Organisation for Economic Co-operation and Development

DELSA/HEA(2018)4

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DIRECTORATE FOR EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
HEALTH COMMITTEE

CURRENT WORK ON PUBLIC HEALTH (OBESITY) AND FUTURE DEVELOPMENTS - PROGRESS REPORT

23rd Session of the Health Committee

To be held on Wednesday 27 and Thursday 28 June 2018
at the OECD Conference Centre, 2 rue André Pascal, 75016 Paris, France

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JT03433098

Note by the Secretariat

1. The Health Committee work on public health has produced analyses of the extent and nature of common risk factors for major chronic diseases, and has produced evidence of the health and economic impacts of alternative approaches to prevent such diseases. A first series of analyses was presented in the OECD Publication titled: "*Obesity and the Economics of Prevention - Fit not Fat*".

2. During the last year, work carried out by the Secretariat considered innovative effective and cost-effective actions to tackle obesity, unhealthy diets and physical inactivity. More specifically, the following outputs were produced:

- *OECD Health Working Paper number 100*: "Diet, physical activity and sedentary behaviours - Analysis of trends, inequalities and clustering in selected OECD countries". The document includes analyses on consumption of fruit and vegetables, quality of diet, physical activity and sedentary behaviours.
- *OECD Obesity Update 2017*. It provides the most recent insights on obesity trends and recent policy developments to promote a healthy diet and an active lifestyle in OECD countries and contains a 'special focus' on communication policies to inform and empower consumers' choices;
- *Healthy people, healthy planet*. This policy brief, released in conjunction with the meeting of the Ministers of Health of G7 countries, analyses the role of health systems to promote healthier lifestyles and a greener future, including promoting the adoption of nutritional guidelines to tackle overconsumption of food, unhealthy diets and food waste and implementing public health actions encouraging more physical activity and greater reliance on active modes of transportation;
- The *FRESHER explorer online platform*. As part of its contribution to the Foresight and Modelling for European Health and Policy Regulation project, OECD has used its modelling platform to foresight potential health scenarios and policy impact in three European regions. Results from this project can be found at http://www.fresher-explorer.eu/.

3. In addition, the Secretariat has further developed its work on public health, including work on obesity, in a number of directions. First, the Secretariat has expanded data work to investigate trends and inequalities of the key determinants of obesity, including diet and physical inactivity. Second, the Secretariat has started work on evidence on 'what works' in tackling obesity, unhealthy diet and physical inactivity. Third, the Secretariat further developed the microsimulation platform to evaluate the effectiveness and cost-effectiveness of innovative policy options. Fourth, the Secretariat has kick-started work to assess the broader economic and social implications of key risk factors and their associated non-communicable diseases, and of public health actions to tackle these risk factors.

4. This paper reports on key advancements of the work, with a particular focus on the following dimensions: i) trends of obesity and associated risk factors; ii) impact of obesity on labour market and educational outcomes; iii) effectiveness of policies to promote a healthy lifestyle; and iv) impact of policies on business and industry (with reformulation as case study). The content of this paper will be further expanded and complemented to prepare a new Obesity report for publication in late 2019.

5. Delegates to the Health Committee are invited to:

- **COMMENT** the analyses and findings presented in this paper.
- **COMMENT** the policy implications of the presented findings, in particular concerning the impact of obesity and associated chronic diseases on labour market outcomes and business and industry.
- **PROVIDE** examples of relevant policies that have been recently implemented in their country (e.g., scope of the policy, population target, any evidence of health and economic impacts, as well as wider impacts on other economic sectors).
- **COMMENT** on the proposed developments and future work on obesity and associated non-communicable diseases, including ways to increase the policy-relevance of its work.

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1. Introduction and objectives of this paper

6. This paper reports some of the key advancements of the work on risk factors associated with non-communicable diseases (NCDs) that the Secretariat has carried out since the release of the previous report to the Health Committee (OECD, 2016[1]). In view of the next publication on obesity, unhealthy diet and physical inactivity, tentatively expected for 2019, this paper has a specific focus on these risk factors and associated NCDs. Such publication will address the broader economic implications of obesity and associated NCDs as well as the impact of public health policies to promote healthier lifestyles. More specifically, the economic analysis will consider the following dimensions: health (including both morbidity and mortality), healthcare expenditure, educational outcomes and impact on the labour market (including employment probability, absenteeism, presenteeism, etc.). The publication will also contain an update of the main analyses on trends and inequalities in obesity and associated risk factors (i.e. physical activity and diet) as well as a chapter exploring the potential impact of public health actions on business and industry.

7. Table 1.1 reports a tentative outline of the final publication with a roadmap of how the different analyses reported in this document fit in the work plan for the final publication. The Committee will further review in a future session the advancement of this work, including in areas not covered by this document.

Table 1.1. Draft outline of the final report

Chapter in the report	Corresponding section in this document	Description of the chapter
Assessment and recommendation	-	The A&R chapter will summarize the main messages from the various chapters and discusses key policy implications.
Analysis of trends and patterns	3	This chapter will analyse the latest data on trends and inequalities in obesity and associated risk factors (i.e. diet and physical activity) in OECD countries. Some preliminary analyses are presented in section 3 of this document.
The impact of obesity on health and healthcare expenditure	-	This chapter will build on previous OECD modelling work to calculate the impact of key NCDs caused by obesity on the population health and healthcare expenditure.
The impact of obesity on the economy	4	This chapter will discuss the impact of obesity and associated NCDs on labour market outcomes, education and the broader economy. Some preliminary analyses are presented in section 4 of this document.
Promoting healthier lifestyles: what policy approaches?	5	This chapter will discuss the expected effectiveness of innovative policy options to tackle unhealthy lifestyles and present 'case studies' and 'best practices' of how these policies are implemented in OECD countries. Some preliminary analyses are presented in section 5 of this document.

The health and economic impact of obesity policies	-	This chapter will build on previous OECD modelling work to calculate the effectiveness (health and economic impact) of selected policy options drawn from those discussed in the previous chapter of the final publication
The impact of policies on business	6	This chapter will discuss the potential impact of selected public health actions on business and on approaches to mitigate unwanted effects.
Country notes	-	A series of country notes will summarize country-specific results and policy implications

Note: Chapter outline subject to adjustments as the work progresses.
Source: OECD Secretariat.

8. The remainder of this document is divided into a number of sections, closely aligned with the chapters of the final publication. Section 2. focuses on the data analysis and presents preliminary findings on trends in obesity and on the identification of population groups with the least healthy behaviours. Section 3. focuses on the impact of NCDs on labour market outcomes and welfare benefits (Section 3.1) and on education outcomes (Section 3.2). Section 4. presents early results on the effectiveness of interventions to promote a healthier lifestyle and discuss work to better tailor public health actions to population groups at highest risk for unhealthy lifestyles and related NCDs. Section 5. presents an analysis of the potential impact of reformulation on business and industry; this is used as a 'proof of concept' analysis that will be extended to other selected public health actions. Finally, Section 6. discusses next steps in the finalisation of the analyses.

9. It should be noted that this paper does not discuss current work to further develop the OECD microsimulation platform: the OECD SPHeP-NCD (Strategic Public Health Planning for NCDs) model. While work to develop the model is ongoing, structure and characteristics of the model will be discussed in a future document, when the preliminary results for the chapters on "the impact of obesity on health and healthcare expenditure" and on "the health and economic impact of obesity policies" will be presented. Results presented in these chapters will, in fact, heavily rely on analyses carried out with the OECD SPHeP-NCD model. Further information on the future development of the OECD SPHeP-NCD model can be found in Section 6.

Box 1.1. The OECD SPHeP-NCD model

The OECD Strategic Public Health Planning for NCDs (SPHeP-NCD) model is an advanced systems modelling tool for public health policy and strategic planning. The model is used to predict the health and economic outcomes of the population of a country or a region up to 2050. The model consolidates into a single platform previous OECD modelling work to reproduce a comprehensive set of key behavioural and physiological risk factors (e.g. obesity, physical activity, salt intake, blood pressure, etc) and their associated NCDs. The model is built on four major modules: demography, diseases, risk factors, and medical costs. The model reproduces the demographic, epidemiological, and risk factor characteristics by age- and gender-specific population groups for a comprehensive set of countries at different points in time, using international databases. Medical costs of disease treatment are extrapolated from national health-related expenditure data. The model can be used to evaluate the expected long-term gains of innovative public health actions in terms of health and economic outcomes.

2. Obesity is growing; some population groups are at higher risk

10. This section presents some preliminary results of the stream of work focused on updating data analyses on trends in obesity and associated risk factors. Section 2.1 presents the latest obesity data as well as a new set of obesity projections taking into account the latest statistics. Section 2.2 presents results from a new analysis aiming to identify population groups at higher risk for unhealthy lifestyles. Additional work is being carried out to study obesity inequalities across different population groups and patterns of diet and physical activity (PA).

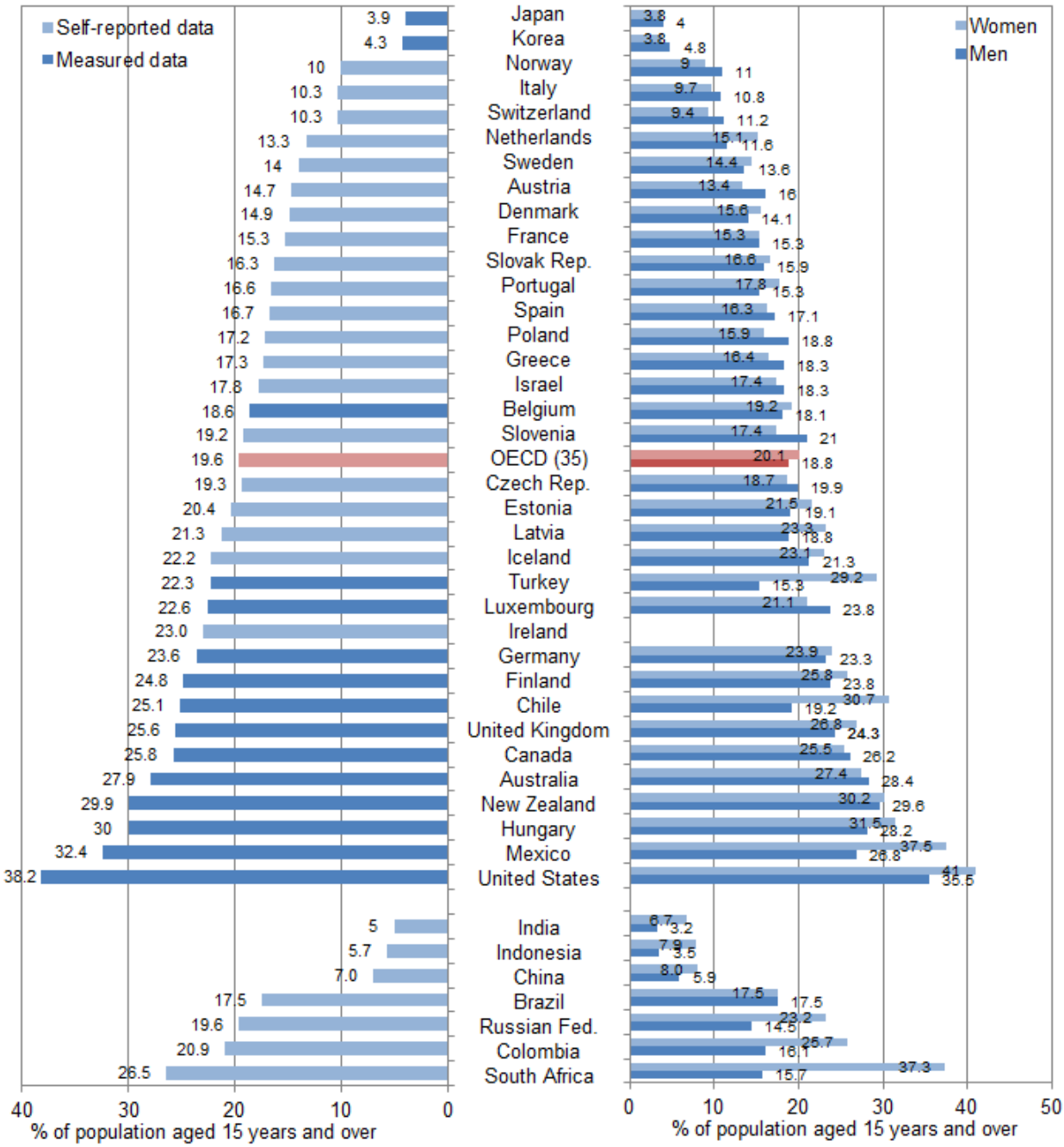
2.1. Obesity and overweight have continued to increase is some countries

11. In 2015, across the OECD, 19.5% of the adult population was obese (Figure 2.1). This rate ranges from less than 6% in Korea and Japan to more than 30% in Hungary, New Zealand, Mexico and the United States. More than one in four adults is obese in Australia, Canada, Chile, South Africa and the United Kingdom. Overweight and obesity rates have grown rapidly in England, Mexico and the United States since the 1990s, while the increase has been slower in the other OECD countries for which trend data are available. Over the past decade, the prevalence rate of overweight and obesity has increased in Canada, France, Mexico, Switzerland and the United States, while it has stabilised in England, Italy, Korea and Spain. There is, however, no clear sign of retrenchment of the epidemic, in any country.

