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CHARACTERIZING THE IMPLEMENTATION OF INNOVATIVE NONCOMMUNICABLE DISEASES POLICIES IN A HIGH PREVALENCE SOUTH EUROPEAN COUNTRY

PORTUGAL

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DECLARATION OF ORIGINALITY

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Abstract

Noncommunicable diseases (NCDs) are the main cause of death and disability worldwide. They are responsible for more than 70% of all global mortality. Furthermore, being among the biggest generators of health care expenditure, they pose important economic sustainability challenges to health care systems worldwide. After a slow start, the international community has come to prioritise these conditions, as evidenced by high-level meetings on NCDs at the UN General Assembly. In 2015, 193 countries committed to reducing premature deaths from NCDs by a third by 2030, as part of the Sustainable Development Goals. WHO Member States have also endorsed a menu of cost-effective NCDs best buy policy options that can be used to tackle the NCD pandemic. However, many governments have been grappling with this challenge and looking for effective policy-based solutions, particularly in the area of promoting healthy eating.

In Europe, NCDs are responsible for approximately 80% of all health care spending. Nevertheless, 80% of such NCDs are preventable if their behavioural risk factors are properly addressed. This was why countries in the WHO European Region have implemented a wide range of mandatory and voluntary policies to promote healthy lifestyles, including a growing number of interpretative nutrition labelling schemes, targeted food and beverage taxes, comprehensive reformulation strategies, and restrictions on the marketing of unhealthy foods. Recently, the Portuguese example has been repeatedly used by the WHO as a good role model for other countries to follow in this area.

The aim of this thesis was to assess whether Portugal is a strong implementer of the WHO's recommended policies for tackling NCDs and whether the strategy used for the

implementation of the healthy nutrition policies was therefore successful. In this thesis, five of the most challenging policies to implement were individually analysed and characterised using different health impact and effectiveness assessment methods. Furthermore, all the policy areas were critically assessed regarding their implementation challenges and determinants.

Among the biggest scientific innovations resulting from this thesis research development is the usage of real food consumption data from Portuguese Population cohorts in order to model the impact of both mandatory and voluntary policies. Furthermore, this thesis presents research using total SSBs consumption data at the national level for the first time in this research area. Also, the ability to model the impact of a SSBs tax on obesity incidence is one of the biggest scientific break throughs of the hereby-presented research.

The outcomes of the strategy developed by Portugal in order to address its unhealthy eating habits provide an opportunity for refining the reason why some countries score better than others at implementing the WHO's NCD policies. Furthermore, the lessons learned from this case study may contribute to the improvement of change management as a way to push for high health impact implementation of NCD policies.

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Table of Contents

ABSTRACT 4

ACKNOWLEDGEMENTS 6

LIST OF FIGURES AND TABLES 14

LIST OF ACRONYMS 20

CHAPTER 1 22

INTRODUCTION 22

NCD: A GLOBAL THREAT 22
NCD RISK FACTORS 26
'BEST BUYS' AND RECOMMENDED INTERVENTIONS 29
EUROPEAN REGION: AN UNHEALTHY EATING REALITY 33
PORTUGAL: A HIGH NCD PREVALENCE COUNTRY 38
THESIS OVERVIEW 44
ORIGINAL CONTRIBUTIONS OF THE THESIS 48

CHAPTER 2 51

NCD POLICIES IMPLEMENTATION: A GLOBAL ANALYSIS 51

INTRODUCTION 51
OBJECTIVES 54
METHODS 54
RESULTS 60
DISCUSSION 70
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 78
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 79

CHAPTER 3 80

SETTING A POLICY FRAMEWORK: THE PORTUGUESE INTEGRATED STRATEGY FOR HEALTHY EATING 80

INTRODUCTION 80
OBJECTIVES 86
METHODS 86
RESULTS 91
DISCUSSION 98
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 101
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 102

CHAPTER 4 106

FISCAL POLICIES: THE SUGAR-SWEETENED BEVERAGES TAX 106

INTRODUCTION 106
OBJECTIVES 110
METHODS 111
RESULTS 119
DISCUSSION 125

POLICY IMPLICATIONS AT THE NATIONAL LEVEL 133
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 134

CHAPTER 5 136

SELF REGULATION POLICIES: THE FOOD REFORMULATION AGREEMENT 136

INTRODUCTION 136
OBJECTIVES 140
METHODS 140
RESULTS 144
DISCUSSION 151
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 155
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 157

CHAPTER 6 158

MANDATORY POLICIES: REGULATING SALT CONTENT IN BREAD 158

INTRODUCTION 158
OBJECTIVES 162
METHODS 162
RESULTS 168
DISCUSSION 171
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 178
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 179

CHAPTER 7 181

NUDGES: LOOKING FOR A SINGLE FRONT OF PACK LABELLING SYSTEM 181

INTRODUCTION 181
OBJECTIVES 188
METHODS 189
RESULTS 195
DISCUSSION 210
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 213
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 215

CHAPTER 8 216

EDUCATION: SCHOOL-BASED PROGRAMS 216

INTRODUCTION 216
OBJECTIVES 220
METHODS 220
RESULTS 222
DISCUSSION 225
POLICY IMPLICATIONS AT THE NATIONAL LEVEL 231
POLICY IMPLICATIONS AT THE GLOBAL LEVEL 233

CHAPTER 9 235

DISCUSSION AND CONCLUSIONS 235

POLICY INSIGHTS 235
IMPLEMENTATION INSIGHTS 243
RECOMMENDATIONS AT THE NATIONAL LEVEL 264

RECOMMENDATIONS AT THE GLOBAL LEVEL 273

REFERENCES 282

APPENDIX 337

List of Figures and Tables

CHAPTER 1. Introduction	
Figure 1	Life expectancy and healthy life years at 65, by sex.
Figure 2	The proportion of deaths from NCDs occurring among those aged 30-69 years, by income groups.
Figure 3	The proportion of deaths from NCDs occurring among those aged 30-69 years, by WHO region.
Figure 4	Voluntary global targets of the Global NCD Action Plan.
Figure 5	Risk factors driving death and disability combined.
Figure 6	Distribution of different body mass profiles in Portugal.
Figure 7	How Food Systems Work.
Table 1	WHO recommended actions for Member States to tackle NCDs.
Table 2	WHO 'best buys' and other recommended interventions addressing dietary habits.
CHAPTER 2. NCD policies implementation: a global analysis	
Figure 8	Mean 2017 implementation scores for each policy across 151 countries.

Figure 9	Mean indicator score and 95% confidence intervals for the top 20 countries, bottom 20 countries, and the rest of the world.
Figure 10	Waterfall chart showing the relative contribution of each policy to the overall increase in mean implementation score between 2015 and 2017.
Figure 11	Changes in individual mean scores for each policy for countries whose overall implementation improved (left), stayed the same (centre), and regressed (right) from 2015-2017.
Figure 12	Aggregate policy implementation score and human capital index.
Table 3	The WHO's NCD progress monitor policies nested under ten indicators and four commitments.
Table 4	Explanatory variables.
Table 5	Top and bottom 20 countries by 2017 aggregate implementation score.
Table 6	Regression analyses for 2017 aggregate score and seven explanatory variables.
Chapter 3. Setting a policy framework: the Portuguese Integrated Strategy for Healthy Eating	
Figure 13	The process leading to the publication of order No. 11418/2017.
Table 7	Overview of measures planned as part of axis 1 of EIPAS.
Table 8	Overview of measures planned as part of axis 2 of EIPAS.

Table 9	Overview of measures planned as part of axis 3 of EIPAS.
Table 10	Overview of measures planned as part of the axis 4 of EIPAS.
Chapter 4. Fiscal policies: the sugar-sweetened beverages tax	
Figure 14	Time trend of the average energy intake from SSBs (in kcal/100ml) per SSBs product, using market data.
Figure 15	Time trend of total sales of SSBs according to different data sources.
Table 11	Dietary energy density from SSBs in 2016 (baseline) and 2018 (counterfactual scenarios), by age group.
Table 12	Potential impact fraction (PIF) and prevented obesity cases due to the decrease in sugar content of SSBs (counterfactual 1) and due to decreases in sugar content and consumption volume (counterfactuals 2 and 3).
Chapter 5. Self regulation policies: the food reformulation agreement	
Figure 16	Historic and projected risk of premature deaths from NCDs in Portugal compared with sustainable development goal targets for 2025.
Table 13	Preliminary objectives of the 2015 co-regulation agreement between the Portuguese government and the food industry for reducing sugar, salt and trans-fatty acids in processed food.
Table 14	Projected daily intake of salt, total energy and total fat by age and sex in Portugal in 2021 if a co-regulation agreement on the nutrient content of processed food were implemented.

Table 15	Projected mean number of deaths from NCDs averted in Portugal in 2016 if targets for the reduction of sugar, salt and trans-fats intake by the population were achieved, by age, sex, disease and behavioural risk factor.
Table 16	Projected number of deaths from NCDs averted in Portugal in 2016 if targets for the reduction of sugar, salt and trans-fat intake by the population were achieved, by sex, disease and nutrient.
Chapter 6. Mandatory policies: regulating salt content in bread	
Figure 17	Illustration of the estimated consumption of different types of bread in Portugal.
Table 17	Simulations to estimate the overall decrease in salt consumption by the Portuguese population, assuming that all bread sold in Portugal complied with the legislation on the limit of the salt content.
Chapter 7. Nudges: looking for a single front of pack labelling system	
Figure 18	Different FoPLs applied to different biscuits.
Figure 19	Percentage of participants having deteriorated or improved their food choices within the pizza food category.
Figure 20	Percentage of participants having deteriorated or improved their food choices within the cakes food category.
Figure 21	Percentage of participants having deteriorated or improved their food choices within the cereals food category.
Figure 22	Percentage of correct answers for the ranking tasks within the pizza category.

