C.J.L. Murray (2003), "Econometric Estimation of Country-Specific Hospital Costs", *Cost Effectiveness and Resource Allocation*, 1, 3.

Adam, T. and D.B. Evans (2006), "Determinants of Variation in the Cost of Inpatient Stays Versus Outpatient Visits in Hospitals: a Multi-Country Analysis", *Social Science and Medicine*, 63, pp. 1700-10.

Barendregt, J.J. (2003), "A Generic Model for the Assessment of Disease Epidemiology: the Computational Basis of DisMod II", *Population Health Metrics,* 14;1(1), p.4.

Buller, D.B. *et al.* (1999), "Randomized Trial Testing the Effect of Peer Education at Increasing Fruit and Vegetable Intake", *Journal of the National Cancer Institute* 91(17), pp. 1491-1500.

Butland, B. *et al.* (2007), *Foresight – Tackling obesities: future choices – project report* http://www.foresight.gov.uk/OurWork/ActiveProjects/Obesity/Obesity.asp

Chisholm, D. *et al.* (2004), "Reducing the Global Burden of Depression: Population-Level Analysis of Intervention Cost-Effectiveness in 14 World Regions", *British Journal of Psychiatry*, 184, pp. 393-403.

Chisholm, D. *et al.* (2004), "Reducing the Global Burden of Hazardous Alcohol Use: a Comparative Cost-Effectiveness Analysis", *Journal of Studies on Alcohol*, 65, pp. 782-793.

Chou, S., I. Rasha and M. Grossman (2005), "Fast-Food Restaurant Advertising on Television and its Influence on Childhood Obesity", NBER Working paper no. 11879, JEL no. I10, I12.

Craig, C.L., C. Tudor-Locke and A. Bauman (2007), "Twelve-Month Effects of Canada on the Move: a Population-Wide Campaign to Promote Pedometer Use and Walking", *Health Education Research,* 22(3), pp. 406-13.

Dixon, H. *et al*. (1998), "Public Reaction to Victoria's '2 Fruit 'n' 5 Veg Every Day' Campaign and Reported Consumption of Fruit and Vegetables", *Preventive Medicine*, 27(4), pp. 572-582.

Emmons, K.M. *et al.* (1999), "The Working Healthy Project: a Worksite Health Promotion Trial Targeting Physical Activity, Diet and Smoking", *Journal of Occupational & Environmental Medicine*, 41(7), pp. 545-555.

Evans, D.B. *et al.* (2005), "Methods to Assess the Costs and Health Effects of Interventions for Improving Health in Developing Countries", *BMJ*, 331, pp. 1137-40.

Foerster SB, California's "5-a-Day - for better health" campaign: an innovative population-based effort to effect large scale dietary change. American Journal of Preventive Medicine 1995; 11:124-131.

Gortmaker, S.L. *et al.* (1999), "Impact of a School-Based Interdisciplinary Intervention on Diet and Physical Activity among Urban Primary School Children: Eat Well and Keep Moving", *Archives of Pediatrics & Adolescent Medicine*, 153(9), pp. 975-983.

Groot, M.T. *et al.* (2006), "Costs and Health Effects of Breast Cancer Interventions in Epidemiologically Different Regions of Africa, North America, and Asia", *Breast Journal*, 12, Supplement 1 S81-90.

Heijink, R. *et al.* (2008), "Cost of Illness: an International Comparison. Australia, Canada, France, Germany and the Netherlands", *Health Policy,* 88(1), pp. 49-61.

Herbert, J.R. *et al.* (1999), "A Dietician-Delivered Group Nutrition Program Leads to Reductions in Dietary Fat, Serum Cholesterol and Body Weight: the Worcester-Area Trial for Counselling in Hyperlipidaemia (WATCH)", *Journal of the American Dietetic Association*, 99(5), pp. 544-52.

Hespel, V. and M. Berthod-Wurmser (2008), "La pertinence et la faisabilité d'une taxation nutritionnelle", République Française, Inspection Générale de Finances et Inspection Générale des Affaires Sociales.