12. Similarly, and despite policies put in place in OECD countries for a number of years, the number of 15-year-olds who report being overweight or obese has steadily increased since 2000 in the majority of countries. According to the Health Behaviour in School-aged Children survey (HBSC) (Inchley et al., 2016[2]), the share of children who are overweight or obese at age 15 ranges from 10% in Denmark to 31% in the United States.

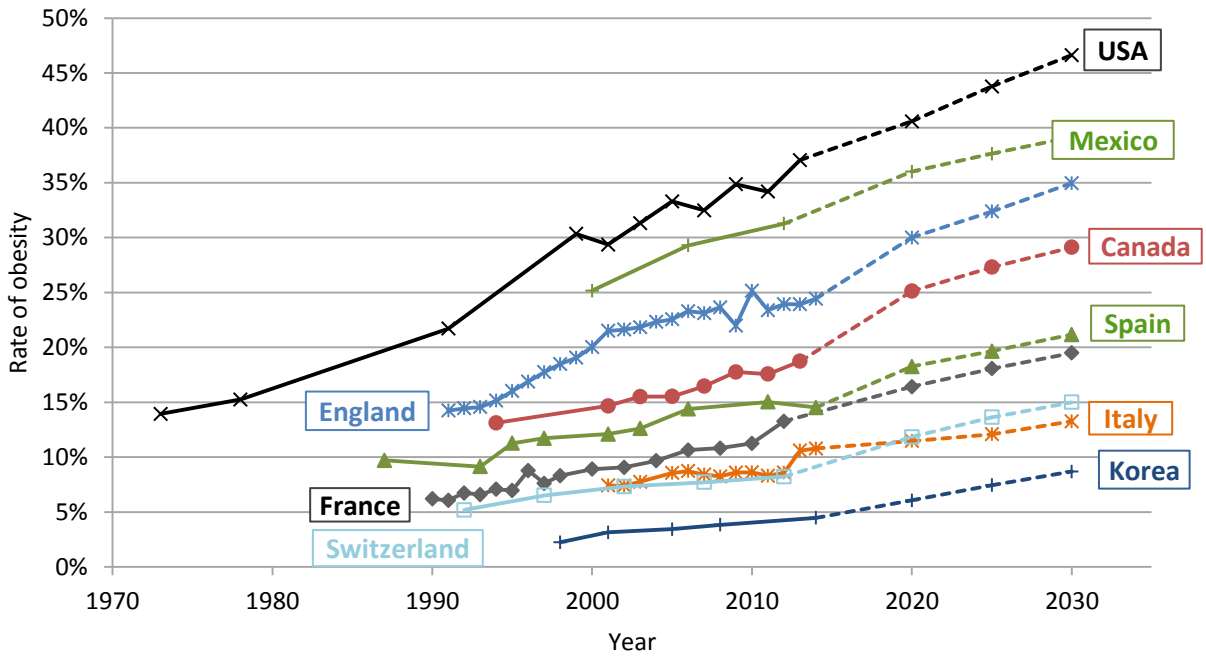
13. OECD projections show a steady increase in obesity rates until at least 2030 (Figure 2.2). Obesity levels are expected to be particularly high in the United States, Mexico and England, where 47%, 39% and 35% of the population respectively are projected to be obese in 2030. On the contrary, the increase is expected to be weaker in Italy and Korea, with obesity rates projected to be 13% and 9% in 2030, respectively. The level of obesity in France is projected to nearly match that of Spain, at 21% in 2030. Obesity rates are projected to increase at a faster pace in Korea and Switzerland where rates have been historically low.

Figure 2.1. Obesity among adults, 2015 or nearest year



Source: OECD Obesity update 2017 (OECD, 2017[3]).

Figure 2.2. Projected rates of obesity



Note: Obesity defined as Body Mass Index (BMI) ≥30kg/m². OECD projections assume that BMI will continue to rise as a linear function of time.
Source: OECD analysis of national health survey data.

2.2. Identifying population groups at higher risk

14. Unhealthy behaviours tend to cluster in specific population groups that can be identified through their demographic and socio-economic characteristics. Unhealthy lifestyles, including poor diet, physical inactivity and sedentary behaviours (SB)1 are highly-prevalent and spread across OECD populations. Often, these risk factors are considered in isolation but, in fact, there are population groups that may show multiple unhealthy behaviours.

[1] While often closely correlated, it should be noted that the concepts of being physically active and not displaying excessive SBs are different and separately concur to increasing the risk for key chronic diseases. Physical activity refers to moderate- or vigorous-intensity movement for leisure, house work, transportation or at work. Individuals are considered physically active if they meet the WHO recommendations (WHO, 2010[4]). SB represents time spent sitting (in OECD analyses, an individual is considered excessively sedentary if sitting time lasts more than seven hours daily). An individual can be excessively sedentary, but still meet the WHO recommendations, and vice versa.

Box 2.1. Latent class analysis: an introduction

The use of a latent class analysis (LCA) approach allows the clustering of individuals into different classes, based on their behaviours. It is a useful tool for policy-making, as it allows to determine which behaviours occur simultaneously, and which sub-populations display these behaviours (e.g. by gender, age, socio-economic status, region of residence, etc.). As a result, once identified, these sub-populations can be specifically targeted by public policies aiming to improve their lifestyle and their well-being. LCA can be also used to 'fine-tune' the scope of policies already in place by allowing policy-makers to 'reframe' a policy on some aspects or by allowing them to modify the scope of the policy.

LCA is a statistical technique used to sort individuals from a heterogeneous population into homogenous unobservable (i.e. latent) classes. The algorithm uses observable variables to separate individuals into groups of people who share similar characteristics, by searching for the most frequent and similar patterns among the distributions of these variables. The technique produces membership probabilities, which list the probability of belonging to each latent class, and the item-response probabilities, which list the probability of possessing a certain manifest characteristic conditional on latent class membership. These probabilities are model-based as they depend on the model specification and estimated parameters.

Physical activity (PA), sedentary behaviours (SB) and diet quality were used as the manifest variables. PA was assessed by determining whether the WHO (WHO, 2010[4]) guidelines were met or not. Sedentarism was assessed by determining whether daily SB was seven hours or more, as risk of mortality increases significantly beyond this threshold (Chau et al., 2013[5]). Diet quality was evaluated depending on the national guidelines.

The best fitting latent class model was selected for each country, based on a standard set of statistical tests (e.g. G^2, AIC, BIC, etc.). After the LCAs were completed, multinomial logistic regressions were run, using latent class membership as the dependent variable to identify the demographic and socio-economic characteristics best identifying each group. Additional information on the methodology used to run this analysis can be found elsewhere (Graf and Cecchini, 2017[6]).

15. Table 2.1 reports the summary of the analysis carried out using the most recent waves of national health surveys from Chile, Korea, Mexico, Spain, and the United States. The analysis (described in Box 2.1) identifies three population groups at highest risk of unhealthy diet, lack of PA and SB: those with the least healthy lifestyle, those with the lowest quality of diet and those with the lowest levels of PA and high SB. Based on the results presented in the table, some general conclusions can be drawn:

- Men tend to show more unhealthy behaviours than women. In all the countries, except for the United States, men consistently report an unhealthier lifestyle than women. On the other hand, in the majority of countries, women tend to report lower levels of PA or more SB.
- The effect of socio-economic status (SES) and education varies according to the different lifestyles. Individuals with low SES or level of education are more likely to report an unhealthy diet.
- In the majority of countries, individuals with high SES are more likely to report low PA or high SBs. Overall, when all the dimensions (i.e. both diet and PA) are

taken into account, individuals with high-SES tend to show more unhealthy behaviours, mainly due to the lower level of PA.

- Unhealthy lifestyles go beyond overweight and obesity. With the exception of the United States, overweight and obesity were not strong predictors for the unhealthy lifestyles included in this study. Thus, policies to tackle unhealthy lifestyles should not exclusively focus on overweight individuals but should be based on a broader perspective.

Table 2.1. Population groups with unhealthy dietary and physical activity patterns

	Least healthy population group	Low quality diet	Low physical activity, highly sedentary
Chile	Men, under 20 or over 65, with low education, high SES	Men and women, aged 35-49, with low or medium SES	Men, under 20 or over 65, with low education, high SES
Korea	Men, aged 50-64, with medium or high education or SES	Men and women, aged under 20 with medium education	Women, aged under 20, with low SES and education, living in an urban area
Mexico	Men, with high education, high SES	Women, with low or medium SES or education	Men, with high education, high SES
Spain	Men, with low or medium SES or education, living in large cities	Women with higher SES or education, living in a small city	Women aged under 20 with high SES, living in a small city
United States	Women, age of 50 or more, non-Hispanic white or other ethnicities, overweight or obese	Men, aged 20-34, Mexican-American, with low education, normal weight	Women, aged 50 or more, non-Hispanic white or other ethnicities, overweight or obese

Note: SES is socio-economic factor. "Other ethnicities" refers to ethnicities other than non-Hispanic white, non-Hispanic black, and Mexican-American.
Source: OECD analysis on national health surveys (Graf and Cecchini, 2017[6]).