Figure 23	Percentage of correct answers for the ranking tasks within the cakes category.
Figure 24	Percentage of correct answers for the ranking tasks within the cereals category.
Figure 25	Percentage of correct answers for the ranking tasks for pizza, among participants who only recalled seeing the FoPL during the survey.
Figure 26	Percentage of correct answers for the ranking tasks for cakes, among participants who only recalled seeing the FoPL during the survey.
Figure 27	Percentage of correct answers for the ranking tasks for cereals, among participants who only recalled seeing the FoPL during the survey.
Figure 28	Principal component analysis map.
Table 18	Description of the population sample from Portugal (N=1.059).
Table 19	Association between FoPLs and change in the nutritional quality of food choices, by FoPL and food category.
Table 20	Association between FoPLs and the ability to correctly rank products according to nutritional quality, by FoPL and food category.
Table 21	Associations between FoPLs and ability to rank products according to nutritional quality.
Table 22	Associations between FoPLs and the ability to rank products according to nutritional quality.
Chapter 8. Education: school-based programs	

Figure 29	Mean salt content (g) of the complete school meals analysed at the diagnosis phase and at the post-intervention phase.
Table 23	Sodium and salt equivalent content of the components of the school meals.
Chapter 9. Conclusions	
Image 30	Health Policy Implementation Framework

List of Acronyms

AIPAN	National Association of Bread Producers
BMI	Body Mass Index
CI	Confidence Interval
COSI	Childhood Obesity Surveillance Initiative
CVD	Cardiovascular Disease
DED	Dietary Energy Density
eAT24	Electronic Assessment Tool for 24-hour recall
EC	European Commission
EIPAS	Estratégia Integrada para a Promoção da Alimentação Saudável
EM	Eat Mediterranean
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCTC	Framework Convention on Tobacco Control
FoPLs	Front-of-pack labels
GBD	Global Burden of Disease
HFSS	High in saturated Fat, free Sugars and Salt
HiAP	Health in All Policies
HSR	Health Star Rating system
IAN-AF	Inquérito Alimentar Nacional e de Atividade Física
LMICs	Low- and Middle-Income Countries
MTL	Multiple Traffic Lights
NCD	Noncommunicable Disease
PCA	Principal Component Analysis
PED	Price Elasticity of Demand

PIF	Potential Impact Fraction
PNPAS	Plano Nacional de Promoção da Alimentação Saudável
PROBEB	Portuguese Association of Non-Alcoholic Drinks
RI	Reference Intakes
RR	Relative Risk
SD	Standard Deviation
SDG	Sustainable Development Goal
SSBs	Sugar-Sweetened Beverages
t	tonnes
TFAs	Trans Fatty Acids
UN	United Nations
VIF	Variance Inflation Factors
WHO	World Health Organization

Chapter 1

Introduction

Noncommunicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors (WHO, 2018a). NCDs, mainly cancer, cardiovascular disease, chronic respiratory diseases and diabetes, are the main cause of death and disability worldwide, accounting for more than 70% of all deaths (WHO, 2018b) and more than 3 out of every 4 years spent living with a disability (NCD Alliance, 2020). Furthermore, NCDs claim at least 75% of all the care spending in most developed countries and pose a growing economic burden on low- and middle-income countries (LMICs). Therefore, it is fair to say that NCDs are a top challenge threatening health systems economic sustainability worldwide (Ward health, 2011).

NCD: a global threat

During the years that followed the Second World War, the discovery of several antibiotics, combined with the development of vaccines that made it possible to control different diseases, led to the erroneous belief that medical sciences would be capable of curing any disease. High expectations were created that assumed the continuation of this tremendous progress, due to the eradication of various infectious agents, such as those that cause smallpox, diphtheria or poliomyelitis. However, other diseases arose and took the place of their infectious predecessors, such as cancer, rheumatism, psychiatric disorders, heart attacks and strokes. Such diseases proved to be much more complex and challenging to address (Weatherall, 1995). As a result of this epidemiologic transformation, the remarkable achievements in life span brought by the cure of several communicable diseases were progressively supplanted by the fast escalation of NCDs, along with the massive costs associated with them (Maskell, 2016).

Nevertheless, it was possible to make some noteworthy improvements in the symptomatic control of NCDs, due to research, treatments and disease management innovations carried out by academia and the pharmaceutical industry. The development of treatments for heart failure and high blood pressure, as well as strong analgesic drugs used to treat rheumatic disorders, are some examples of the triumphs accomplished. Other accomplishments of note include organ transplantation, the development of extremely sophisticated diagnostic tools, life support systems and methods that allow the combination of modern surgery and chemotherapy for curative and palliation purposes of several forms of cancer, among many other (Weatherall, 1995).

Thanks to such improvements, medical science has become successful at increasing our life expectancy. Nonetheless, not much improvement seems to have been made regarding the effective cure of several of the leading killers of western society. This pattern of medical care translates to rising costs, which are causing several significant economic problems, even for the wealthiest nations (Weatherall, 1995). It is important to note that the social and individual impacts of NCDs begin long before death and are not restricted to premature death. Therefore, despite the increase in life expectancy to age 65 across all OECD countries between 1970 and 2017, these years are not necessarily lived in good health mostly thanks to NCDs. Moreover, among those countries, the number of years of healthy life at age 65 varies considerably (OECD, 2019a).



Figure 1 - Life expectancy and healthy life years at age 65, by sex.

Source: OECD (2019b)

Regarding the number of healthy life years at 65 years of age, overall, it was about 9.6 in the case of women and 9.4 in the case of men, as shown in Figure 1. Nevertheless, in Norway, Sweden and Iceland, both men and women had a healthy life expectancy at age 65 of over 15 years. On the other hand, in the Slovak Republic and Latvia healthy life expectancy at 65 years of age was significantly lower, being less than 5 years for both men and women. In these two countries, female individuals spend close to 80% of the extra life years in poor health. These asymmetries are largely the result of NCDs, which have shown to have a strong impact on both health systems and sustainability (OECD, 2019a).

When considering NCD's association with death the numbers are striking. NCDs are without a doubt the primary cause of death globally. In 2016, out of the 57 million deaths occurring worldwide, these types of diseases caused 41 million fatalities (71%) (WHO, 2018b). These deaths were mostly caused by the four main NCDs.

Cardiovascular diseases (CVDs) resulted in 44% of deaths from NCDs and 31% of all global deaths, totalling 17.9 million deaths. Cancer was responsible for 9 million deaths, which is 22% of deaths from NCDs and accounted for 16% of all global deaths. In turn, chronic respiratory diseases caused 9% of deaths from NCDs and 7% of all global deaths (3.8 million deaths). Finally, diabetes resulted in 1.6 million deaths, which is 4% of deaths from NCDs and 3% of all global deaths. It should be noted that NCDs do not only affect the older sectors of the population. In fact, they were responsible for an even greater proportion (75%) of premature deaths in adults aged between 30 and 69 years. Moreover, in 2016 the overall likelihood of dying as a consequence of the four main NCDs was 18%, with a somewhat greater risk for men (22%) compared to women (15%) (WHO, 2018b). Furthermore, data from 2016 revealed that premature deaths caused by NCDs are strongly related to the income level of countries. Around 78% of deaths caused by these diseases and 85% of premature adult deaths by NCDs took place in LMICs. Similarly, the number of premature deaths from NCDs was almost double in low-income countries and lower-middle-income countries (43% and 47%, respectively), when compared to high-income countries where NCDs were accountable for only 25% of premature deaths (Figure 2). Depending on the WHO region (Figure 3), the likelihood of premature adult deaths from NCDs was variable, with the highest probability seen in Eastern Mediterranean (24%), South-East Asian (23%) and African (22%) regions, compared to the Region of the Americas (15%), the European Region (17%) and Western Pacific Region (16%). Also, regardless of the WHO region, men are more likely to die from an NCD than women (WHO, 2018c). That said, there is no doubt that NCDs have an important impact both in High and LMICs and therefore they represent a relevant issue to be tackled not only at the local level, but also at the global level. Learnings and successful experiences from specific countries may therefore contribute to the international knowledge and development tackling this burden.

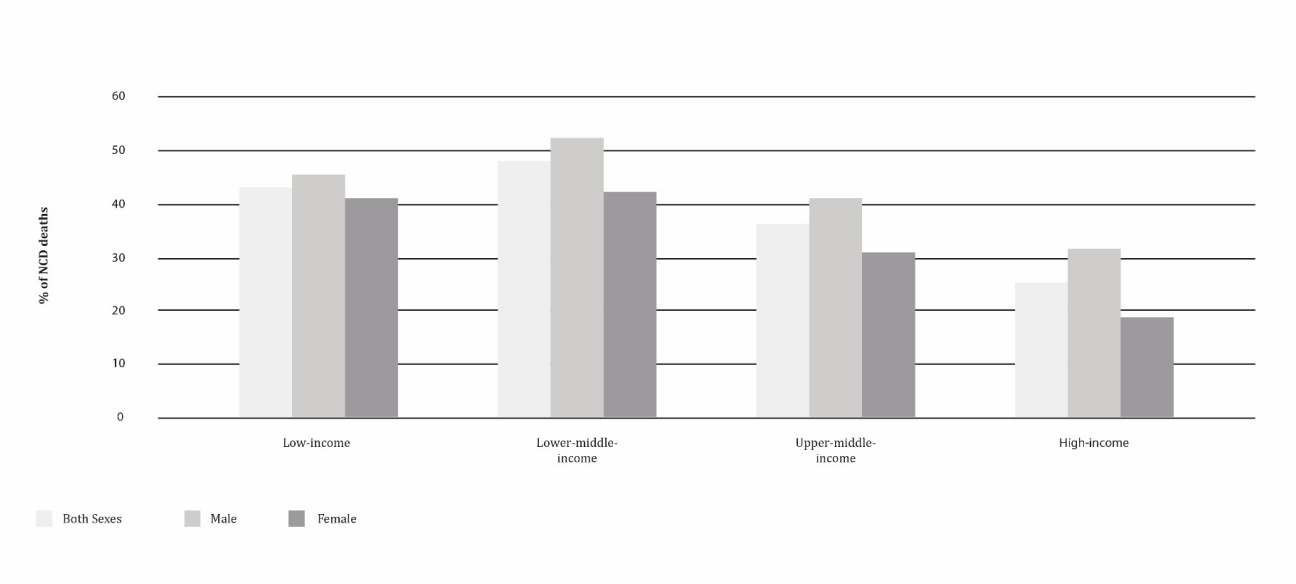


Figure 2 – The proportion of deaths from NCDs occurring among those aged 30-69 years by income groups.

Source: WHO (2018b)

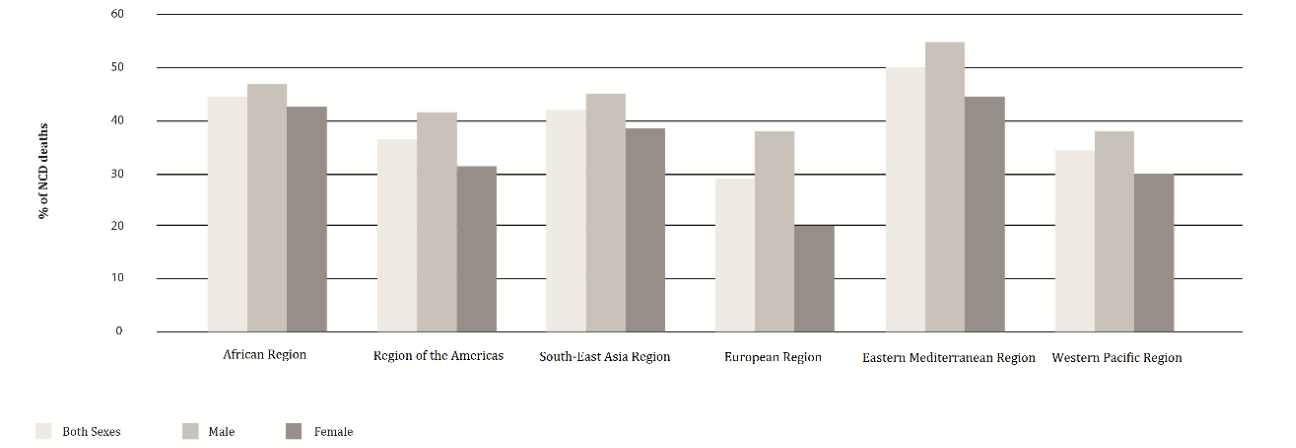


Figure 3 – The proportion of deaths from NCDs occurring among those aged 30-69 years, by WHO region.