Hutubessy, R., D. Chisholm and T. Tan Torres (2003), "Generalized Cost-Effectiveness Analysis for National-Level Priority-Setting in the Health Sector", Cost Effectiveness and Resource Allocation, 1, 8, http://www.resource-allocation.com/content/1/1/8.

Johns, B., T, Adam and D.B. Evans (2006), "Enhancing the Comparability of Costing Methods: Cross-Country Variability in the Prices of Non-Traded Inputs to Health Programmes", *Cost Effectiveness and Resource Allocation*, 4, 8.

Johns, B. *et al.* (2003), "Programme costs in the economic evaluation of health interventions", *Cost Effectiveness and Resource Allocation*, 1, 1.

Luepker, R.V. *et al.* (1998), "The child and adolescent trial for cardiovascular health (CATCH)", *Journal of Nutritional Biochemistry*, 9, pp. 525-534.

Millstone, E. and T. Lobstein (2007), "The PorGrow Project: Overall Cross-National Results, Comparisons and Implications", *Obesity Review*, vol. 8 suppl. 2, pp. 29-36.

Murray, C. J. L. *et al.* (2000), "Development of WHO Guidelines on Generalized Cost-Effectiveness Analysis", *Health Economics*, 9, pp. 235-251.

Murray, C. J. L. *et al* (2003), "Effectiveness and Costs of Interventions to Lower Systolic Blood Pressure and Cholesterol: a Global and Regional Analysis on Reduction of Cardiovascular Disease", *The Lancet*, 361, pp. 717-725.

Murray, C. J. L. and D. B. Evans (2003), "Health Systems Performance Assessment: Goals, Framework and Overview", in C. J. L. Murray and D. B. Evans (eds), *Health System Performance Assessment: Debates, Methods and Empiricism*, Geneva, World Health Organization, pp. 3-18.

Ockene, I.S., *et al.* (1996), "Effect of Training and a Structured Office Practice on Physician-Delivered Nutrition Counseling: the Worcester-Area Trial for Counseling in Hyperlipidemia (WATCH)", *American Journal of Preventive Medicine*, vol. 12(4), pp. 252-258.

Perry, C.L. *et al.* (1998), "Changing Fruit and Vegetable Consumption Among children: the 5-a-Day Power Plus Program in St. Paul, Minnesota", *American Journal of Public Health*, vol. 88(4), pp. 603-609.

Pritchard, D.A., J. Hyndman and F. Taba (1999), "Nutritional Counselling in General Practice: a Cost-Effective Analysis", *Journal of Epidemiology and Community Health*, vol. 53, pp. 311-316.

Reynolds, K.D. *et al.* (2000), "Increasing the Fruit and Vegetable Consumption of Fourth-Graders: Results from the High 5 Project", *Preventive Medicine*, vol. 30(4), pp. 309-319.

Shibuya, K. *et al.* (2003), "WHO Framework Convention on Tobacco Control: Development of an Evidence-Based Global Public Health Treaty", *British Medical Journal*, vol. 327, pp. 154-157.

Sorensen, G. *et al.* (1998), "The Effects of a Health Promotion-Health Protection Intervention on Behavior Change: the WellWorks Study", *American Journal of Public Health*, vol. 88(11), pp. 1685-1690.

Sorensen, G. *et al.* (1999), "Increasing Fruit and Vegetable Consumption through Worksites and Families in the Treatwell 5-a-day Study", *American Journal of Public Health*, vol. 89(1), pp. 54-60.

Sorensen, G. *et al.* (1996), "Worksite-Based Cancer Prevention: Primary Results from Working Well Trial", *American Journal of Public Health*, vol. 86(7), pp. 939-947.

Tan Torres, T. *et al.* (2003), "Making Choices in Health: WHO Guide to Cost-Effectiveness Analysis", Geneva, World Health Organization.

Tengs, T. O. *et al* (1995), "Five Hundred Life-Saving Interventions and their Cost-Effectiveness' [see comments], *Risk Analysis*, 15, pp. 369-390.

World Health Organization (2002), "Some Strategies to Reduce Risk", *World Health Report 2002: Reducing Risks, Promoting Health Life*, Chapter 5, pp. 101-144. Geneva, WHO.