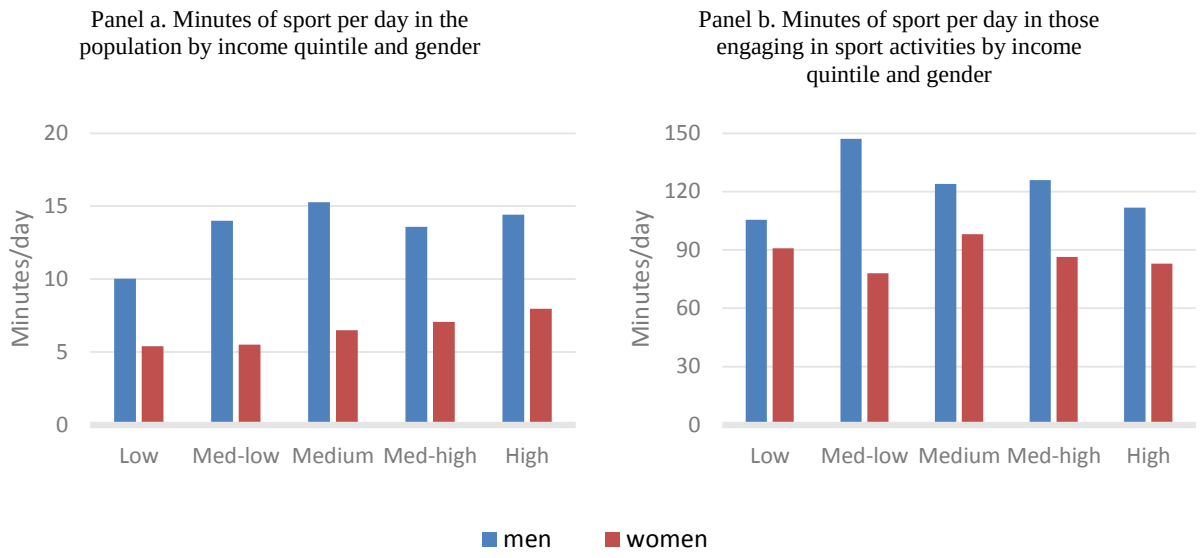
16. Further analyses are being carried out to specifically understand the type of PA that people carry out as well as the determinants of participation. Following the WHO framework on PA (Bull et al., 2004[7]), total level of PA is split into four domains: i) occupational (i.e. at work); ii) domestic (i.e. at home); iii) during leisure time, including sport; and iv) transportation. Results from these analyses can be used by policy-makers to i) identify which dimensions of highest concerns and on which action needs to be taken; and ii) to better tailor actions to the specific lifestyles of population groups (e.g. to promote active transportation in individuals that tend to use private cars to commute). Further information on how these analyses will be carried out can be found in Box 2.2.

17. For example, preliminary analyses using nationally representative time-use surveys show that women in France, particularly those with low socio-economic status, spend less time in sport activities[2]. Figure 2.3 shows the average number of minutes of sport per day in the French population by gender and income quintile. Panel a, on the left, reports the result at the population level (i.e. the denominator represents the entire French

[2] The sport category includes leisure time spent participating in moderate-to-vigorous intensity sports and exercise, such as swimming, running, and biking. The category does not include travel or waiting time relating to sports, nor does it include physical activities at lower intensity, such as fishing, hunting, or billiards.

population), while panel b, on the right, shows results for those that actually do sport (i.e. the denominator excludes those that do not report sport activity).

Figure 2.3. Minutes of sport per day in the French population



Source: OECD analysis on the French time-use survey.
Note: The sports category includes leisure time spent participating in moderate-to-vigorous intensity sports and exercise; please note that confidence interval is not reported but variability is quite large.

18. Individuals with high-income status report more minutes of sport compared to individuals with low socio-economic status. However, once that the likelihood of getting engaged in sport activity is taken into account (panel b, on the right), inequalities level off, suggesting a similar amount of sport among individuals that do get engaged in sport activities, independently from their socio-economic status.

19. From a policy perspective, analyses reported in Figure 2.3 support the implementation of actions to increase the likelihood of getting engaged in sport activities (rather than increasing the length of sport sessions) with the objective of addressing real (or perceived) barriers to sport. In addition, these actions should be designed with a particular focus on women as they show significantly worse patterns compared to men. By looking at the potential drivers of lower sport activity in women, the Scottish National Agency for Sport identified lack of time and childcare, lack of money or transport, personal safety, and difficult access to facilities among the top causes of low levels of PA in women (SportScotland and WomensSports Foundation UK, 2005[8]).

Box 2.2. Assessing the return on investment of policies to promote physical activity (PA)

Analyses presented in Figure 2.3 seek to better understand patterns of PA and sedentarism, and to assess the return on investment of actions to promote an active lifestyle. This involves the analysis of time-use surveys to study who participates in which kinds of activity, and for how long. The analysis also assesses best policy practices to increase PA, through the use of literature reviews and, when possible, meta-analyses. The policies being assessed concern promotion of PA in schools and work places, investment into PA infrastructures, PA prescriptions in the primary care sector, and more. The results from the empirical analysis and literature reviews will be incorporated into our microsimulation model to carry out a full cost-effectiveness analysis. A full set of analyses will be carried out for France, and selected analyses for Canada, the United States, and Germany will be also carried out. Interested countries can contact the Secretariat for further information and to participate in the analyses.

3. The impact of obesity on economies: from health expenditure to the broader socio-economic impact

20. Unhealthy lifestyles have an economic impact that goes beyond an increase in healthcare expenditure. For example, poor health is correlated with detrimental labour market outcomes, including labour force participation, productivity and wages (Devaux and Sassi, 2015[9]). Similarly, there is correlation between level of obesity and years spent in full-time education (Sassi et al., 2009[10]), with most educated individuals displaying lower rates of the condition.

21. The Secretariat has worked to include a broader socio-economic perspective in the calculation of the return of investment of public health policies to tackle major risk factors and unhealthy behaviours. Work has focused on two main dimensions:

- First, the Secretariat is using cross-sectional and longitudinal surveys (SHARE - the survey of health, ageing and retirement in Europe) to calculate the causal relationship between chronic diseases caused by obesity and labour market outcomes.
- Second, the Secretariat is further investigating the relationship between obesity-related risk factors and education by assessing how educational outcomes (e.g. school attendance, marks, etc.) may be influenced by high BMI or other risk factors.

22. Results from these two streams of work will be useful *per se*, as they will provide new evidence on the negative effects of unhealthy behaviours on human capital, making the case for action. In addition, as discussed in section 6. , results from these analyses will be gradually implemented into the microsimulation platform to allow more comprehensive assessments, in particular with regards to the broader economic benefits produced by investing in public health actions promoting a healthier lifestyle.

3.1. Obesity and associated chronic diseases have detrimental effects on the labour market

23. Overweight and associated risk factors are among the leading risk factors contributing to the development of NCDs. Previous OECD work suggested that there is a strong correlation between diseases like cancers, cardiovascular diseases and diabetes and labour market outcomes including, for example, employment opportunities, wages, productivity (Devaux and Sassi, 2015[9]). The Secretariat has enlarged the scope of its action to further explore and quantify the impact of lifestyle and physiological risk factors and associated NCDs on the economy of OECD countries.

3.1.1. Available evidence suggests that the impact of obesity on productivity and the economy may be about 1% of GDP in OECD countries

24. According to published literature[3] and despite significant differences in the methodologies used in the different studies, the impact of indirect costs[4] may be substantial. In France the cost was estimated at about 1% of GDP in 2016; two studies carried out in Canada (in 2010) and Australia (in 2008) concluded that in both countries indirect cost of obesity was slightly under 0.4%. A German study, using a similar approach, concluded that the indirect cost of obesity would account for about 0.2% of GDP in 2015; however, a second study, using a more refined methodology and including a broader set of cost-items, concluded that the impact could be of up to 1.2% of GDP.

3.1.2. Poor health status damages labour market outcomes

25. Overall, and after adjusting for a rich set of confounders, chronic conditions caused by high BMI affect current employment likelihood negatively:

- Suffering from hypertension, diabetes, cancer, lung disease (used as proxy for COPD), heart disease, or stroke all impact employment likelihood negatively in countries covered by the SHARE survey, by decreasing the likelihood of being employed by between 6% (relative risk equal to 0.94) for hypertension and up to 23% (relative risk equal to 0.77) in the case of stroke (Figure 3.1 – panel a).
- Women with diabetes have the lowest employment probability, a result that is significant compared to diabetic men in Estonia, Germany, Sweden, Switzerland, Denmark, Belgium, and Czech Republic.
- Men with COPD had significantly lower employment likelihood than their female counterparts without the disease, in all modelled countries. However, the overall impact of the disease was stronger in men than in women, and once diagnosed with lung disease, looking at the impact in each country separately, the employment likelihood did not differ significantly by gender.

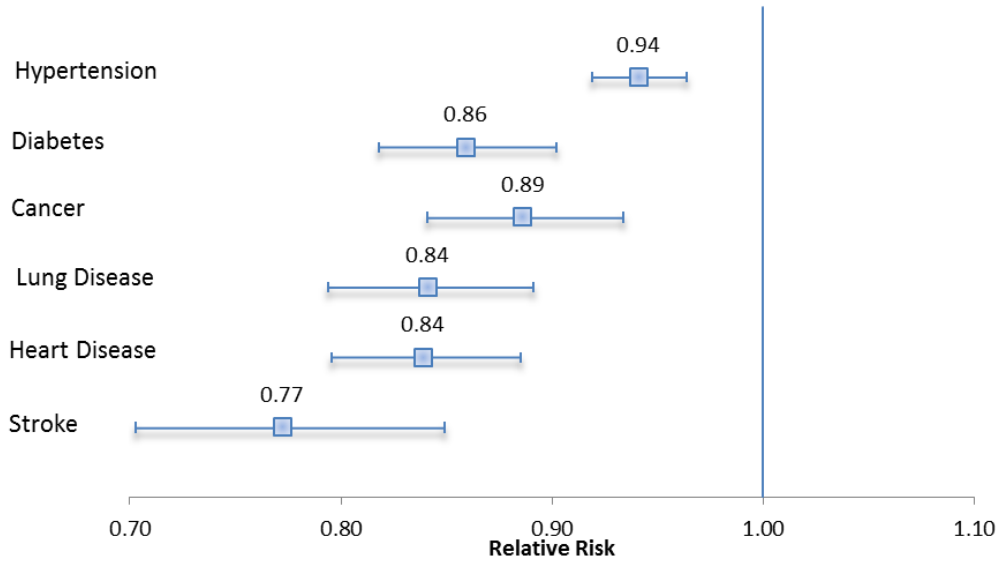
26. Similarly, the presence of a chronic condition is a strong determinant for reporting the intention to retire early (Figure 3.1 – panel b). For all the chronic conditions but lung diseases, the presence of the clinical condition determines a statistically significant higher intention to retire early compared to an individual in good health, everything else being adjusted for. As for employment likelihood (but to a more limited extent), more severe chronic conditions seem to have a stronger effect on the studied outcome. So, for example, having had a stroke increases the probability of reporting an intention to retire early by 21%, compared to an increase of 8% in the case of lung diseases or 10% in the case of hypertension. However, the relatively large confidence intervals imply a non-statistically different probability across diseases.

[3] Analysed literature includes: 2016: (Ministère de l'Économie et des Finances, 2016[80]); (Anis et al., 2010[81]); (Anis et al., 2010[81]); (Access Economics, 2008[82]); (Konnopka, Bodemann and Konig, 2011[83]); (Effertz et al., 2016[84]).