Source: WHO (2018b)

NCD risk factors

The causes of chronic diseases are well established and well known; a small set of common risk factors is responsible for most of the main chronic diseases. These risk factors are modifiable and the same in men and women: alcohol consumption;

tobacco use, insufficient physical activity and unhealthy diets. The so-called harmful consumption of alcohol results in the death of 3 million people annually. There are 230 different types of diseases where alcohol has a significant role. It also causes harm to the well-being and health of people around the drinker (WHO, 2019). Alcohol is a colossal global health issue and small reductions in health-related harms at low levels of alcohol intake are outweighed by the increased risk of other health-related harm, including cancer. Therefore, it can be considered that there is indeed no safe level of alcohol consumption (Global Burden of Disease Study collaborators, 2018).

Smoking is a practice in which a substance like tobacco is burned and the resulting smoke inhaled to be tasted and absorbed into the bloodstream (Mustafa, 2012). Smoking has negative health effects and is the single largest preventable cause of morbidity and mortality all over the world (Munire et al., 2010). The WHO estimates that over 1 billion people are addicted to smoking tobacco and 5 million people die from tobacco-related diseases each year and the toll will rise to over 8 million by 2030 if the current trends continue (Khalid, 2014; Mary et al., 2018). Tobacco smoking is a recognized risk factor for many chronic diseases such as chronic obstructive pulmonary disease, hypertension, cardiovascular disease, atherosclerosis, diabetes, cancer and microbial infections (respiratory tract infections, bacterial meningitis) which leads to heavy burden involving health care and economic as well as social costs in all countries (McGhee & Ho, 2006; Michael et al., 2018; Seulggie et al., 2018). Therefore, there is no safe level of tobacco consumption.

Insufficient physical activity is one of the leading risk factors for global mortality and is on the rise in many countries, adding to the burden of NCDs and affecting general health worldwide. People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active (WHO, 2018d). Sedentary

lifestyles increase all causes of mortality, double the risk of cardiovascular diseases, diabetes, and obesity, and increase the risks of colon cancer, high blood pressure, osteoporosis, lipid disorders, depression and anxiety. According to WHO, 60 to 85% of people in the world—from both developed and developing countries—lead sedentary lifestyles, making it one of the more serious yet insufficiently addressed public health problems of our time. It is estimated that nearly two-thirds of children are also insufficiently active, with serious implications for their future health (WHO, 2020d). By following the WHO recommendations targeting each different age group, people can actually mitigate sedentarism as a risk factor and use physical activity as a health protective factor.

Increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns. People are now consuming more foods high in energy, fats, free sugars and salt/sodium, and many people do not eat enough fruit, vegetables and other dietary fibre such as whole grains. These dietary behaviours, that go against the WHO dietary recommendations, constitute the so-called unhealthy diets (WHO, 2020e). Even though they can have different shapes and forms, in general, unhealthy diets contribute to the occurrence of a cluster of disorders known as the metabolic syndrome – abdominal obesity, hypertension, dyslipidemia, and disturbed metabolism of glucose or insulin – which in turn accounts for a significant share of the global burden of disease (WHO, 2020e). Actually, unhealthy diets are responsible for 11m preventable deaths globally per year, more even than smoking tobacco, according to the Global Burden of Disease Study collaborators (2019).

These four behavioural risk factors are expressed through intermediate health disorders that constitute risk factors themselves. These are the so-called metabolic risk factors (WHO, 2013b; WHO, 2018e): raised blood pressure, raised glucose levels,

abnormal blood lipids, being overweight and obesity. In conjunction with the non-modifiable risk factors of age and heredity, behavioural and metabolic risk factors explain the majority of new events of heart disease, stroke, chronic respiratory diseases and cancers. The relationship between the major modifiable risk factors and the main chronic diseases is similar in all regions of the world. Therefore, in order to be able to tackle the NCDs burden, any country or region shall be able to address these same risk factors, even though adapting to the national context. This is why sharing successful experiences from countries that committed to tackle NCDs risk factors (like Portugal did regarding unhealthy diets) may help others to learn, move faster and be more effective addressing this shared challenge.

'best buys' and recommended interventions

Over the last few decades, mortality caused by NCDs and by infectious diseases showed opposite trajectories, with the first reaching an unquestionable leading position (Habib & Saha, 2010). After years ignoring this "elephant in the room", the United Nations finally decided it was time to act. To prevent and control this type of disease, a political declaration was created at the United Nations General Assembly, which took place in September 2011 in New York, to enable strong responses both globally and nationally (United Nations, 2012). The acknowledgement of a leadership position by WHO was part of the declaration, leading to the creation of the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020 (Global NCD Action Plan) implemented by the World Health Assembly in 2013. This action plan comprised nine voluntary global targets to be achieved by 2025, as illustrated in Figure 4 (United Nations, 2012; WHO, 2013a; WHO, 2013b).

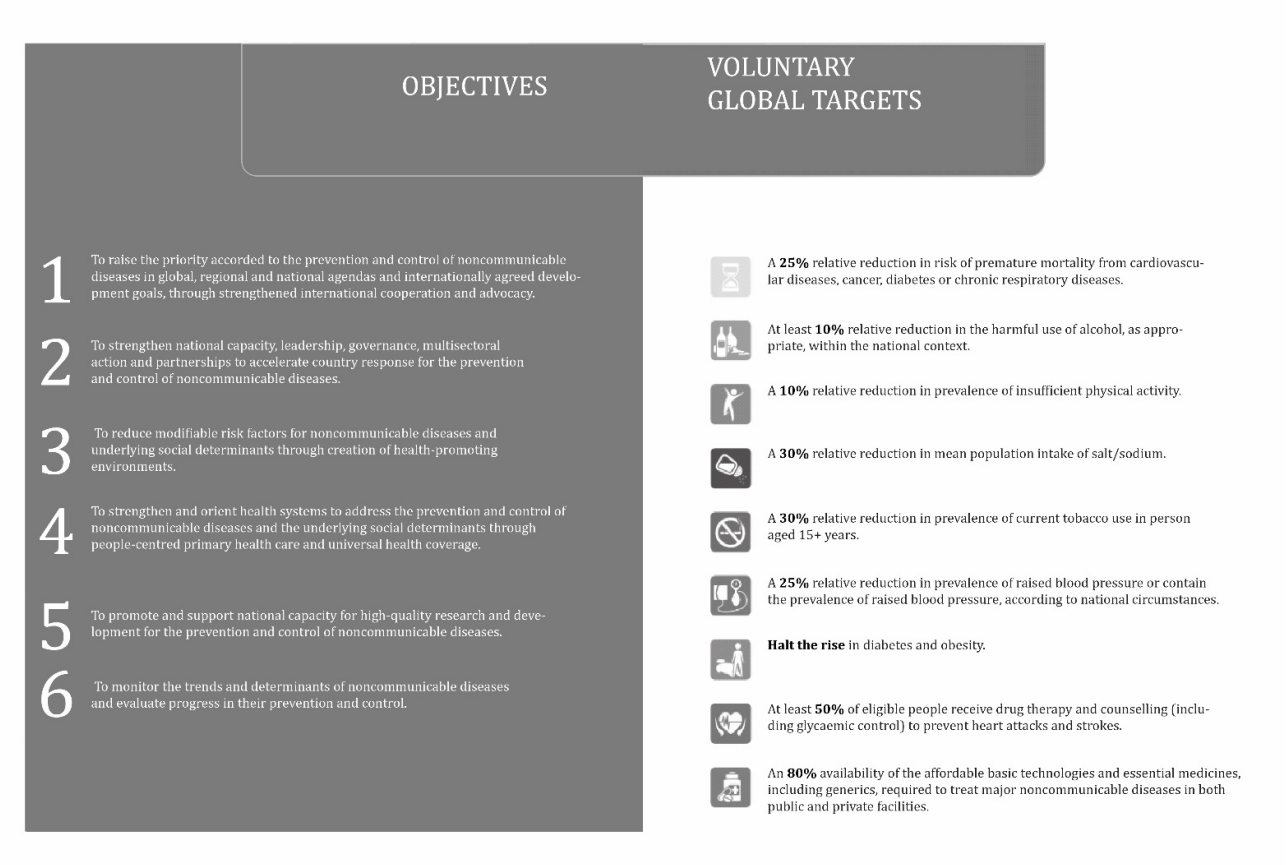


Figure 4 - Voluntary global targets of the Global NCD Action Plan.

Source: WHO (2013b)

The goals established were in line with those for NCDs that were addressed in the 2030 Agenda for Sustainable Development later approved at the United Nations Summit on Sustainable Development in September 2015, as well as the WHO 13th General Programme of Work 2019–2023 implemented by the World Health Assembly in May 2018 (United Nations, 2015a; United Nations, 2015b; WHO, 2018e; WHO, 2018f). Of all the global objectives defined, the first concerns the reduction by 25% in total mortality resulting from the four most important NCDs (cardiovascular diseases, malignant tumours, respiratory diseases and diabetes). Other objectives defined were related to the reduction of risk factors that contribute to this type of diseases, namely behavioural and metabolic risk factors.

However, political declarations and voluntary commitments may sometimes be too vague to actually trigger policy implementation at the national level. Therefore,

Member States specifically asked the WHO for guidance on the identification of specific actions effective in positioning each country to meet the targets defined in the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020. In response, a set of 16 recommended actions was included in Appendix 3 of the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020. Each of the recommended actions covers several requirements namely to be profitable, affordable, achievable and scalable in all settings.

Table 1 – WHO Recommended actions for Member States to tackle NCDs.

Risk factor/ disease to be addressed	Intervention	Detailed description
Reduce tobacco use	Tax	Increase excise taxes and prices on tobacco products
	Informative packaging	Implement plain/standardized packaging and/or large graphic health warning on all tobacco packages
	Advertising, promotion and sponsorship	Enact and enforce comprehensive bans on tobacco advertising, promotion and sponsorship
	Smoke-free public places	Eliminate exposure to second-hand tobacco smoke in all indoor workplaces, public places, and public transport
	Educate	Implement effective mass media campaigns that educate the public about the harms of smoking/tobacco use and second-hand smoke.
Reduce harmful alcohol use	Tax	Increase excise taxes on alcoholic beverages
	Advertising	Enact and enforce bans on comprehensive restrictions on exposure to alcohol advertising (across multiple types of media)
	Availability	Enact and enforce restrictions on the physical availability of retailed alcohol (via reduced hours of sale)
Reduce unhealthy diet	Reformulate food	Reduce salt intake through the reformulation of food products to contain less salt and the setting of target levels for the amount of salt in foods and meals
	Supportive environments	Reduce salt intake through the establishment of a supportive environment in public institutions such as hospitals, schools, workplaces and nursing homes, to enable lower sodium options to be provided
	Educate	Reduce salt intake through a behaviour change communication and mass media campaign
	Informative packaging	Reduce salt intake through the implementation of front-of-pack labelling

Reduce physical inactivity	Educate	Implement community-wide public education and awareness campaigns for physical activity which includes a mass media campaign combined with other community-based education, motivational and environmental programmes aimed at supporting behavioural change of physical activity levels
Manage cardiovascular disease and diabetes	Drug therapy and counselling	Drug therapy (including glycaemic control for diabetes mellitus and control of hypertension using a total risk approach) and counselling to individuals who have had a heart attack or stroke and to persons with high risk (≥ 30%) of a fatal and non-fatal cardiovascular event in the next 10 years
Manage cancer	Vaccinate	Vaccination against human papillomavirus (2 doses) of 9-13-year-old girls
	Screening	Prevention of cervical cancer by screening women aged 30-49 either through: i) Visual inspection with acetic acid, linked with the timely treatment of precancerous lesions; ii) Pap smear (cervical cytology) every 3-5 years, linked with the timely treatment of precancerous lesions; iii) Human papillomavirus test every 5 years linked with the timely treatment of precancerous lesions.

Source: WHO (2018b)

However, it did not take too long for this list of 16 actions to show itself to be both too short and outdated. Therefore, driven by the emergent need of new evidence the WHO suggested an update of Appendix 3 of the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020. It was renamed *'best buys' and other recommended interventions* and included a total of 88 interventions that complemented the prior 16 main measures.

To identify interventions, effectiveness criteria were followed:

- An intervention is required to have a demonstrated and measurable effect size, from no less than one published study in a peer-reviewed journal;
- An intervention is required to have an undeniable association with one of the global NCD objectives.

All interventions were evaluated on several parameters such as cost-effectiveness and feasibility, along with other non-financial concerns (WHO, 2017a).

Still, if countries aimed to be successful in this fight against NCDs, a document of evidence-based written policies was not enough to ignite change at the scale needed. Implementation played an essential role. In fact, health policy implementation is precisely where most of the countries seem to struggle in what concerns going from evidence-based WHO policy recommendations to achieving real results and impacting the health of their populations.

Even though they have lower rates of premature deaths related to NCDs when compared to most of the other five WHO regions, the European Region health systems' sustainability is particularly affected by NCDs. This is due to the very high burden of disease of its population of over 69s, where deaths are no longer considered premature but are normally associated with large amounts of previous healthcare demands. The fact that Europeans live longer than the average inhabitants of other WHO regions is, in fact, an achievement, but it also brings additional healthcare access demands with it. It is, therefore, worth looking at the WHO European Region and analysing why such a high-income region, where Universal Health Coverage is higher than in the rest of the world is still struggling to tackle the NCD pandemic.

European region: an unhealthy eating reality

According to the CHRODIS Joint Action Project, a European Commission funded initiative, it has been estimated that NCDs cost EU economies €115 billion or 0.8% of their GDP annually. Approximately 70% to 80% of health care budgets across the EU are spent on treating chronic diseases. Nevertheless, 80% of this group of diseases is preventable if their behavioural risk factors are properly tackled (CHRODIS, 2020).
If we broaden our scope to focus on all the WHO European Region countries, about 89% of deaths result from NCDs, of which around a third are premature (occurring in adults aged between 30 and 69 years) (Silva da Costa et al., 2018; WHO, 2017a).

During the past decade, rapid expansion in a number of relevant scientific fields and, in particular, in the amount of population-based epidemiological evidence has helped to clarify the role of diet in preventing and controlling morbidity and premature mortality resulting from NCDs. Some of the specific dietary components that increase the probability of occurrence of these diseases in individuals, and interventions to modify their impact, have also been identified.(WHO, 2021)

In 2017, 11 million deaths and 255 million DALYs were attributable to dietary risk factors worldwide (GBD 2017 Diet Collaborators, 2019). High intake of sodium (3 million deaths and 70 million DALYs), low intake of whole grains (3 million deaths and 82 million DALYs), and low intake of fruits (2 million deaths and 65 million DALYs) were the leading dietary risk factors for deaths and DALYs globally and in many countries (GBD 2017 Diet Collaborators, 2019). The European Region was aligned with all of these trends.

If we look to the region in more detail, it is possible to conclude that diets rich in excessive consumption of saturated fat and trans-fat, high consumption of sugar and salt along with low consumption of fresh vegetables and fruits are to blame for its high prevalence of NCDs (WHO, 2013c).

In countries belonging to the region, the percentage of adults that are overweight reaches 80% in some cases (WHO, 2007; WHO, 2007) alongside an average of more than 20% of children and adolescents, of whom one third are obese. This incidence of obesity in both children and adolescents is alarming throughout the region, and it is now 10 times higher than it was in the 1970s (WHO, 2013c). Furthermore, in recent decades there has been a rapid change in food consumption patterns, such as the significant increase in consumption of processed foods high in saturated fat, free

sugars and salt (HFSS foods) (Monteiro et al., 2018; Slimani et al., 2009). Overall, adults and children in the majority of the European countries do not adhere to dietary guidelines (Rippin et al., 2018), which results in the exacerbation of risk factors characterized by excessive energy, saturated fat, free sugar and salt, and minimal consumptions of fruit, vegetables and whole grains. These risk factors, in turn, contribute to the onset of hypertension and cardiovascular diseases, as well as overweight/obesity, type 2 diabetes and cancer, which are the leading causes of death and illness in the WHO European Region (Institute for Health Metrics and Evaluation, 2016).

One may think that the rapid degradation of food consumption patterns in the WHO European Region countries was motivated by any lack of scientific evidence. However, as previously mentioned, the WHO created a list of recommended interventions with 13 specific measures designed to improve the dietary habits of its member states, as shown in Table 2.

Table 2 – WHO 'best buys' and other recommended interventions addressing Dietary Habits.

'Best buys': effective interventions with cost-effectiveness analysis (CEA) ≤ I$100 per DALY averted in LMICs	Reduce salt intake through the reformulation of food products to contain less salt and the setting of target levels for the amount of salt in foods and meals*
	Reduce salt intake through the establishment of a supportive environment in public institutions such as hospitals, schools, workplaces and nursing homes, to enable lower sodium options to be provided
	Reduce salt intake through a behaviour change communication and mass media campaign
	Reduce salt intake through the implementation of front-of-pack labelling**
Effective interventions with CEA >I$100 per DALY averted in LMICs	Eliminate industrial trans-fats through the development of legislation to ban their use in the food chain**
	Reduce sugar consumption through effective taxation on sugar-sweetened beverages
Other recommended interventions from WHO	Promote and support exclusive breastfeeding for the first 6 months of life, including the promotion of breastfeeding

guidance (CEA not available)	Implement subsidies to increase the intake of fruits and vegetables
	Replace trans-fats and saturated fats with unsaturated fats through reformulation, labelling, fiscal policies or agricultural policies
	Limiting portion and package size to reduce energy intake and the risk of overweight/obesity
	Implement nutrition education and counselling in different settings (for example, in preschools, schools, workplaces and hospitals) to increase the intake of fruits and vegetables
	Implement nutrition labelling to reduce total energy intake (kcal), sugars, sodium and fats
	Implement a mass media campaign on healthy diets, including social marketing to reduce the intake of total fat, saturated fats, sugars and salt, and promote the intake of fruits and vegetables

Source: WHO (2017a)

Based on these policies, the various countries belonging to the WHO European Region have applied several policies, both mandatory and voluntary. For instance, some countries have implemented interpretive nutrition labelling schemes, taxes on unhealthy food and beverages, comprehensive reformulation strategies and restrictions on the advertising of unhealthy foods (WHO, 2018g). However, in order for the WHO recommended policies to achieve full impact, they must not be seen as a set of 13 individual and independent measures. They must be seen as a policy pack for implementation.

Actors not typically related to the health sector also recognize the need for policy-based actions, as shown in the McKinsey Global Institute report, which reinforces the importance of implementing "as many interventions as possible", among which are several measures that aim not only to promote product reformulation, by reducing standard portion sizes and redesigning foods but also to change the way food is advertised. According to this report, those interventions should be delivered "at scale and (…) effectively by the full range of sectors in society" so that we can "overcome obesity" and constrain its economic burden (Dobbs et al., 2014).

Regardless, in a more detailed analysis of the current extent of implementation in different countries, it appears that it is very likely that the scope and depth of policies in most nations are not enough to accomplish changes at scale. This may be due to individual measures that are very narrowly defined or to the lack of consideration for the multiple factors influencing food intake. This can be demonstrated through analysis of the impact of reformulation strategies, marketing restrictions and labelling schemes. In addition, isolated and occasional initiatives result in limited gains and can even potentially broaden inequalities (Boyland et al., 2018; Kelly & Jewell, 2018; Kraak et al., 2016). There is increasing evidence that intricate and multifactorial problems cannot be resolved through a sequence of single, unrelated interventions but by combined, well-crafted, mutually supportive strategies that can reinforce a wider and more coherent policy framework (Hawkes, Jewell & Allen, 2013).

Moreover, it is important to consider several contextual factors that can be important and may explain, at least in part, the limited progress. In addition to the food industry being able to loudly oppose some of the suggested policies, governments may also feel that their mandate or capacity to implement that set of policies is limited, as they operate within a political environment. Moreover, not all governments currently have identical abilities to implement policies, nor do they have the equivalent capacity to demand accountability from the industry (Swinburn et al., 2015). Regardless, some countries have made collaborative efforts to create policies that are comprehensive, ambitious, implementable and accountable, thereby managing to overcome significant implementation barriers. Portugal stands out in this context. It has recently gained the WHO's attention (WHO, 2018h; WHO, 2020a) for the usage of WHO ‘best buys’ to fix its food system and therefore tackle its concerning high prevalence of NCDs.

Portugal: a high NCD prevalence country

In Portugal, the average life expectancy exceeds 80 years, which is above average when compared to the OECD (Eurostat, 2018b). Although this increase in average life expectancy is a notable achievement, if the proportion of healthy life years after age 65 is assessed, Portugal is among the worst-ranked European countries. Even though the Portuguese have more years of life, they also have numerous diseases that negatively impact the quality of life throughout the final years (Silva da Costa et al., 2018).

Considering the way in which the trends in NCD risk factors have evolved over time, it is possible to conclude that there is a significant increase in the prevalence of these diseases and in the number of people suffering from comorbidities in Portugal. Consequently, there is a strong need to have a wide range of complex healthcare services which translate into significant costs for the society (Silva da Costa et al., 2018).

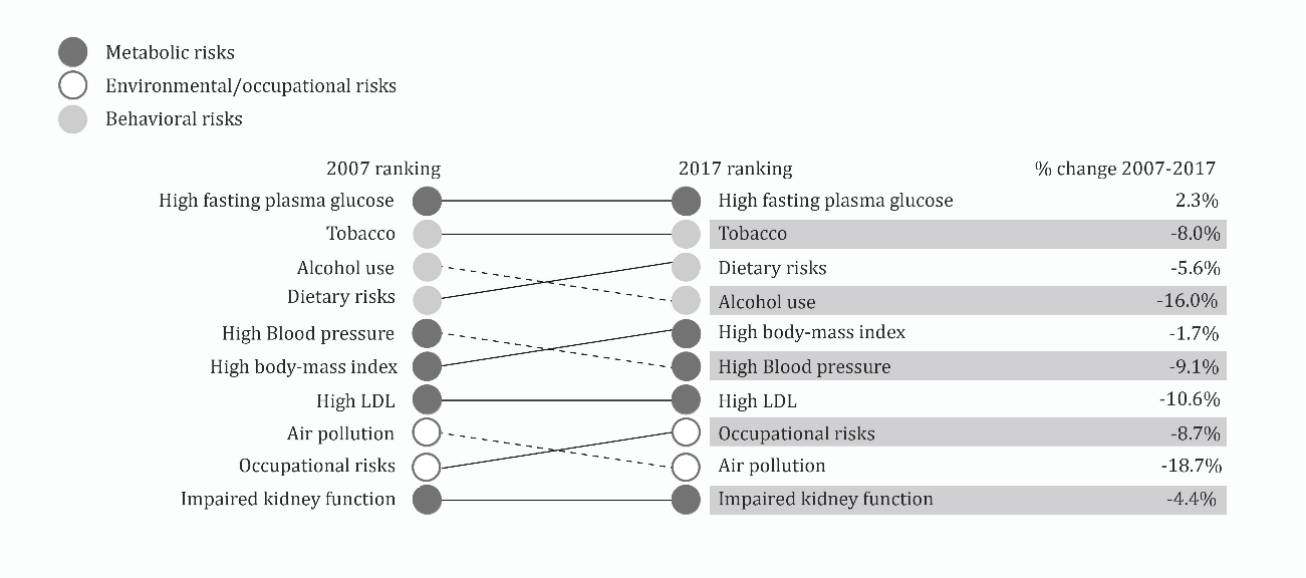


Figure 5 - Risk factors driving death and disability combined.