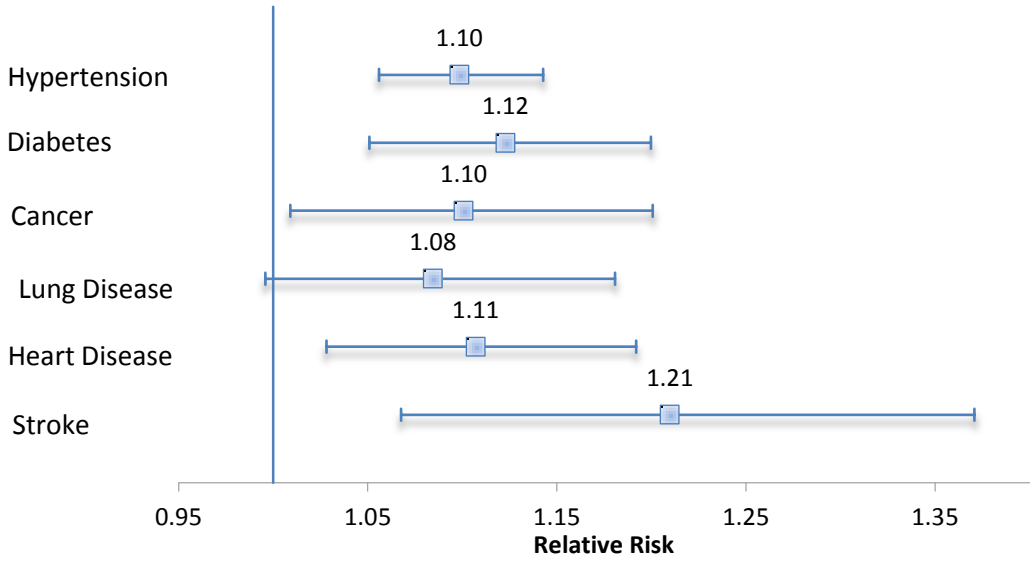
[4] The term indirect costs generically refers to all the costs caused by a risk factor or disease (obesity in this case) in addition to its impact on healthcare expenditure. The list of indirect costs may vary according to the study but it usually includes productivity losses (e.g. absenteeism, presenteeism, etc.) and premature mortality. Other items that may be included in the calculation of indirect costs are: impact on wages, welfare programmes, etc.

Figure 3.1. Poor health decreases the likelihood of being employed

Panel a. Employment likelihood with (vs without) NCDs



Panel b. Intention to retire early in presence of chronic disease



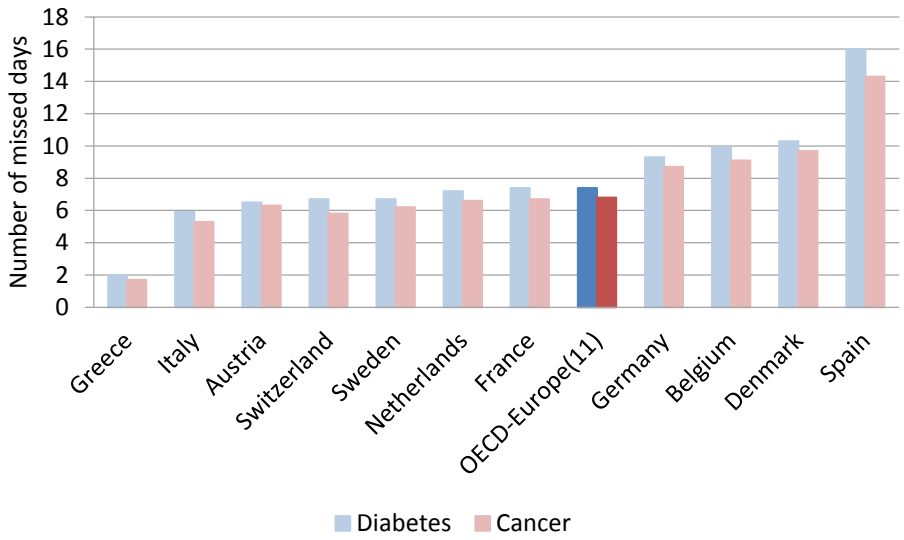
Note: The results are shown as relative risks (see Box 3.4 for further info). A relative risk < or > 1 means, respectively, a lower or higher probability of the outcome conditional to the presence of a NCD. For example, in panel a, a person with hypertension is 6% less likely to be employed as a person without hypertensions, all else being adjusted for. Similarly, in panel b, a person with hypertension is 10% more likely to wish for early retirement compared to a person without hypertension, all else being adjusted for.
Source: OECD analysis of harmonized SHARE.

27. Only two diseases, diabetes and cancer, produce a statistically significant increase in the number of days of work missed during the previous year (Figure 3.2). More specifically, diabetes would lead to an additional 7.4 days of absenteeism while cancer would be responsible for an additional 6.8 days of absenteeism.

28. An additional set of analyses show that both overweight and obesity would cause a small increase of about 1 day of absenteeism per year in otherwise healthy individuals. These results suggest that overweight and obesity do not directly impact the productivity of the employed population, rather it is the chronic conditions caused by increased BMI that cause these results.

29. Analyses at the country level (Figure 3.2) vary from 16 and 14.3 days of absence due to, respectively, diabetes and cancer in Spain to 2 and 1.7 days of absence due to, respectively, diabetes and cancer in Greece. Even after excluding these 2 outliers, the annual days of absenteeism attributable to cancer and diabetes vary from around 5.5 for Italy to about 10 in Denmark. It is possible that different welfare arrangements and benefit packages across countries may explain some of this difference (OECD, 2016[11]).

Figure 3.2. Annual days of absenteeism attributable to cancer and diabetes in OECD countries



Source: OECD analysis of Harmonized SHARE.

3.2. Overweight and education outcomes in children are closely interlinked

30. By affecting school performances, health behaviours may have important social and economic consequences. First, education outcomes are key determinants for the formation of human capital, an individual's future socioeconomic status, and thus a country's economic growth. An increase by 25 points in the average PISA score over the next 20 years would increase OECD gross domestic product by USD 115 trillion over the lifetime of the generation born in 2010 (OECD, 2010[12]). Second, differences in health and education outcomes can reinforce existing social inequalities (e.g. inequalities in job prospect and income gaps); which may impact a country's social welfare. This is a main concern for European countries, which have recently agreed on the European Pillar of

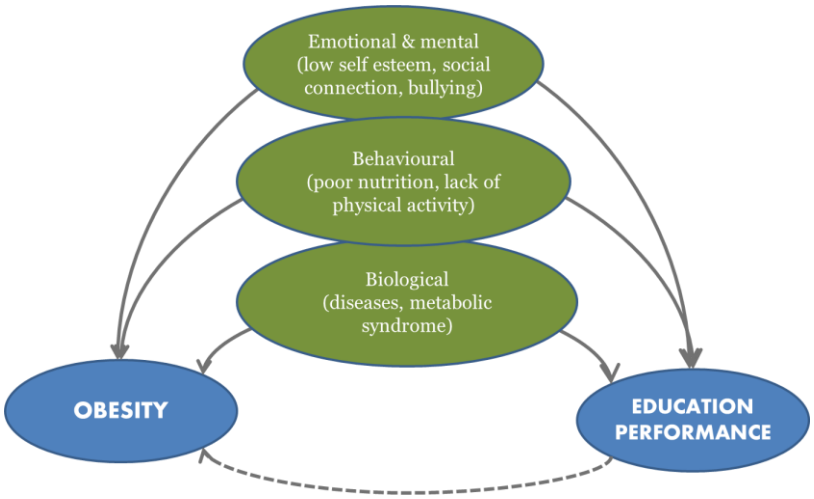
Social Rights that seeks to guarantee equal opportunities and access to the labour market, fairer working conditions, and social protection and inclusion (Tajani and Juncker, 2017[13]).

3.2.1. The relationship between obesity and education is complex, and not necessarily uni-directional

31. The relationship between obesity and education involves various mediating factors: biological factors (e.g. diseases), behavioural factors (poor nutrition and lack of PA), emotional and mental health factors (e.g. low self-esteem, poor social connection) or even discrimination (Figure 3.3). Some of the most studied factors include:

- Obesity and its related diseases (such as the metabolic syndrome) may have a direct effect on cognitive functions and concentration at school. For instance, there is evidence for a causal impact of the metabolic syndrome on cognitive functions and brain structure through physiological impairments (Yates et al., 2012[14]).
- Behavioural risk factors such as poor nutrition and lack of PA may play a role on both obesity and low concentration at school and poor school performance, and thus mediate the effect of obesity on education outcomes.
- The relationship between obesity and education performance may also be mediated by emotional and mental health. Obese people may have a lower self-esteem, poor social connections – in particular if they are bullied by other pupils – that may affect their school performance outcomes.
- Finally, there may be discrimination against obese students. For instance, a US study provides evidence that individuals interviewing applicants to graduate programs may systematically favour thinner applicants, due to a (conscious or unconscious) bias against obese applicants, or a stereotype threat and social identity threat that eventually lead to the applicant to under-perform (Burmeister et al., 2013[15]).

Figure 3.3. Relationships between obesity and education performance



Source: OECD analysis.

3.2.2. Published evidence points to a complex relationship between obesity and school performance

32. A great number of studies converge to show a significant association between obesity and poor academic performance (whether it is a direct or indirect effect, whether it applies to specific age range, or to specific education outcomes) (Bustillo et al., 2016[16]); (Anderson and Good, 2017[17]); (Pan et al., 2013[18]) (Carey et al., 2015[19]); (Li et al., 2012[20]). However, some studies showed that the relationship vanishes once controlling for confounders (Carey et al., 2015[19]); (Torrijos-Niño et al., 2014[21]). The design of these studies differs (e.g. age range, measure of education performance, controls for cofounders) which limits comparability.

33. Conversely, the body of evidence on the causal effect of obesity on school performance is much smaller and mixed as concerns the results. Two studies respectively from the Netherlands (Ruijsbroek et al., 2015[22]) and the United States (Datar, Sturm and Magnabosco, 2004[23]) found no significant causal effect of obesity on school performance. In contrast, a study from the United Kingdom found that girls obese at 11 years had lower academic attainment at 11, 13 and 16 years, compared with girls of a healthy weight, even after controlling for a wide range of confounders (Booth et al., 2014[24]). Results were less clear in boys.

3.2.3. More evidence is needed about the way to implement physical activity to achieve better school outcomes

34. A recent systematic review of 64 studies found that PA has a positive influence on cognitive functions as well as brain structure and function (Donnelly et al., 2016[25]). Similarly, a meta-analysis of 44 studies showed that PA has a positive association with cognition in children, with a significant effect size of 0.32 (SD=0.27) (Sibley B A, 2003[26]).

35. Regarding school achievement, a systematic review of 14 longitudinal studies finds evidence for a positive relationship between PA and academic performance (Singh et al., 2012[27]). In a Cochrane review, PA interventions produced small improvements in mathematics achievements, executive function, and working memory. No evidence suggests an effect on reading, vocabulary and language achievements, attention, inhibitory control or simultaneous processing (Martin et al., 2014[28]). Hence, while the association between PA and cognitive functions and school achievement is clear, the best way to incorporate PA within schools to improve academic achievement is less clear (Donnelly et al., 2016[25]).

Box 3.1. Data and methods for the analysis on obesity and education outcomes

Analyses are based on the 2013-14 Health-Behaviours in School-based Children survey (HBSC) which collects information on school students aged 11, 13 and 15 years old every four years. School and health information are self-reported by children (e.g. school performance compared to classmates, bullying, life satisfaction, height and weight, smoking and alcohol drunkenness). Body Mass Index, measured from height and weight, is categorised into normal-weight, pre-obese and obese, using the WHO age- and sex-specific BMI cut-off points (de Onis et al., 2007[29]).

A multivariate logistic regression analysis is performed to assess the probability of being bullied and a linear model is used for the assessment of life satisfaction. The probability of having good performance at school is modelled through a mixed logit model with random effects on the intercepts and the BMI coefficient at the country level, while controlling for individual characteristics. Analyses presented in this document were carried out on 29 HBSC countries including 26 European countries plus Iceland, Norway and Switzerland.

3.2.4. Obese children have lower performance at school, less life satisfaction and face more bullying

36. This section presents some preliminary analyses carried out by the Secretariat on the HBSC (Health Behaviour in School-aged Children) survey. The analyses focused on the link between obesity and school performances, life satisfaction and likelihood of being bullied. Information on the methodology used to carry out the analyses can be found in Box 3.1.