Source: IHME (2020)

Similarly to other countries in the WHO European Region, in Portugal, behavioural risk factors together are responsible for the biggest impact on the prevalence trends of NCDs, and therefore on their consequences in relation to premature deaths and disability (Figure 5). However, the fact that over the last decade dietary risks were the ones improving their impact on death and disability combined highlights the fact that Portugal has not probably not been performing as well addressing dietary risk factors as it as been addresimg tobacco or alcohol consumption. This reality is evidenced by the most recent National Food, Nutrition and Physical Activity Survey [*Inquérito Alimentar Nacional e de Atividade Física* – IAN-AF] (DGS, 2017a; Goiana-da-Silva, 2018a).

Furthermore, according to the Portuguese Directorate General of Health, unhealthy eating is the main responsible for years of healthy life lost in Portugal (15.8%) (DGS, 2017c). This alarming number results from different others. About 52.7% of the Portuguese population does not comply with WHO recommendations, which include the daily intake of 400 grams of fruits and vegetables. In addition, approximately 15% have regular daily consumption of free sugars of over 10% of their total energy intake and 17% of the Portuguese (of whom 40.6% are teenagers) claim to consume soft drinks every day, including nectars. Another associated public health problem is the high consumption of salt in Portugal. Varying from 7.4 to 10.7 grams daily, it's nearly double what is recommended by the WHO (Goiana-da-Silva et al., 2018a; Lopes et al., 2017a; Lopes et al., 2018b). To clarify, these differing values result from different approaches to estimating salt consumption among the Portuguese population. The former is a result of self reporting through a national survey, which may lead to underreporting, whilst the latter results from measurements of urinary excretions of sodium across a sample of patients suffering from hypertension, which

leads to a more reliable result; despite it being measured across a sub-sample of the Portuguese population.

The epidemiological pattern established by the correlation between eating habits and the prevalence of NCDs raises concern (Lopes et al., 2017c; WHO, 2013b). All things considered, according to the Global Burden of Disease (GBD) study, it is estimated that unhealthy eating habits contribute to a 15.4% loss of healthy life years by the Portuguese (Goiana-da-Silva, 2018a; WHO, 2010). Overweight and obesity are directly affected by unhealthy eating habits. Physical inactivity combined with excessive consumption of fat, sugar and salt seems to be the most important factor responsible for overweight disorders (OECD, 2010; Withrow & Alter, 2012). Therefore, it is not surprising that the Portuguese population raises concerns regarding the high prevalence of excessive body mass.

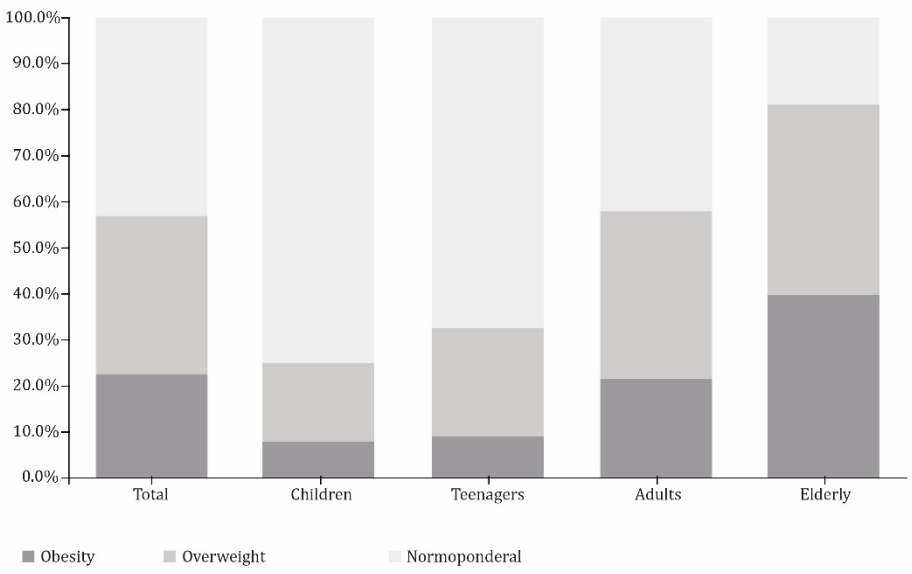


Figure 6 – Distribution of different body mass profiles in Portugal.

Source: Lopes et al. (2017)

According to IAN-AF (DGS, 2017a; Lopes et al., 2017c), it is estimated that more than 50% of the Portuguese population (about 5.9 million people) are overweight. There

are currently numerous studies that warn of a high incidence of childhood obesity in Portugal. Among these, the Childhood Obesity Surveillance Initiative (COSI) (Cecchini et al., 2010) emphasizes the fact that 30.7% of Portuguese children are above the recommended weight, with 11.7% in this group being counted as obese. In addition, according to the OECD, when compared to other member countries, Portugal has an above-average prevalence of childhood obesity (Rito et al., 2016). As shown in Figure 6, among the elderly this prevalence increases to 8 out of 10 individuals. In addition, the prevalence of overweight and abdominal obesity is higher in less educated individuals, according to analyses of social inequalities in obesity prevalence (Goiana-da-Silva et al., 2018).

Nonetheless, it is important to note that it is possible to largely avoid such high levels of overweight and obesity and the consequences that result from them (i.e. NCDs). In this context, the Portuguese Government defined the prevention of NCDs as a national priority and focused its actions on improving the population's eating patterns. However, addressing existing problems in food systems such as the Portuguese one is an ambitious challenge due to the diversity of different stakeholders as well as the government departments involved. Figure 7 highlights the complexity of these multilateral systems where the citizen plays a central role (The Lancet, 2015).

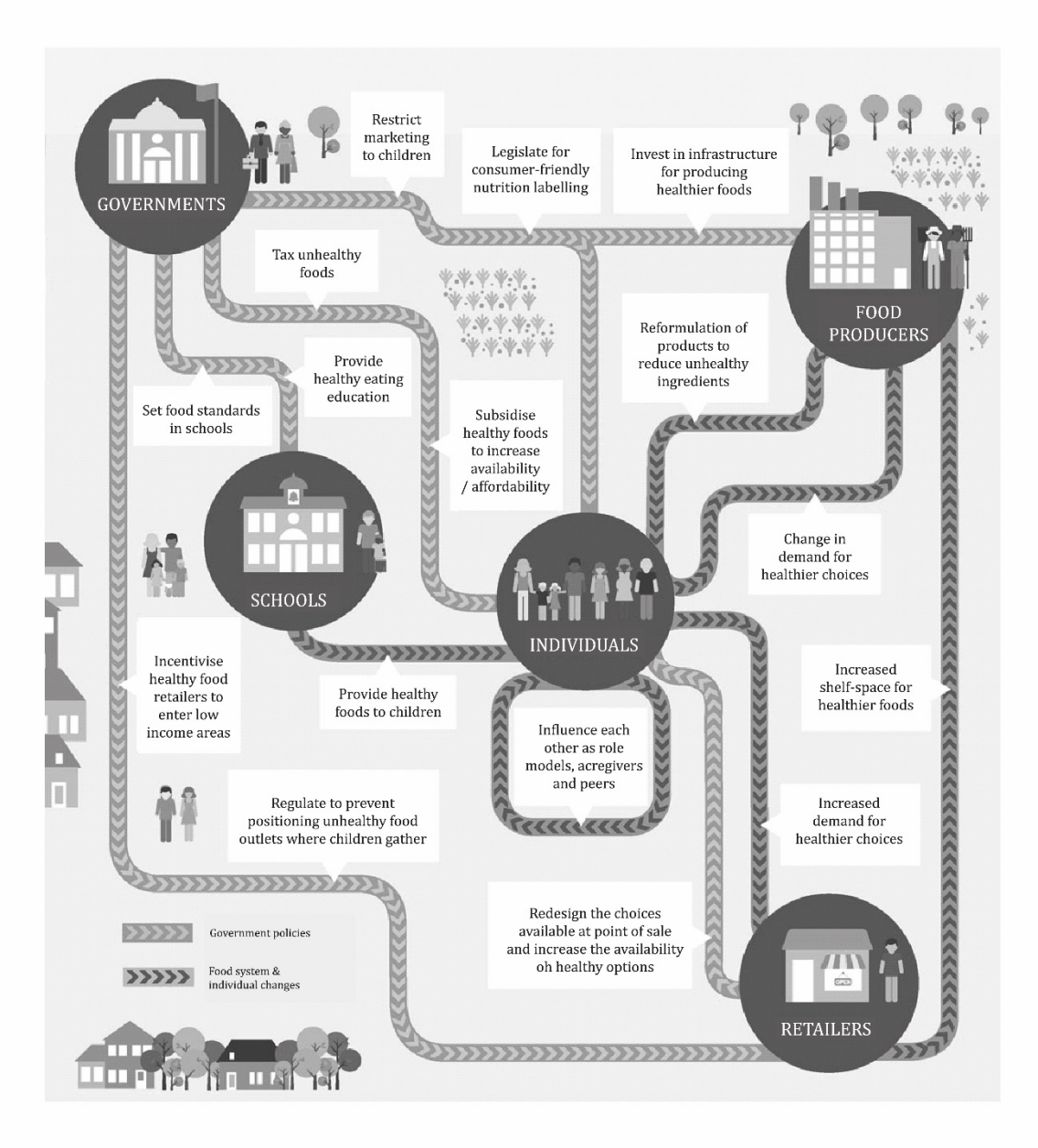


Figure 7 – How Food Systems work.

Source: The Lancet (2015)

In order to support healthier food preferences and behaviours in Portugal, political leaders and policy makers were inspired by the WHO's 'best buys' and policy recommendations to take action. In 2017, the Portuguese Prime Minister announced the first Inter-Ministerial Strategy for the Promotion of Healthy Eating. It was only one of several steps to be taken in order to take the WHO recommendations off the paper and into reality.

In the chapters of this thesis, the Inter-Ministerial Strategy for the Promotion of Healthy Eating as well as the most relevant policies it embodied will be characterized and evaluated using different methods. However, the Portuguese case also encompasses valuable insights regarding the implementation challenges faced by health authorities in order to bring evidence-based policies to life. Therefore, implementation management concepts, such as leadership, strategy, governance, management, accountability and sustainability, shall be used to bring all of the findings of this thesis together as well as in the critical assessment of all the policies characterized in this scientific work. Furthermore, building on several original findings made all over this thesis, important conclusions and lessons learned shall be useful for institutions and policy makers at the national and international level.

Thesis overview

Hypothesis – Portugal is a good international role model for the implementation of the WHO Best Buys' in the area of promoting healthy diets.