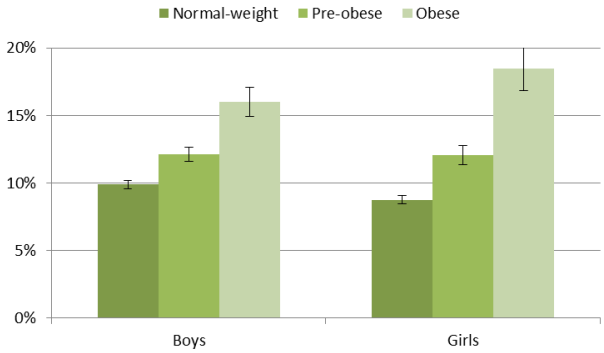
37. Life satisfaction diminishes gradually with high BMI in children, suggesting that obesity is related to emotional and mental health. In the HBSC survey, children were invited to rate their life satisfaction from 0 to 10. The average life satisfaction ranges from 7.4 in obese boys to 7.8 in normal-weight boys, and from 6.9 in obese girls to 7.5 in normal-weight girls, all other things being equal (Figure 3.4 – panel a).

38. Obesity is also strongly associated with bullying. In 2013/14, 16% of boys (18% of girls) who were obese were bullied by schoolmates compared to 10% in normal-weight boys (9% in girls) (Figure 3.4 – panel b). High BMI has a direct relationship with bullying, not mediated by socioeconomic status or emotional health.

Figure 3.4. Life satisfaction and probability of bullying by BMI category, in children aged 11-15, 2013-14

Panel a. Life satisfaction and BMI categories, in children aged 11-15, 2013-14

Panel b. Bullying and BMI categories, in children aged 11-15, 2013-14

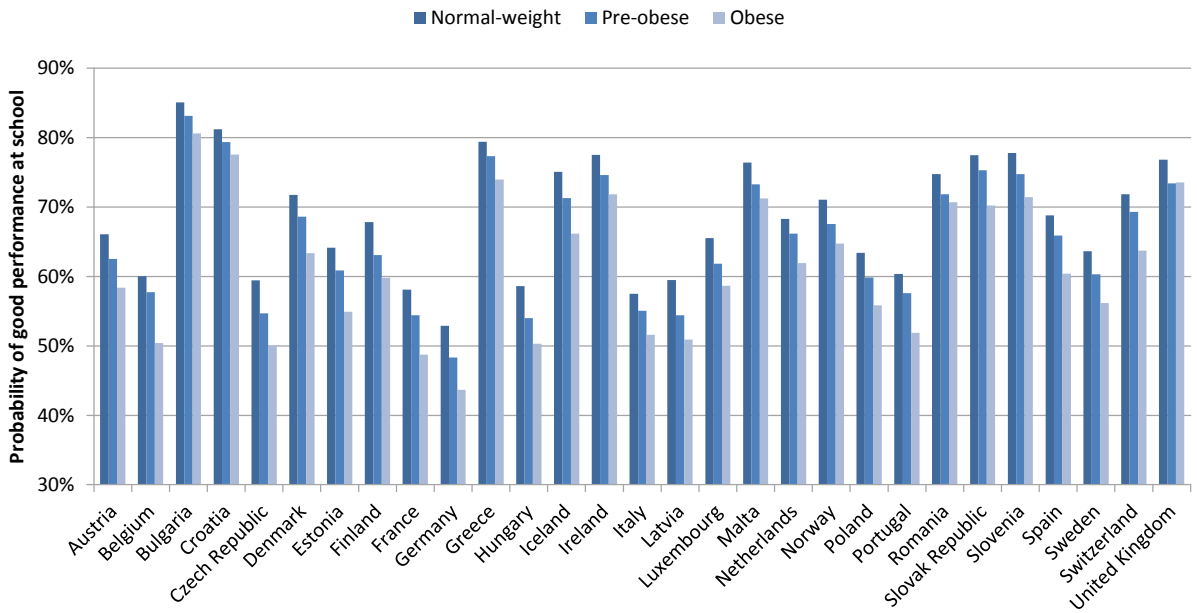


Note: Analysis adjusted for age, family affluence, smoking, and drunkenness in lifetime.
Source: OECD estimates based on 29 countries from HBSC 2013-14.

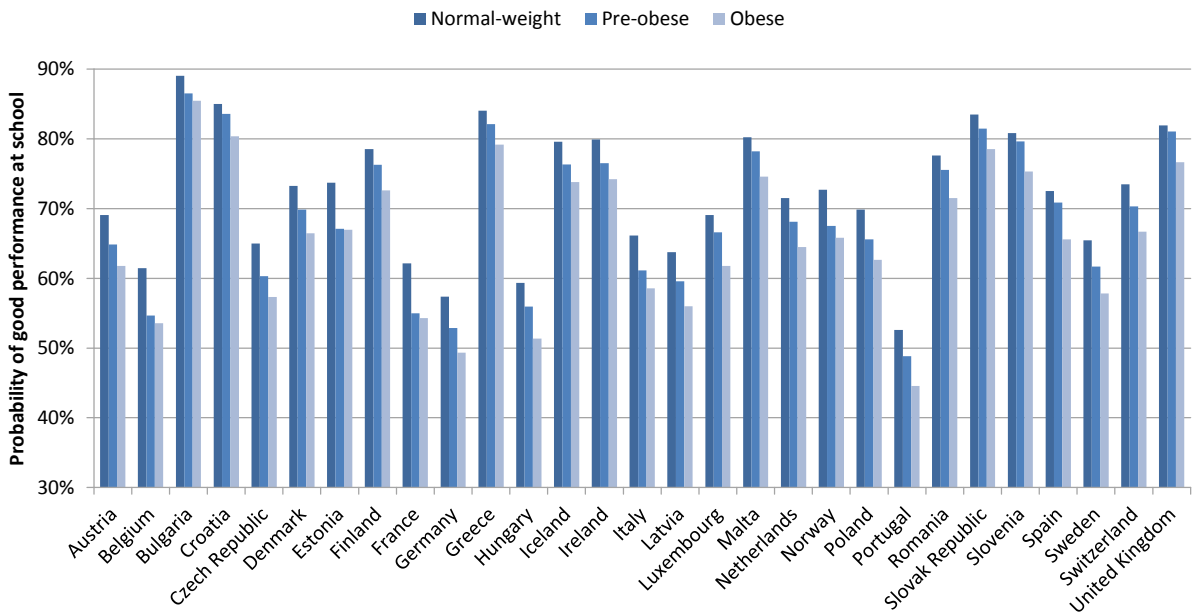
39. Further, children with high BMI levels show poorer school performance in the 29 countries (Figure 3.5). For instance in Italy, 58% of normal-weight boys are likely to perform above the average at school compared to 52% of obese boys. The gradient is steeper in France, with 58% of normal-weight boys compared to 49% of obese boys. Girls have better school performance than boys in all countries studied but Portugal. The gradient of inequalities appears larger in boys compared to girls in 13 countries (Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iceland, Latvia, Poland, Slovak Republic, Spain, and Switzerland) while greater in girls in Romania and the United Kingdom.

Figure 3.5. Obese children show poorer performance at school

Panel a. Boys



Panel b. Girls



Note: Mixed model with random slope. Adjusted for age, family affluence, smoking, and drunkenness in lifetime. Covariates are set at fixed values (Age 13, Middle family affluence, Never been drunk, Never smoked).
Source: OECD estimates based on 29 countries from HBSC 2013-14.

4. Policies to address obesity: targeting specific population groups to increase the effectiveness and the efficiency of interventions at the individual level

40. Previous work by the OECD has identified policy priorities and the most effective ways to tackle obesity, unhealthy diet and physical inactivity. One of the main messages of this work is that tackling major risk factors and their associated chronic diseases requires more than a single prevention intervention. Fundamental change can only occur through wide-ranging strategies which address multiple determinants of health, such as diet and PA (Cecchini et al., 2010[30]).

41. Prevention policies with the most attractive cost-effectiveness profile are those reaching the largest amount of individuals (i.e. population strategies), but health systems can also have a strong impact by focusing on individuals at higher risk (at a higher cost per targeted individual, though) by implementing effective individual-level interventions. In this second case, the cost-effectiveness of preventive measures is typically improved by targeting high-risk groups with well-designed interventions. This approach increases the proportion of individuals who benefit and therefore the health benefits gained per unit of money spent. For instance, well-designed primary care-based interventions, to identify adults with obesity or other risk factors, followed by lifestyle counselling have been shown to be cost-effective and affordable for healthcare systems in OECD countries (OECD, 2010[31]).

42. The achievement of highly-efficient and people-centred public health actions requires evidence on two key questions: i) who are the population groups to target? And ii) what are the most effective interventions to tackle risk factors in these population groups? Preliminary work to respond to the first question, concerning the identification of target population, is presented in section 2.2 of this document. This section focuses on the Secretariat's work to update the evidence on what works to promote healthier lifestyles.

43. Governments can put in place a comprehensive suite of policy options to promote healthier behaviours. For example, specific actions can be employed as part of health promotion and social marketing campaigns aimed at changing behaviours adversely affecting health. Actions can also be used to regulate and restrict exposure of the public to the commercial marketing of potentially harmful products, or to inform them when buying pre-packaged foods, or making purchases in restaurants or fast food places. Finally, a number of policies are designed to nudge people into making healthier behavioural choices, either through economic incentives or through more subtle changes to the surrounding environment (Figure 4.1).

44. Many of the abovementioned policy options can be designed to target specific population groups, for example children, working-age populations, or people visiting primary care. The Secretariat is working to identify new evidence to model the effectiveness of these policy actions (Box 4.1). A particular focus is placed on identifying potential differences in the effectiveness of the interventions by population group (e.g. by gender, age-group, etc.) and to identify new interventions that can target specific unhealthy behaviours or population groups.

Figure 4.1. List of potential policy options with some examples

Obesity prevention in children
- Nutritious school meal programs
- Physical activity education
- Nutritional education
- Advertising restrictions in schools

Food and menu labelling
- Traffic light systems for pre-packaged foods
- Contextual menu labelling in restaurants and fast-food places

Food reformulation and portion size control
- Voluntary reformulations to reduce salt or sugar content
- Legislated reformulation of nutrients in pre-packaged food

Workplace interventions
- Wellness programs
- Programs to reduce sitting at work
- Environmental interventions to alter eating behaviour

Primary care interventions
- Prescribing physical activity
- Dietary counselling
- Behavioral change interventions targeting people at an increased risk of CVD

Fiscal policies
- Taxation of foods high in sugar
- Subsidising foods considered healthy by their nutritional profile

Altering urban environment
- Introducing mass transit and intermodal transportation options
- Bike lanes and bike sharing schemes
- Land use mix policies
- Building infrastructure promoting physical activity

Use of new technologies
- Mobile apps and text messaging promoting healthier behaviours

Mass media campaigns
- Campaigns to raise awareness about the benefits of healthy diets and physical activity

Environmental interventions
- Options to buy food in healthier food outlets and at farmers markets
- Food placement in stores and near check outs

Source: OECD analysis.

4.1. Interventions targeting children and younger adults

45. Statutory ban of food advertisement on television, targeting children below 18 years of age, is an effective policy to limit their consumption of unhealthy food. Available evidence suggests targeted children would decrease calorie consumption by 4.16%, with a 1.86% reduction in body weight. The effect of childhood obesity prevention programmes (with both dietary and PA components) in school settings, which

has been shown to reduce children's BMI by about 0.30 kg/m^2, will be further analysed (Wang, Cai et al. 2015).

46. Smartphone applications and/or text messages tend to be used more frequently among younger adults, making this technology a good tool to promote healthier lifestyle in this population groups. For example, individuals can receive periodic text prompts encouraging healthy eating and doing more exercise. Alternatively, participants can input their self-reported data on physical activity and eating habits in an 'app' to receive tailored advice on making behavioural improvements. Information from a meta-analysis suggests that this intervention can produce an average decrease in BMI by 0.43 kg/m^2. Further work will model the effect of text messaging for weight management (Mateo et al., 2015[32]).

47. Although there is growing interest in the impact of some other policies, for example procurement requirement for nutritious school meal programmes, the evidence base is still inadequate for policy impact simulation. Nevertheless, the Secretariat will keep looking for new studies evaluating the effectiveness of such policies while the work progresses over the next two years.

Box 4.1. Gauging the effectiveness of interventions

To estimate population-level effectiveness of public health policies and interventions, a number of parameters are needed as model inputs (e.g. effectiveness; time to the maximum effectiveness achieved, definition of eligible population, coverage and participation, etc.). Effectiveness at the individual level is the most important parameter in this list. As agreed at the 2015 meeting of the Expert Group of the Economics of Prevention, the Secretariat follows a well-codified approach to identify and gauge interventions to be included in any modelling attempt. As much as possible, the Secretariat uses recent systematic-reviews and meta-analyses to feed the model. As randomized controlled trials (RCTs) are very scarce in public health, meta-analyses of both RCTs and observational studies can be considered. When no meta-analysis can be identified, the second best option is to conduct "in-house" meta-analyses, following best-practices suitable for publication of the study in peer-reviewed journals. As this approach is costly and time-consuming, 'in-house' meta-analyses are carried out for key interventions for which a preliminary review concludes that available studies are sufficiently homogeneous to be pooled together. Lastly, and least preferably, using the evidence from a few studies that are impossible to meta-analyse, or even from a single study can be acceptable in selected cases. In such cases, it is important to be reasonably sure that the evidence comes from high quality sources, preferably from RCTs.

4.2. Interventions targeting mostly healthy adults in work settings

48. There is an interest in studying the effectiveness of complex workplace interventions targeting employees (such as dietary intakes, nutrition knowledge and health status, as well as interventions promoting PA) as well as various workplace wellness programmes. While originating in the private sector, such programs have public health implications in that they are designed to prevent chronic diseases. The available evidence suggests that policies to reduce SBs among white collar workers would decrease sitting time by about 40 mins per normal day of work, while worksite wellness programs

would reduce BMI of participating employers by about 0.28kg/m^2. On the other hand, the evidence on environmental changes for healthier eating in workplaces is still lacking.

4.3. Interventions targeting people at an increased risk of NCDs

49. GPs may be ideally suited to provide advice on adequate PA levels. Physicians may also be in a good position to provide advice on dieting and proper nutrition in general. A systematic review and meta-analysis concluded that prescribing PA in primary care may lead to a reduction in BMI by about 0.21 kg/m^2 and to an increase in PA-related energy expenditure by about 1.77 METs (Metabolic Equivalents). The effect would be stronger in subgroups where there is more active engagement between primary care workers and patients (Cohen and Babey, 2012[33]; Goryakin, Suhlrie and Cecchini, 2018[34]). The Secretariat is also working to model the effectiveness of behaviour change interventions for the prevention of cardiovascular disease in primary care (Alageel et al., 2017[35]).

4.4. Interventions targeting urban dwellers

50. Living in more environmentally sustainable cities, with more opportunities for buying healthier food and for PA, may be associated with better health and less pollution. Providing an active transport option would increase the amount of light/moderate PA per week by about 30 minutes in the exposed population. Evidence also suggest that access to infrastructures (e.g. playgrounds, sport facilities, etc.) is associated with an increase in leisure time PA. On the other hand, limited evidence can be found on the effect of bike sharing schemes; cycle lanes; closing parts of cities to traffic; land use mix policies.

4.5. Interventions without clearly defined target groups

51. Various mass media campaigns can be implemented through traditional (television, radio, newspaper) or new media (internet, social networks, mobile apps) to raise awareness about the benefits of healthy diets and PA. Analyses on the effectiveness of such campaigns in the general population conclude that a mass media campaign can be expected to increase the number of people with at least a moderate level of PA by 36%, with the largest effect expected during the first month of the campaign. On the other hand, all the effect of the campaign would completely fade out in two years.

52. Nutritional labels can be used to provide information about the nutrient content of foods sold in stores/supermarkets. Such information can either include nutrient lists, for example “informative” calorie labels, or clearly visible “interpretive” labels. This type of labelling aims to inform consumers about the nutritional value of food products, and may either warn about potentially negative issues (e.g. on salt, sugar, saturated fats content), as well as highlight positive aspects (such as about dietary fibre and protein content). Such action can be expected to increase the number of people selecting a healthier food product by about 17.95% (Cecchini and Warin, 2016[36]). Likewise, restaurants and fast food places can be required to provide information on the calorie, or other nutrient content of foods on the menus they sell. Such interventions could decrease calorie intake by up to 81 kcal per targeted individual, with a higher effectiveness in women (Sinclair, Cooper and Mansfield, 2014[37]).

53. Although these interventions generally do not target a particular group, their effectiveness in some cases may depend on factors like socioeconomic status of the

population. For example, restaurant menu labelling leads to greater calorie reduction in areas where residents are more educated and have higher incomes (Sinclair, Cooper et al. 2014). Women choose fewer calories in response to this intervention than men. Education may also modify the effect of food label format on food choice (Borgmeier and Westenhoefer, 2009[38]), or the effectiveness of mass media campaigns promoting PA (Craig et al., 2009[39]).

5. Assessing the impact of public health policies on business and industry

54. The implementation of policies to tackle obesity raises a number of implementation challenges and trade-offs. Among these is the impact of policies on business and industry. In the broader framework of assessing the broader economic impact of obesity and public health actions aimed to tackle obesity, the Secretariat is carrying out work to identify how selected public health policies may affect business and industry, and to discuss potential policy approaches that governments and businesses can implement to avoid or mitigate unwanted negative consequences caused by policies. More specifically, the Secretariat is working to understand the impact of the following policies: product reformulation, portion size changes, food labelling, food taxes and healthy lifestyle subsidies, and advertising restrictions. The remainder of this section presents preliminary findings on the 'case study' for reformulation.

5.1. Initial findings on the impact of food reformulation on the industry

5.1.1. Reformulation: an effective policy with implementation challenges

55. To halt the rising rates of obesity, many countries have implemented public health actions that aim to improve diets in the population. In addition to affecting consumers, these policies may also impact the industries that provide food and drinks. They may carry direct costs for the industry, or change the volume of sales. Cost associated with public health policies can be one-off cost associated with implementation, or ongoing cost as production or ingredient cost change (OECD, 2014[40]). For example, a new public health policy can result in R&D cost, redesign cost, downtime cost due to an interruption of operations, cost of production and machinery, ingredient cost, marketing cost, distribution or import cost, sales cost and taxes. Obesity policies may also impact sales. Especially policies aimed at reducing consumption of specific food products, such as taxes or advertising restrictions, can impact on the industry's profitability. Moreover, in addition to cost to the food industry, there may be direct cost or sales implications for associated businesses, such as advertising agencies, media, and suppliers.

56. Product reformulation is a deliberate change in production process or ingredients that results in a different end product. Most producers reformulate their products every few years as part of their normal business, to improve quality, save cost or respond to changes in consumer preferences (Webster and Hawkes, 2009[41]). In principle, reformulation can also be done as a public health measure, to improve the nutritional value of the product and reduce harmful substances. For example, in 2016, 97% of 102 surveyed food companies had programmes to offer consumers healthier products, and in total they reformulated 180,000 products to support a healthier lifestyle (The Consumer Goods Forum, 2016[42]). The most common targets of reformulation were salt or sodium (67%), sugar (61%), saturated fat (50%) and trans-fat (47%). Other targets focused on healthy additions, including whole grains (25%) and vitamins (20%).

57. While very appealing in theory, reformulation presents a number of practical issues that, if not well addressed, may hinder its implementation or its impact on population health:

- *Consumer acceptance of a reformulated product depends on changes in taste, changes in the image of the product, and general resistance to change*. A reformulation resulting in a reduced fat, sugar or salt level may negatively impact the taste of a product. Moreover, these nutrients often have a technical or functional role in foods, as they influence the preservation of the product, its texture and mouthfeel, the colour and size, and the firmness or softness of the product (Buttriss, 2013[43]). Reformulation can also change consumers' perception of a product by improving its image (e.g. because the product is perceived as healthier) or by worsening its attractiveness (e.g. if the product is perceived as 'unnatural') (World Health Organization, 2017[44]). Even if consumers do not dislike the taste of the new product, or even prefer it over the original in blind taste tests, reformulation can be met with protest because consumers can become attached or used to the status quo.
- *Reformulation may require changes in production, transport, packing and storage*. In addition to affecting the consumer's experience, the salt, sugar or fat levels of a product can have direct implications for the industry's production and logistical processes (Buttriss, 2013[43]). For example, salt is an important preservative and a low salt content weakens the gluten in bread and creates stickier dough, which influences the efficiency of the production process and causes wastage. The sugar content of ice cream changes its freezing point, and consequently how it has to be stored. The type of fat in a product determines how soft a product is, and whether it needs protective wrapping to prevent it from deforming during transportation. As a result, producers need to consider a wide range of implications when developing a reformulated product.
- *Reformulation policies can have inadvertent impacts on public health*. There are very few cases where a nutrient can simply be taken out without adding new ingredients to the product to make up for changes in flavour, colour, texture and preservation (Buttriss, 2013[43]). For example, artificial sweeteners are a common replacement of sugar, but there remains debate about their potential adverse effects on health (Tandel, 2011[45]; Suez et al., 2014[46]). In addition, some systematic reviews have found an association between consumption of artificially sweetened beverages and obesity (Ruanpeng et al., 2017[47]) (Azad et al., 2017[48]). Among the various hypothesised causes, this may be due to a physiological effect of artificial sweeteners on glucose metabolism and absorption, or on the microbiome. Similarly, trans-fats could be replaced with saturated rather than unsaturated fats (Ratnayake, L'Abbe and Mozaffarian, 2009[49]; Mozaffarian, Jacobson and Greenstein, 2010[50]). In addition, products that are reformulated to reduce their fat content often have higher levels of sugar (Nguyen, Lin and Heidenreich, 2016[51]).
- *Reformulation may increase the price of a product and create social inequalities.* Some reformulated food products with low fat or sugar levels are more expensive than their original (Webster and Hawkes, 2009[41]). This can affect customers, who have to spend more or reduce consumption, and food producers, whose sales might suffer. The higher price of reformulated, healthier options also has a negative impact on inequalities. Obesity is already more prevalent in lower

socioeconomic classes and this social gradient will be worsened if poorer people cannot afford the healthier options (Drewnowski, 2007[52]).

5.1.2. The impact of reformulation on food producers

58. The process of reformulation is likely to generate costs for the various actors involved: the government, business and industry and, possibly, the consumers. Many health studies have looked at the impact of reformulation on public health, some taking into account the regulatory cost to the government (Cappuccio et al., 2011[53]). However, the cost of reformulation to the food manufacturing industry is often left out of scope (Cobiac, Vos and Veerman, 2010[54]). The reformulation of a product can impact the profits of producers in a number of ways. There are fixed, one-off costs associated with the development of the new product and its implementation, and changes in ongoing profit due to potential lower sales or higher production cost. Cost dimensions for business and industry are identified in Figure 5.1.

59. First, to develop and launch a reformulated product, producers may need to invest in research and development (R&D), new production processes and marketing. R&D for reformulation needs to go through a number of steps: idea generation; product development; product evaluation; consumer testing; and shelf-life studies. Once the new product has been developed, the changes need to be implemented.