Chapter 2 – **Implementation of NCD policies: a geopolitical analysis of 151 countries**

• **Hypothesis** – In the global context, Portugal performs well regarding NCD policies' overall implementation levels.

In this chapter, the fact that the implementation of WHO-recommended NCD policies has increased over time is highlighted. On average, countries implemented just under half of the NCD policies recommended by the WHO in 2017. Nutrition-related policies saw gains. Aggregate implementation scores tended to be highest in high-income countries that invest in health care and education. In the global context, Portugal is among the top 20 NCD policies implementers.

Chapter 3 – Integrated Strategy for the Promotion of Healthy Eating: a HiAP approach.

• **Hypothesis** – the HiAP Approach is an effective tool to convert the WHO recommended policies into implementation driven national policies.

In this chapter, the pathway followed by political leaders and policy-makers from the

WHO's 'best buys' and policy recommendations to an actionable set of implementation driven measures with the buy in and commitment of all the government sectors is described and critically analysed.

Chapter 4 – Fiscal Policies: the Sugar-Sweetened Beverages Tax

• **Hypothesis** – Mandatory regulations such as the Sugar-Sweetened Beverages Tax are effective in tackling NCD.

In this chapter, the implementation strategy, as well as the impacts of the Portuguese Sugar-Sweetened Beverages Tax on both consumption patterns by the citizens and reformulation processes by the food industry is analyzed building on real data. The impact of this policy on obesity prevalence among different age groups is modelled.

Chapter 5 – Voluntary Self-Regulations: the Food Sector Reformulation Agreement

• **Hypothesis** – Voluntary Self-Regulations such as Food Sector Reformulation Agreements are effective in tackling NCD.

In this chapter, the implementation strategy, as well as the potential impacts of the food reformulation agreement signed between the Portuguese Government and the Food Sector Representatives on NCD related premature deaths is modelled building on real-life consumption data patterns.

Chapter 6 – Mandatory Regulations: reducing added salt levels in bread

• **Hypothesis** – Regulating the maximum amount of added salt on highly consumed products is effective in tackling NCDs.

In this chapter, the potential impact of regulating the maximum amounts of added salt to a highly consumed product such as bread is assessed. The steps taken by the government to implement this policy as well as all the barriers found on the way are analyzed and critically discussed.

Chapter 7 – Information: implementing a Front-of-Pack labelling scheme

• **Hypothesis** – Nutri-Score is the labelling scheme with greater potential of improving the quality of food choices among Portuguese consumers..

In this chapter, all the most relevant Front-of-Pack labelling schemes are analysed and compared regarding their ability to influence better food choices among Portuguese consumers through a controlled trial.

Chapter 8 – Education: promoting healthier cooking practices in public institutions

• **Hypothesis** – Educating the staff responsible for cooking the meals in public schools is an effective way of improving dietary patterns among pupils.

In this chapter, the impact of an education intervention among the cooking staff of public schools on the quality of meals delivered to pupils is analyzed and assessed through a controlled trial.

Original Contributions of the Thesis

The research work developed during this thesis resulted in 19 original publications in scientific journals, contributed to the development of one official Portuguese Government Report and informed one WHO news items. From these 19 original publications, 13 were first-authored and 6 were co-authored by Goiana-da-Silva, as shown below:

- *Bringing government sectors together to address NCD: Portugal's interministerial healthy eating strategy* (Goiana-da-Silva, 2018a)
- *Using Pricing Policies to Promote Public Health: The Sugar Sweetened Beverages Taxation Experience in Portugal* (Goiana-da-Silva, 2018b)
- *The future of the sweetened beverages tax in Portugal* (Goiana-da-Silva, 2018c)
- *A new interministerial strategy for the promotion of healthy eating in Portugal: implementation and initial results* (Graça et al., 2018)
- *Front-of-pack labelling policies and the need for guidance* (Goiana-da-Silva, 2019a)
- *Nutri-Score: A Public Health Tool to Improve Eating Habits in Portugal* (Goiana-da-Silva, 2019b)
- *Changing the channel: television health campaigns in Portugal* (Goiana-da-Silva, 2019c)
- *Modelling impacts of food industry voluntary co-regulation on noncommunicable disease mortality, Portugal* (Goiana-da-Silva, 2019d)
- *Disrupting the landscape: how the Portuguese National Health Service built an omnichannel communication platform* (Goiana-da-Silva, 2019e)
- *Portugal's voluntary food reformulation agreement and the WHO reformulation targets* (Goiana-da-Silva, 2019f)

- Eight years of sugar-sweetened beverages consumption among Portuguese children aged 6 to 8 years old: COSI Portugal 2008 – 2016 (Mendes et al., 2019)
- *Projected impact of the Portuguese sugar-sweetened beverage tax on obesity incidence across different age groups: A modelling study* (Goiana-da-Silva, 2020a)
- *The Ethics of Taxing Sugar-Sweetened Beverages to Improve Public Health (Goiana-da-Silva, 2020b)*
- *Prioritizing health over internal market interests: a policy dilemma between Portugal and the European Commission* (Goiana da Silva, 2020c)
- *Implementation of NCD policies: a geopolitical analysis of 151 countries* (Allen et al., 2020)
- *Democracy and implementation of NCD policies – Authors' reply* (Allen et al., 2020)
- *Salt reduction strategies in Portuguese school meals, from preschool to secondary education – The Eat Mediterranean Program* (Rito et al., 2020)
- Improving dietary intake and achieving food product improvement policy opportunities and challenges for the WHO European Region in reducing salt and sugar in the diet (Goiana-da-Silva et al., 2020a)
- The Gift of Data: Industry-Led Food Reformulation and the Obesity Crisis in Europe (Campbell et al., 2021)

Furthermore, the evidence produced within the development of this thesis was essential for the production of the following Portuguese Government report:

- *Portuguese Sugar Sweetened Beverages Taxation Impact Assessment Report* (Portugal, 2018)

Finally, the evidence gathered during this PhD thesis development led to the following publications by the WHO – European Region:

- Portugal brings down obesity by taxing sugary drinks (WHO, 2020a)
- Improving dietary intake and achieving food product improvement (WHO, 2020b)

Chapter 2

NCD Policies Implementation: a global analysis

Introduction

In 2015 and 2017, NCD monitoring reports were released by the WHO (Roth et al., 2017; WHO, 2015a; WHO, 2017c). These reports evaluated the extent to which 18 NCD policies, supported by the 'best buys', had been implemented across 151 countries. In these reports, the policies were grouped according to four deadline commitments that were previously approved at the second UN High-Level Meeting (Table 3). Both reports comprise an assessment of the implementation of each policy (whether full, partial or non-existent) in each of the 151 countries under study, as well as the respective profiles of each of those countries. In carrying out these assessments, opinions of national experts were taken into account, as well as pre-existing data and policy files sent for the WHO's NCD country capacity surveys. Moreover, no analysis on a global scale of general policy implementation has been provided through the progress monitors.

Currently, there is comprehensive data at a global level that allows us to ascertain how NCDs and risk factors are distributed regionally and socioeconomically, as well as clear guidelines regarding the interventions that really 'work' to deal with NCDs (Roth et al., 2017; Allen et al., 2017). However, there are only a few studies that assess why effective policies are implemented globally, as well as where this happens. So, although there was a rich set of data that could be used to explore patterns of implementation, thanks to the two WHO progress monitors, there was no systematic involvement based on this wealth of information, except for small regional outlines for Europe and the Caribbean (Juma et al., 2018; Healthy Caribbean Coalition, 2017).

Most of the current understanding of the reasons that lead countries to implement specific policies or not considers narratives rather than quantitative facts. The most common case studies relate to the weak human and financial capacity that undermines the implementation of NCD policies in Sub-Saharan Africa (Dalal et al., 2017; Juma et al., 2018); to the blocking by libertarian America of the inclusion of economic measures in the 2018 Political Declaration on NCDs (Kessler, 2018); or even high levels of social solidarity in Scandinavia that promote the adoption of policies that are personally restrictive (WHO, 2020c). Of the various factors underlying the influence of policy implementation, those commonly mentioned include region, the onus of NCDs, financial and human resources, as well as social solidarity and political ideology (Hunter & Reddy, 2013; Jamison et al., 2013; Lupafya et al., 2016; Sacco et al., 2013). Importantly, one of the highest current priorities for studies on global health must be to understand what makes countries more prone to introducing effective NCD policies. Also, it is essential that, instead of 'n of 1' high-profile examples, quantitative analysis is used to inform the global NCD strategy.

Table 3 – The WHO's NCD progress monitor policies nested under ten indicators and four commitments.

	Policy	Abbreviation	Obs
Commitment 1: Consider setting national NCD targets for 2025			
1	Member State has set time-bound national targets based on WHO guidance	National NCD targets	
2	Member State has a functioning system for generating reliable cause-specific mortality data on a routine basis	Mortality data	
3	Member State has a STEPS survey or a comprehensive health examination survey every 5 years	Risk factor surveys	
Commitment 2: Consider developing national multisectoral policies and plans to achieve the national targets by 2025:			
4	Member State has an operational multisectoral national strategy/ action plan that integrates the major NCD and their shared risk factors	National action plan	
Commitment 3: Reduce risk factors for NCD, building on guidance set out in the WHO Global NCD Action Plan:			

5	Member State has implemented the following five demand-reduction measures of the WHO FCTC at the highest level of achievement		**
	a) Reduce affordability by increasing excise taxes and prices on tobacco products	Tobacco tax	
	b) Eliminate exposure to second-hand tobacco smoke in all indoor workplaces, public places and public transport	Smoke-free places	
	c) Implement plain/standardized packaging and/or large graphic health warnings on all tobacco packages	Graphic warnings	
	d) Enact and enforce comprehensive bans on tobacco advertising, promotion and sponsorship	Advertising bans	
	e) Implement effective mass media campaigns that educate the public about the harms of smoking/tobacco use and second-hand smoke	Mass media	
6	Member State has implemented, as appropriate according to national circumstances, the following three measures to reduce the harmful use of alcohol as per the WHO Global Strategy to Reduce the Harmful Use of Alcohol:		***
	a) Enact and enforce restrictions on the physical availability of retailed alcohol (via reduced hours of sale)	Alcohol sale restrictions	
	b) Enact and enforce bans or comprehensive restrictions on exposure to alcohol advertising (across multiple types of media)	Advertising bans	
	c) Increase excise taxes on alcoholic beverages	Alcohol tax	
7	Member State has implemented the following four measures to reduce unhealthy diets:		
	a) Adopt national policies to reduce population salt/sodium consumption	Salt reduction	****
	b) Adopt national policies that limit saturated fatty acids and virtually eliminate industrially-produced trans-fatty acids in the food supply	Fat policies	****
	c) WHO set of recommendations on the marketing of foods and non-alcoholic beverages to children	Child marketing	****
	d) Legislation /regulations fully implementing the International Code of Marketing of Breast-milk Substitutes	Breast-milk substitutes	*****
8	Member State has implemented at least one recent national public awareness and motivational communication for physical activity, including mass media campaigns for physical activity behavioural change.	Physical activity mass media	
Commitment 4: Strengthen health systems to address NCD through people-centred primary health care and universal health coverage, building on guidance set out in WHO Global NCD Action Plan			
9	Member State has evidence-based national guidelines/protocols/ standards for the management of major NCD through a primary care approach, recognized/approved by government or competent authorities.	Clinical guidelines	
10	Member State has provision of drug therapy, including glycaemic control, and counselling for eligible persons at high	CVD therapy	

	risk to prevent heart attacks and strokes, with emphasis on the primary care level		

*Based on data collected by WHO and stored in the WHO mortality database through a routine annual call for data.
**Based on data collected from Member States in 2014 (for the 2015 report) and 2016 (for the 2017 report) for the production of the WHO Report on the Global Tobacco Epidemic. The WHO assessment was shared with national authorities for review and approval.
***Based on the responses of country focal points, officially nominated by the Ministry of Health, to the 2012 (for the 2015 report) and 2016 (for the 2017 report) Global Survey on Alcohol and Health conducted by WHO. Responses were reviewed and validated by WHO, and subsequently endorsed by the Member States.
****Country responses for these indicators were reviewed against responses from the 2nd Global Nutrition Policy Review and supporting documentation contained in the WHO Global database on the Implementation of Nutrition Action (GINA).
*****Based on the analysis by WHO, UNICEF, and IBFAN/ICDC of copies of all national legislation and regulations on the International Code of Marketing of Breast-milk Substitutes for the production of the report on Marketing of breast-milk substitutes: National implementation of the international code Status Report 2016
Source: Allen (2020)

Hypothesis

In the global context, Portugal performs well regarding NCD policies' overall implementation levels.