60. For example, the UK Food Standards Agency (FSA) estimates that the R&D cost for reformulation, which includes kitchen samples, a factory run, consumer panels, nutritional analysis, relabelling, shelf-life evaluation and repackaging design, can vary from GBP 5,000 to GBP 450,000. The cost of factory and transport re-tooling in response to a reformulated product would instead range from GPB 8,000 to well over GBP 100,000 (Food Standards Agency, 2010[55]). The cost of each step in R&D is influenced by the degree of change needed for the reformulation. Some nutrients may have replacers that are widely used and will need little additional research; some products may not taste different and will need less consumer testing; and there may be no need for a change in production process.

Figure 5.1. Impact of product reformulation on the industry

	Potential impact on industry		Influencing factors
R&D	− Negative	Producers will need to invest in research and development to reformulate their products	These cost depend on the type of product and reformulation; with minor, non-critical ingredients being easier to replace than major ingredients
	○ Neutral	If reformulation can be incorporated into planned reformulation cycles, additional cost can be reduced or eliminated	A longer transition period (e.g. 48+ months) increases the chance that the reformulation can be done as part of normal business activity
Marketing	− Negative	There may be marketing cost associated with the promotion of the new reformulated product	Whether or not the change in formula is marketed will depend on consumer perception (e.g. are low-in products perceived to be less tasty, or are they considered healthier)
	○ Neutral	If a stealth approach is taken, there will be no marketing cost for the new product	
Sales	+/− Variable	If the reformulated product is (or is perceived to be) of lower quality, sales may be reduced. However, sales could also be increased if the new product is considered healthier.	Changes in sales will depend on: • Changes in product quality • Consumer perception of the change • Marketing or stealth approach • Whether the reformulation is voluntary or mandated, the latter creating a level playing field between producers • The length of the transition period and whether it allows incremental changes • Awareness of consumers, aided by public health campaigns
Production cost	+/− Variable	The reformulated product may carry higher or lower ingredient cost, or different production cost	Changes in production cost depend on the type of reformulation

Source: OECD analysis on cited literature.

61. Second, reformulation can result in a reduction (or an increase) of sales. Reformulation could lead to a reduction in sales if the product is of a lower quality (e.g. consumers dislike the taste of the new product), or if the reformulation has a negative image. Producers can try to mitigate this impact in two ways (Webster and Hawkes, 2009[41]). They may choose not to communicate the change explicitly to the public, taking a 'stealth' approach. For example, a study of a Danish supermarket chain showed that stealth reformulations across a range of products reduced the total calories sold, while having either positive, zero or very moderate negative effects on sales (Jensen and Sommer, 2017[56]). Large food producers have also highlighted the benefit of stealth reformulation (Fortune.com, 2017[57]) (MIT Technology Review, 2015[58]). Conversely, if the change is perceived as positive by the public, marketing can be used to emphasise the new and healthier product, possibly increasing sales.

62. Third, reformulation may result in higher (or lower) production cost for producers. Depending on the change in product, food producers may face higher ingredient costs (Buttriss, 2013[43]). For example, engineered salt-replacement products can carry higher cost than traditional salt (Wilson, Komitopoulou and Incles, 2012[59]). Some oils lower in saturated fat are more expensive than those high in saturated or trans-fats (Skeaff, 2009[60]; Food Standards Agency, 2010[55]). Conversely, artificial sweeteners may be cheaper to use than sugar because of the low volume needed to reach the same level of sweetness (Tandel, 2011[45]) (Piisola, 2014[61]). In 2012, the price for aspartame, saccharin and cyclamates was only ca. 12%, 3% and 10% of the white sugar price, on a sweetness-equivalent basis (LMC International, 2012[62]). In addition to ingredient cost,

the different characteristics of the reformulated product may carry higher transport, storage or packaging cost. Sugar, fat and salt can all act as preservative agents, and reducing their levels therefore affects the shelf-life of a product. A reduced shelf-life will impact the profitability and efficiency of the company. Products with a shorter shelf-life are more difficult to transport for long distances, carry more re-stocking cost, are subject to more wastage, and may be less attractive to consumers.

5.1.3. Policy actions can influence the impact of reformulation on industry

63. As described above, the impact of reformulation on industry is dependent on a large range of factors. Some of these factors can be influenced by policymakers, to facilitate reformulation and disburden producers. The same factors also emphasise the need for a carefully designed reformulation policy. Some of the key policy issues that policymakers have to address while implementing actions to support reformulation are:

Reformulating single nutrients vs whole product approach

64. Each product category needs to be reviewed as the impact of reformulation on taste, texture, structure, microbial safety and nutrient replacement varies (National Heart Foundation of Australia, 2012[63]). While in some cases, for example salt, the solution can be as simple as reducing current levels, in other cases a whole product approach may be more beneficial to public health as well as the producers (Webster and Hawkes, 2009[41]) as it can help prevent unwanted substitutions (e.g. substituting fat with sugar) and it prevents producers from having to go through several reformulation processes when policies are introduced for each separate nutrient.

Putting in place a collaborative approach to R&D

65. While for some nutrients cheap and effective substitutes may already exist, in other cases more research is needed. Developing a new replacement ingredient can provide a producer with a competitive advantage, but usually requires a significant financial and time investment (Webster and Hawkes, 2009[41]). Alternatively, government can support shared research, to encourage collaboration and accelerate development. A number of OECD countries have already put in place similar arrangements and provide funding to universities as well as commercial companies to support R&D.

Box 5.1. Government funding of reformulation R&D: the case of Ireland and Chile

In Ireland, the Food Institutional Research Measure (FIRM), funded by the Department of Agriculture, Food and the Marine, is the primary national funding mechanism for food research (Department of Agriculture Food and the Marine, 2017[64]). It has funded research into nutritional and sensory optimisation of reduced salt and fat processed meat products, the development of biofortification approaches for enhanced vitamin K content of foods, and novel technological approaches for the development of low sugar but highly consumer accepted food and beverage products.

The Foundation for Agrarian Innovation (FIA) is an agency of the Chilean Ministry of Agriculture, whose mission is to promote a culture of innovation in the agrarian, agri-food and forestry sector. In 2017, they launched a call for proposals focusing on healthy food innovation (Fundación para la Innovación Agraria, 2017[65]). Projects can focus on developing new functional ingredients and additives, new food technologies and health and safety improvements. For successful projects, the FIA contributes up to 70% of research cost, to a maximum of CLP 120 million (EUR 161 000), with the other 30% covered by the researchers. Agricultural and food companies can apply, as well as universities and other technological organisations if they partner with a producer.

Mandatory vs voluntary policies

66. The costs of a reformulation policy for industry depend on whether participation is voluntary or mandatory, and each approach has its benefits and disadvantages.

67. Mandatory reformulation schemes have the benefit of creating a level playing field for food producers (World Health Organization, 2017[44]). Everyone needs to comply with the same regulation, and there is no competition from cheaper, unhealthy products. In addition, a legislated approach is thought to be more cost-effective than a voluntary approach, and to have a larger impact on public health (National Heart Foundation of Australia, 2012[63]). Reformulation can be mandated by setting maximum levels for specific nutrients and products, as was done for salt in South Africa (Charlton, Webster and Kowal, 2014[66]). Another approach is to incentivise reformulation by introducing a mandatory front-of-package label (National Heart Foundation of Australia, 2012[63]). In Finland, the launch of a national warning label for products high in salt led to a 20% reduction in salt levels in bread (World Health Organization, 2013[67]).

68. Voluntary programmes on the other hand are beneficial to producers as they allow the creation of line extensions rather than replacing the product completely. By offering consumers an option, the loss of sales can be minimised. Voluntary front-of-package labels indicating healthier choices have been introduced in many countries to encourage reformulation. In the Netherlands, a review of a sample of products which carried the voluntary Healthy Choice logo found that nearly 50% had been reformulated or newly formulated to comply with the label's requirements (Vyth et al., 2010[68]). Many of the existing voluntary programmes are public-private partnerships (PPPs). Partnerships between governments and industry have a number of benefits, including increased commitment of producers, expertise on reformulation, and greater financial and research resources (Hernandez-Aguado and Zaragoza, 2016[69]). However, disadvantages include the inherent conflicts of interests, and the risk of conferring the legitimacy of the government institutions on the industry and their actions.

69. There are a number of other considerations policymakers need to take into account when deciding on a voluntary or mandatory scheme. The image of reformulation for the specific product concerned will play an important part. If a healthier product carries a positive image, producers will be more inclined to participate in a voluntary scheme to receive a 'healthy choice' label. If this is not the case, participation may need to be mandated.

70. The capacity available for monitoring and enforcement also influences the type of approach policymakers can choose. A mandatory approach requires a significant investment to ensure compliance. A voluntary approach would remove most of the legislative burden, but some form of regulation is still needed to ensure the credibility and dependability of the scheme. For example, where labels are involved, checks are needed to ensure that the food products conform to the requirements of the label. However, it does not need to be solely the role of government. Consumer watch dog organisations can play an important role in monitoring industry compliance.

A longer transition period could provide producers with more flexibility

71. The timing of a new policy, and any leniency or grace period, can have an influence on the cost of implementation for producers. If new standards are introduced in the short-term, producers may see increased transition cost due to long-term contracts with suppliers, left-over stock and greater interruption to production (White et al., 2002[70]).

72. A longer time scale may allow producers to plan their switch to the new production process more carefully to minimise transition cost. In addition, it increases the chance that the public health reformulation can be included in a standard planned reformulation cycle, further reducing cost (Food Standards Agency, 2010[55]). It has been estimated that a 12-month lead time would allow 5% of producers to coordinate reformulation with the usual cycle, at 24 months this would be 20%, at 26 months 30% and at 48 months 40% (White et al., 2002[70]).

73. A longer transition period may also allow producers to make incremental changes to a product, to make the change in flavour more acceptable to consumers (National Heart Foundation of Australia, 2012[63]). This approach has proven successful for the reduction of salt (Doyle and Glass, 2010[71]). For example in the UK, salt levels in breakfast cereals were reduced by 47% between 1992 and 2015 (Pombo-Rodrigues et al., 2017[72]). South Africa's mandatory salt limits are being introduced in a phased fashion, with the more stringent targets not coming into effect until 2019 to allow consumer tastes to adapt (Charlton, Webster and Kowal, 2014[66]).

74. While policymakers should consider the flexibility that a longer transition period provides, and the associated lower cost to industry, this needs to be justified against the delay in public health benefits associated with a long lead time.

A corresponding public health campaign benefits both public health and industry

75. When reformulating a specific product or nutrient, a corresponding public health campaign focused on increasing consumer awareness of this nutrient can positively impact public health as well as the cost to industry. A consumer awareness campaign can encourage consumers to buy the reformulated products, thus increasing the consumption of healthier products, and reducing the impact of reformulation on sales (National Heart Foundation of Australia, 2012[63]).

76. For the UK Salt Reduction Campaign, the government committed to running a high profile campaign on salt and its impact on health, in return for voluntary commitments from industry to reduce salt levels (Charlton, Webster and Kowal, 2014[66]). While producers initially took a silent approach to their salt reduction efforts, once the campaign started to change public perception they actively marketed their improved salt levels.

77. In contrast, Australia's Food and Health Dialogue, a public-private partnership, was not supported by a public campaign. This absence, as well as the incomplete coverage of producers and the small number of food product categories covered, has been cited as a reason for the limited success of the scheme (Magnusson and Reeve, 2015[73]; Trevena et al., 2014[74]).

6. Next steps

78. This document has focused on selected key aspects of the ongoing projects on obesity, unhealthy diet and lack of PA that the Secretariat has carried out since the last report to the Health Committee. The content of this paper will be expanded and complemented with new work on obesity, nutrition and PA in view of the preparation of a new report to be published in 2019. More specifically, future work will include the following:

- **Chapter on the analysis of trends and patterns**: Analyses to identify population groups at higher risk for unhealthy lifestyles associated with obesity (Section 2.2) will be completed and possibly extended in terms of geographical coverage, based on the interest of countries and the availability of data. Results from these various analyses will be consolidated into a single chapter.
- **Chapter on the impact of obesity on the economy**: the quantitative analysis on the impact of unhealthy lifestyles associated with obesity and obesity on educational attainments and labour market outcomes will be completed and complemented with further analyses, including: i) extension of the country coverage to include additional OECD countries; ii) analysis of inequalities across population groups; iii), in the case of educational attainment, analysis on longitudinal studies for selected countries, for which data is available, to assess the causal link (rather than the association as currently done by using cross-sectional data) between risk factors and educational outcomes/attainments. Results from the analyses on labour market and welfare benefits will be implemented in the OECD SPHeP-NCD microsimulation model to allow for the assessment of the effects of public health policies on these dimensions and the broader economy.
- **Chapter on promoting healthier lifestyles: what policy approaches?** Ongoing work to identify and assess the effectiveness of innovative policy options to promote a healthy lifestyle (Section 4.) will be finalised for the interventions presented in this document. Additional (few) selected interventions (e.g. environmental changes and food reformulation) could be included, depending on data availability and interest from countries. In addition, the Secretariat is updating evidence presented in the 2017 Obesity Update on best practices in OECD countries to complement the quantitative evidence presented in this document with the objective of producing a chapter to discuss policy actions already in place in OECD countries. The quantitative component of this work will be also used to feed the OECD SPHeP-NCD (Strategic Public Health Planning for NCDs) microsimulation model.
- **Chapters on the impact of obesity on health and healthcare expenditure and on the health and economic impact of obesity policies.** The OECD SPHeP-NCD microsimulation model will be further developed (see, for example, a proposed development in Box 6.1) and fed with the new data mentioned above to

produce two types of analyses. A first set of analyses will investigate the health and economic impact of obesity. This will be done by comparing the 'business-as-usual' scenario with a counterfactual scenario in which prevalence of overweight and obesity is zero. A second set of analyses will test the potential effects produced by the implementation of the policy options discussed in Section 4. . In both of the analyses, the studied outcomes will include: i) population health in terms of life years, disability-adjusted life years (DALYs), incidence of major NCDs; ii) impact on healthcare expenditure; iii) impact on the labour market and welfare outcomes in terms of employment rates, absenteeism/presenteeism, selected welfare benefits. In addition, the Secretariat is working to assess the impact on GDP. Results from these analyses will be presented in one or two chapters of the final publication.

- Work to discuss the effect of public health policies on business and industry (Section 5.) will be further expanded to other selected policies. As far as possible, this piece of work will count on inputs from policy case studies and will try to provide quantitative evidence from these case studies. Inputs from BIAC are being sought as well as from other relevant Directorates. Results from these analyses are expected to contribute with a chapter in the final publication.

Box 6.1. Incorporating outputs from JANPA into the OECD modelling work

Public institutions from 26 European countries and the EC were involved in the Joint Action on Nutrition and Physical Activity (JANPA). One of the components of this project dealt with the lifetime cost of childhood obesity. More specifically, this stream of work aimed to: i) describe the lifetime impact and cost of overweight and obesity in today's children; ii) to give a breakdown of these impacts and costs according to the year of occurrence; and iii) to assess the benefits of reducing childhood obesity by 1% and 5%. To carry out the analysis, the JANPA team developed specific methodological approaches to model the longitudinal trajectories of risk factors associated with obesity. This approach was applied in seven European countries: Croatia, Greece, Ireland, Italy, Portugal, Romania and Slovenia.

The Institute of Public Health in Ireland, which led the abovementioned stream of work, established contact with the Secretariat to discuss the possibility of implementing a similar methodology to the OECD model. Preliminary technical discussion between the two teams suggests that this would be feasible but would entail some adaptation and further work on the OECD model, particularly to extend the geographical coverage of the analyses. After the implementation of this new feature, the OECD model would be able to further enhance the evaluation of policies specifically targeting children. Among the various new features, this improvement would allow to calculate the lifetime impact of policies on population health, healthcare expenditure and productivity.

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Annex - Further data related to Section 4.

Table A.1 Quantitative evidence on the interventions included in the OECD analyses

Intervention	Brief description	Main target demographic	PA type affected	Effectiveness parameters
Regulation of advertising of unhealthy products to children (OECD analysis, based mostly on meta-analysis of RCTs by(Boyland, Nolan et al. 2016))	OECD modelled the effect of total statutory ban of food advertisement on television, targeting children below 18 years of age, with the intent of limiting their consumption of unhealthy food. The intervention is assumed to be initiated by a government, and may include both regulatory and enforcement components, to support maintenance of healthier dietary patterns among children.	School-aged children	N/A	Total ban → 4.16% fewer calories consumed, or 1.86% reduction in body weight
Childhood obesity prevention programmes (both dietary and PA components) in schools (Wang, Cai et al. 2015)	Wide range of interventions not restricted to one setting (e.g., intensive classroom PA lessons led by trained teachers, moderate-to vigorous, PA sessions, distribution of nutritional education materials and provision of healthy foods.	2-18 y.o. children. Interventions only take place in schools.	Mostly leisure/sport	Nine combined RCTs (with both dietary and PA components): an overall mean difference in BMI of −0.30 kg m−2 (95% CI: −0.45, −0.15, P < 0.001) in favour of the interventions.
Mobile apps (Mateo, Granado-Font et al. 2015)	The use of mobile apps designed to encourage healthier dieting and more physical activity (e.g., "Smart Diet", "My Meals" or "MyFitnessPal")	Mostly younger adults who use smartphone applications	Mostly leisure/sport	Meta-analysis of 12 articles: the use of mobile phone apps associated with significant changes in body mass index of -0.43 kg/m^2 (95% CI -0.74 to -0.13) and body weight (kg) of -1.04 kg (95% CI -1.75 to -0.34)
Text messaging for weight management (Siopis, Chey and Allman-Farinelli, 2015[75])	Wide range of interventions delivered via phone text messaging. In general, they all provided some support for those who wanted to do more PA and improve the quality of their diets.	Both adults and children	Mostly leisure	Meta-regression results show that the intervention mean weight change is -2.17 kg (95% CI = -3.41 to -0.93, P = 0.001). Study duration from 1 to 12 months.
Multiple behaviour change interventions for primary prevention of CVD in primary care (eg designed to modify diet/PA in CVD-free adults) (Alageel et al., 2017[35])	Identifying individuals at high risk of CVD in primary care, and encouraging lifestyle change through multiple health behaviour change (MHBC) interventions to reduce risk factors such as unhealthy eating/lack of PA, represents a widely used strategy for the primary prevention of CVDs. Such interventions, however, can include some other components, e.g. less alcohol consumption, stress management and smoking cessation.	Adults visiting primary care, different age groups.	Mostly leisure	31 controlled trials (36 484 participants) with a minimum duration of 12 months follow-up. Pooled net change in systolic blood pressure (16 trials) was −1.86 (95% CI −3.17 to −0.55; p=0.01) mm Hg; diastolic blood pressure (15 trials), −1.53 (−2.43 to −0.62; p=0.001) mm Hg; body mass index (14 trials), −0.13 (−0.26 to −0.01; p=0.04) kg/m2

Intervention	Brief description	Main target demographic	PA type affected	Effectiveness parameters
Prescribing physical activity in primary care (Goryakin, Suhlrie and Cecchini, 2018[34])	The modelled intervention had to be more than just a simple brief advice, and thus could include exercise on referral or exercise on prescription schemes, or another form of personalized counselling.	Mostly adults older than 40 visiting primary care, at an increased risk of having potentially disabling NCDs (but healthy enough to exercise)	Mostly leisure/sport	Reduction in BMI by about 0.21 kg/m² (95% CI: -0.41 to -0.01) and increase physical activity-related energy expenditure by about 1.77 METs (95% CI: 0.58 to 2.95). Effect stronger in subgroups where there was more active engagement between primary care workers and patients.
Mass media campaigns to promote PA (OECD meta-analysis of a number of studies)	OECD modelled the effect of traditional media campaigns (two 15-second television paid commercials aired on the radio, television, newspapers/magazines) on physical activity levels. The TV commercials can be combined with some other resources, such as adverts in printed media, posters, leaflets, postcards, web sites and public relations events.	Relatively healthy adults (>18 y.o.)	Mostly leisure/sport	Traditional campaigns plus print media adverts→ 36% more at least moderately active people. Maximum level assumed to be achieved during the first month of the campaign (about 60% increase compared to baseline), which then diminishes to about 30% after 1 year, and then goes to zero after 2 more years.
Restaurant menu labelling (Sinclair, Cooper and Mansfield, 2014[37])	The labelling has to be provided on the menus of eating establishments (including fast food places), and will include information on the calorie content of foods, as well as on other nutrients (e.g., sodium, fats, sugar). In addition to simply informing, such menu labels will have an interpretive dimension (e.g. with the help of a traffic lights system; or with a warning sign).	Mostly adults	N/A	Interpretive labelling → 81 kcal less per purchase. Women on average consume fewer calories than men. Effect stronger in areas with higher level of education and income.
Pre-packaged food labelling (Cecchini and Warin, 2016[36])	All manufacturers or retailers required to provide information on the nutritional composition of foods sold in stores/supermarkets. Such information should either include nutrient lists, for example "informative" calorie labels, or clearly visible "interpretive" labels.	Mostly adults	N/A	Food labelling would increase the amount of people selecting a healthier food product by about 17.95% (CI: +11.24% to +24.66%). Stronger effect of traffic light systems for pre-packaged foods, as 29% more people on average choose healthier food. Food labelling would also decrease calorie intake/choice by about 3.59% (CI: 8.90% to +1.72%)
Intermodal transportation options (OECD analysis)	Building, extending, or improving local public transit options.	Relatively healthy adults and adolescents	Mostly travel-related	New transport options → About 30 minute increase in light/moderate physical activity per week in exposed populations
Physical activity infrastructure (OECD analysis)	Investment into physical activity infrastructure, and its effect on physical activity and health	Both children and adults	Mostly leisure/sport	Very few studies examine the effect of *investment* into PA infrastructure on health/PA. Therefore, we mostly consider the evidence on the association between PA infrastructures *per se*, and these outcome variables (work ongoing).

Intervention	Brief description	Main target demographic	PA type affected	Effectiveness parameters
Workplace interventions to reduce sedentary time in white-collar workers (Chu et al., 2016[76])	Different types of workplace interventions assessed: educational, behavioural, environmental and multi-component interventions	White collar workers	Mostly work-related	The pooled effect: significant workplace sitting reduction of -39.6 min/8-h workday, favouring the intervention group. In 9 RCT studies, this effect was -38.9 m. (-60.2 to -17.6). Multi-component interventions reported the greatest workplace sitting reduction (-88.8 min/8-h workday; 95% CI: -132.7, -44.9), followed by environmental (-72.8 min/8-h workday; 95% CI: -104.9, -40.6) and educational/behavioural strategies -15.5 min/8-h workday (95% CI-22.9,-8.2).
Impact of worksite wellness programs (WWPs) on diet and adiposity (Penalvo, Micha et al. 2017)	Multi-component WWP trials	White collar workers	Mostly work-related	Modified abstract poster at Circulation journal: BMI was reduced by -0.28kg/m2 (-0.42; -0.14). Trial duration significantly modified effects on BMI (<12 mo duration: -0.64 kg/m2; 12+ mo: -0.16 kg/m2; P-interaction=0.046).