Objectives

This chapter aims to characterize the NCD policies' implementation and its determinants at the Global Level. It also aims to understand the scope to which discrepancies in the implementation of national policies may be the result of geopolitical factors, which is commonly offered as an explanation for why NCD policies are not implemented, namely the region, the onus of NCDs, financial and human resources, as well as social solidarity and political ideology.

Methods

The methods described follow the methodology used in the research paper *Implementation of NCD policies: a geopolitical analysis of 151 countries*, recently published in The Lancet Global Health (Allen et al., 2020).

Outcome measure: NCD policy implementation

Epidemiological and policy implementation information for 151 countries can be obtained through the WHO NCD progress monitors. Using an Excel spreadsheet, data related to the national level of implementation was extracted. Applying the methodology used in an internal (unpublished) WHO memo, points were assigned to the various interventions, with 1 point allocated to those that were accomplished, half a point to those partially accomplished and zero to those that were not accomplished or for which it was not possible to obtain information (in 2015, 11.4% policies and in 2017 3.8%). For both 2015 and 2017, the national scores that were obtained and later converted into a percentage were aggregated so that the total implementation of each policy results in the sum of 100%.

Explanatory variables

To this purpose, the seven variables shown in Table 4 were applied.

Table 4 - Explanatory variables.

Geopolitical characteristic	Variable name	Data type and description	Source	Notes
Region	Geographic region	Categorical: Seven world regions (East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America, South Asia, and Sub-Saharan Africa)	World Bank	The most widely used regional classifications in global health are those compiled by WHO and the World Bank. I opted for the regional classification used by the latter because it provides extra detail by breaking the Americas (PAHO) into two regions; 'North America' and 'Latin America & Caribbean' (World Bank, 2018).

NCD burden	Percentage of deaths caused by NCD	Continuous: Percentage of all deaths caused by NCD	WHO NCD Progress Monitor	I used the WHO estimates of the proportion of overall deaths caused by NCD and risk of premature NCD mortality from the 2015 progress monitor to examine whether baseline NCD burden was associated with 2017 score and change in score over time.
	Risk of premature NCD mortality	Continuous: Risk of premature NCD mortality		
Human and financial resources	Human capital index	Continuous: Composite indicator combining child mortality, stunting, adult survival, expected years of schooling, and harmonised educational test scores	World Bank	I obtained the latest available (2017) World Bank 'human capital index' scores for each country; a widely used composite measure based on child mortality, stunting, adult survival, expected years of schooling, and harmonised educational test scores (World Bank, 2020a; World Bank, 2020b).
	World Bank income group	Ordinal: World Bank income group based on per capita gross national income (Low <$1,045; Lower-middle <$4,125; Upper-middle <$12,736; High >$12,736)	World Bank	I used the 2017 World Bank analytic classification. This assigns each country to one of four ordinal income groups based on per capita gross national income (World Bank, 2015).
Political ideology and social solidarity	Democracy index	Continuous: Weighted average of 60 items covering civil liberties, pluralism, and political culture	Economist Intelligence Unit	I obtained the last available (2017) 'democracy index' data from the Economist Intelligence Unit. These annually produced scores are based on a weighted average of 60 items covering civil liberties, pluralism, and political culture. These data are well-respected and have been previously used in global health research to analyse access to services.

	Tax burden	Ordinal: Top, second, third, bottom, and 'missing data'. Tripartite composite score with equal weighting accorded to top marginal tax rate on individual income, the top marginal tax rate on corporate income, and the total tax burden as a percentage of GDP	Heritage Foundation	I obtained tax burden data from the Heritage Foundation to help distinguish between highly democratic countries that lie on opposing ends of an ideological spectrum that ranges from valuing social solidarity to valuing self-determination (libertarianism). I reasoned that countries that tolerate high top marginal tax rates on individuals and corporations may be more likely to tolerate NCD policies that constrain free trade and personal choice. The Heritage Foundation is a US think tank with a political bias (right-of-centre) however their tax burden data is widely respected, transparently composed, and available for a large number of countries. I used their latest available data (2016).

Source: Allen (2020)

Analytic approach

To investigate policy implementation among the included countries, straightforward descriptive statistics were applied. Afterwards, three series of analysis were executed as follows:

1. Using the rest of the world as a reference, patterns of implementation among countries with the top 20 and the bottom 20 aggregate implementation scores in 2017 were analysed. Using the T distribution for the top and bottom 20 countries (owing to the small sample size) and the normal distribution for the rest of the world, 95% confidence intervals were calculated around these mean implementation score for every single policy.

2. An evaluation of the shifts in aggregate scores between 2015 and 2017 was conducted. To do this, depending on whether the aggregate score increased, decreased or remained unchanged between 2015 and 2017, all of the countries were divided into three groups and waterfall graphs were created for each of these groups. For the 2017 NCD Progress Monitor a new indicator was added; 'effective mass media campaigns that educate the public about the harms of smoking/tobacco use and second-hand smoke'. Given that certain countries may have implemented tobacco mass media policies earlier than 2015 this point was deducted when considering variations in aggregate score between 2015 and 2017 (i.e. the highest score at 18 points for both years was established) in order to perform a fair comparison.

3. The degree to which the 2017 aggregate policy implementation scores associated with several factors such as region, human capital index, democratic index income group, NCD burden, risk of premature NCD mortality, and also tax burden was evaluated. Using SPSS (Armonk, NY: IBM Corp), a simple linear regression of the aggregate score was executed on every explanatory variable. Among the variables above mentioned, the ones applied were tax burden, income group, and world region as categorical variables with 'bottom tax quartile', 'low income', and 'Europe & Central Asia' as the corresponding references. To build a model that considered all of the variables and would be able to give an assessment of the impact of a given explanatory variable while maintaining the others constant, multiple linear regression was also executed.

For all variables, normality was tested with residual plots and found to be acceptable (data not shown). For all analysis, an α=0.05 was considered.

Missing data

It was essential to examine the relationship between tax burden and implementation. One of the hypotheses to be tested would be that high-tax countries (such as the Nordic countries) might have more solidarity/a social contract that allowed for implementation of restrictive policies.

As referred, tax burden data were taken from the Heritage Foundation 2016 database. Such data were continuous, running from 0% - 100% for each country. However, data were only available for around 110 countries of the 151 countries that comprised the WHO NCD progress monitors. Risk of premature mortality along with the proportion of casualties triggered by NCDs was also only accessible for 147 of the 151 countries that comprised the WHO NCD progress monitors and democracy index scores were only accessible for 144 countries.

Therefore, tax burden was the most relevant amount of missing data. In that context, one could have correlated the available tax burden data against implementation for only 110 countries, but this would involve throwing out around a third of all countries in the overall sample.

In order to be able to run an analysis that included all 151 countries the data was converted from continuous to ordinal. Five bins were used in the process:

1. Countries with no tax data;
2. Countries with tax rates >75th percentile (top quartile);
3. Countries with tax rates 50-74th percentile (second quartile);
4. Countries with tax rates 25-49th percentile (third quartile);
5. Countries with tax rates <24th percentile (bottom quartile).

When other variables (i.e. democracy index, human capital índex) were looked across, it was evident that the countries with no tax data were the same countries that were missing data for other variables. In fact, a small group of 7 countries accounted for

almost all of the missing data: Kiribati, Nepal, Seychelles, Solomon Islands, South Sudan, Tonga, and Vanuatu. For these countries it wasn't possible to find alternative estimates and, therefore it seemed that the most reliable way to handle the missing data was to exclude them from the regression analyses. It is worth noting that these locations are predominantly small island developing states.

Sensitivity analysis

To evaluate the effect of excluding the seven countries that were missing full data it was necessary to re-run the multiple linear regression with the inclusion of these countries. Likewise, since the number 20 was a random threshold, the analysis of high- and low-achievers was also re-run making use of the top and bottom 30 countries to evaluate if this altered the patterns observed.

Results

2017 policy implementation

Regarding policy implementation data, aggregate scores had a normal distribution, with a slight shift to the right. These scores had a mean of 48.5%, a standard deviation of 18.4% and presented a range between 5.3% and 86.8%. Surveys, clinical guidelines and graphic warnings on tobacco packaging were the most implemented policies. On the other hand, both tobacco media campaigns and restrictions on alcohol advertising, tobacco taxation and the provision of cardiovascular therapies were the least implemented policies. This can be observed in Figure 8.

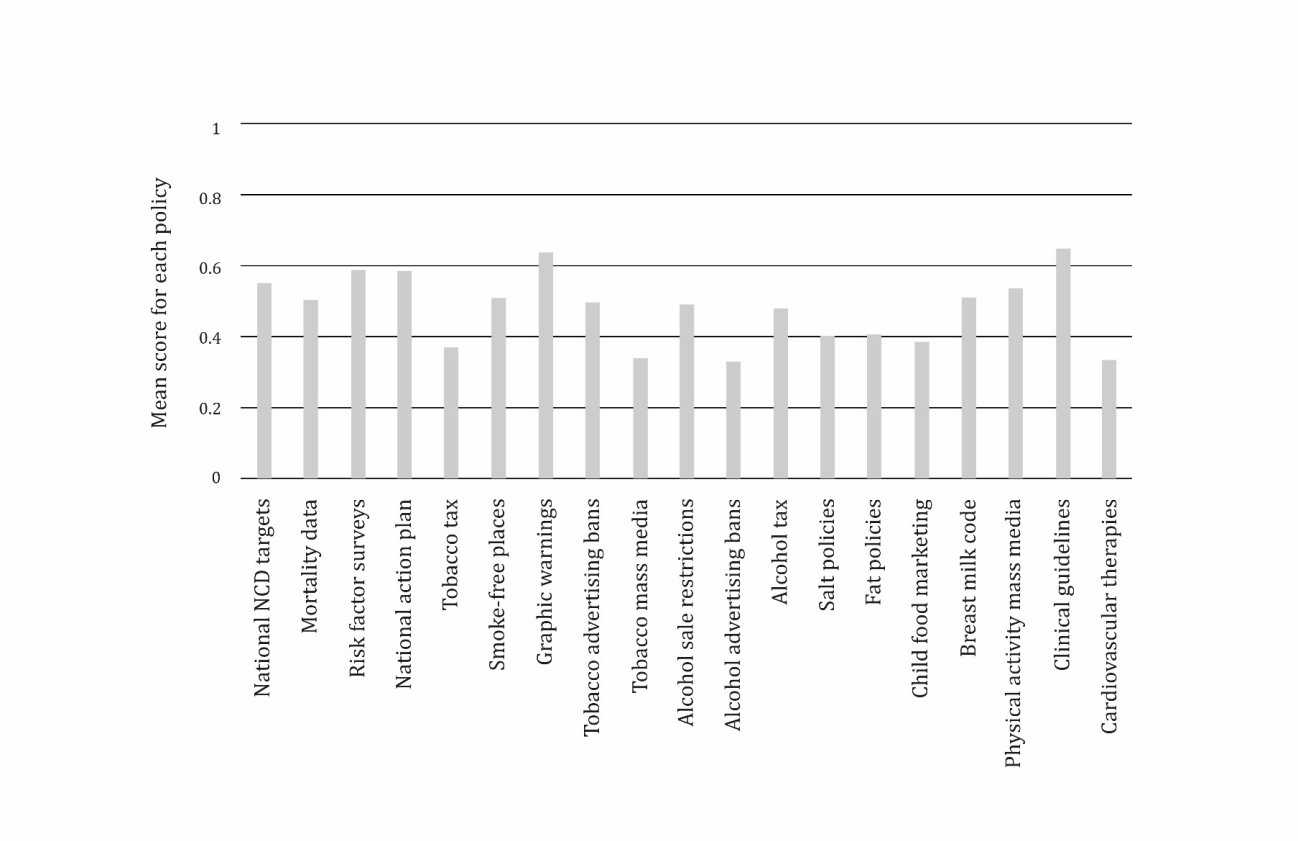


Figure 8 - Mean 2017 implementation scores for each policy across all 151 countries.

Source: Allen (2020)

High and low implementers

Among the top 20 countries, the ones from Europe and Central Asia were overly represented, as shown in Table 5. These countries were particularly effective in providing adequate means to deal with cardiovascular diseases, as well as in strengthening policies related to the consumption of salt, unhealthy fats and child marketing. On the other hand, the bottom 20 countries, when compared to the rest of the world, were the weakest in terms of market policies. Apart from graphic warnings on cigarette packages, these countries had failed to apply measures aimed at restricting the marketing, sale and consumption of tobacco and alcohol, as well as advertising regulations for breast milk substitutes (Figure 9).

Table 5 - Top and bottom 20 countries by 2017 aggregate implementation score.

Top 20			Bottom 20	
Costa Rica	87%		Haiti	5%
Iran	87%		South Sudan	5%
UK	82%		Angola	8%
Norway	82%		Liberia	11%
Latvia	79%		Sierra Leone	13%
Turkey	79%		Burundi	16%
Bulgaria	79%		DR Congo	18%
Saudi Arabia	79%		Zimbabwe	18%
Brazil	79%		Guinea	21%
Estonia	76%		Mauritania	21%
Portugal	76%		Nicaragua	21%
Moldova	74%		Nigeria	21%
Lithuania	74%		Papua New Guinea	21%
Slovenia	74%		Rwanda	21%
Thailand	74%		Comoros	24%
Finland	74%		Côte d'Ivoire	24%
Russia	74%		Gabon	24%
Malta	71%		Gambia	24%
Spain	71%		Zambia	24%
Italy	71%		Lesotho	26%

Source: Allen (2020)

Considering the bottom 20, seventeen of these countries were from Sub-Saharan Africa. None of the 20 countries with the lowest scores had points for interventions

related to child food marketing, cardiovascular therapies or fats. Also, as shown in

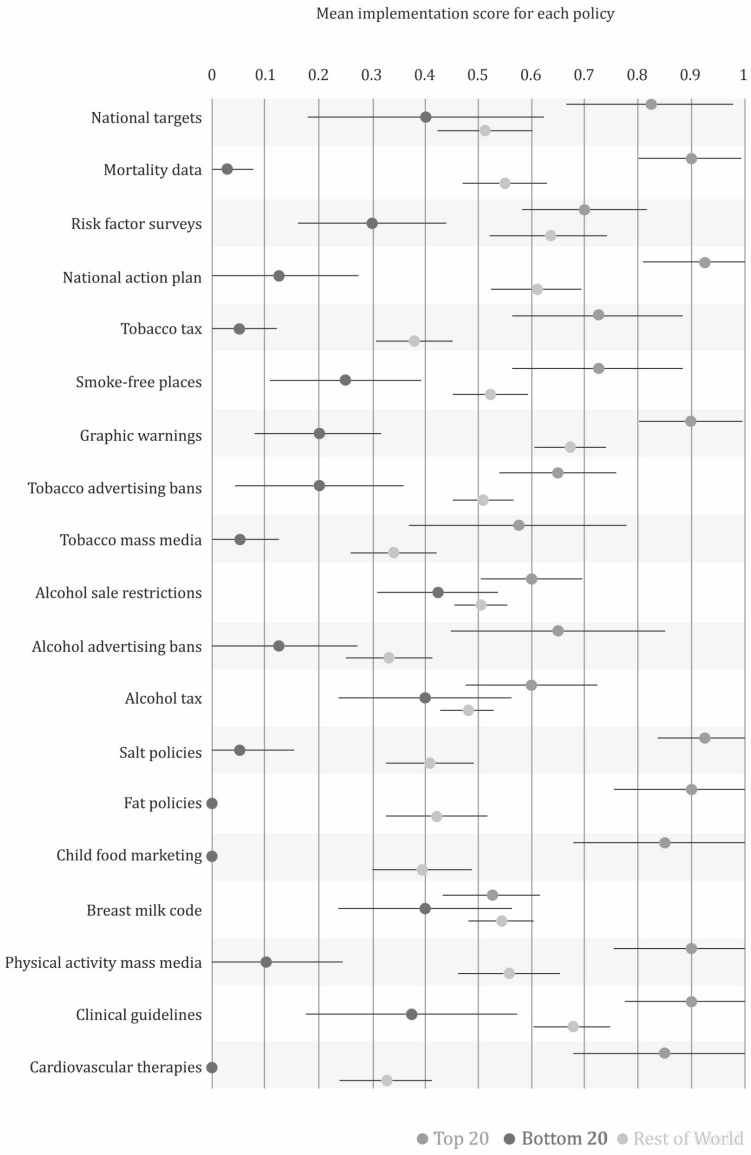


Figure 9, considering the mean policy implementation score in the top 20 countries there was an overlap of the 95% confidence intervals in three cases: implementing the code for marketing breast milk substitutes, alcohol sale restrictions and alcohol taxation.

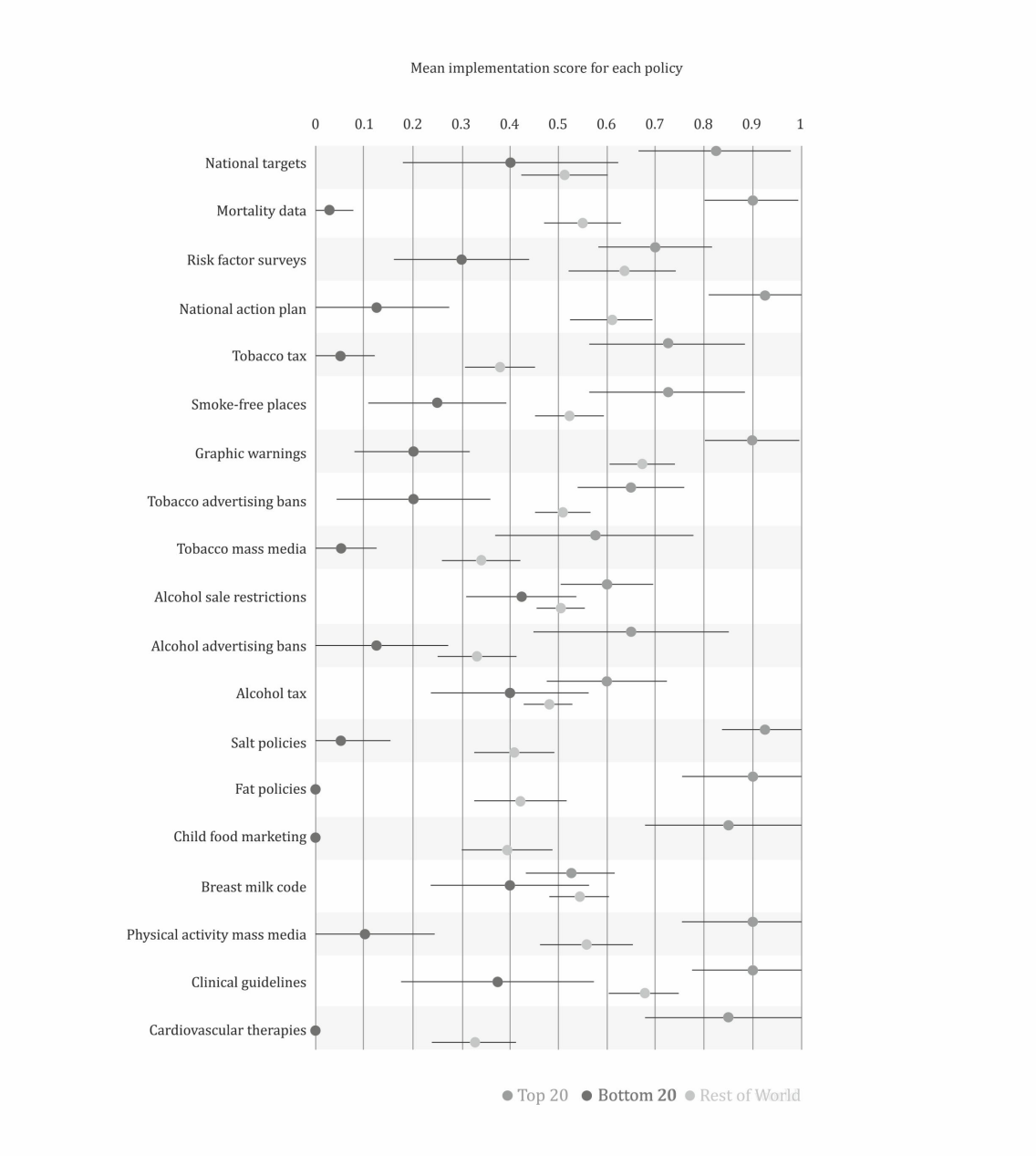


Figure 9 – Mean indicator score and 95% confidence intervals for the top 20 countries, bottom 20 countries, and the rest of world.

Source: Allen (2020)

Regarding the sensitivity analysis, which included 30 countries with the highest scores and 30 countries with the lowest scores, there were practically no changes in the patterns of implementation.

Changes in policy implementation over time.

Between 2015 and 2017, there was an increase from 41.7% to 49.4% of the mean aggregate implementation score. Although many countries regressed in restrictions on promotion and sale of alcohol and physical activity media campaigns, both gains and losses have been evenly distributed across individual policies, as can be seen in Figure 10. Both the introduction of tobacco-related policies and clinical guidelines and therapeutics, as well as the establishment of national targets, were related to the most frequent gains.

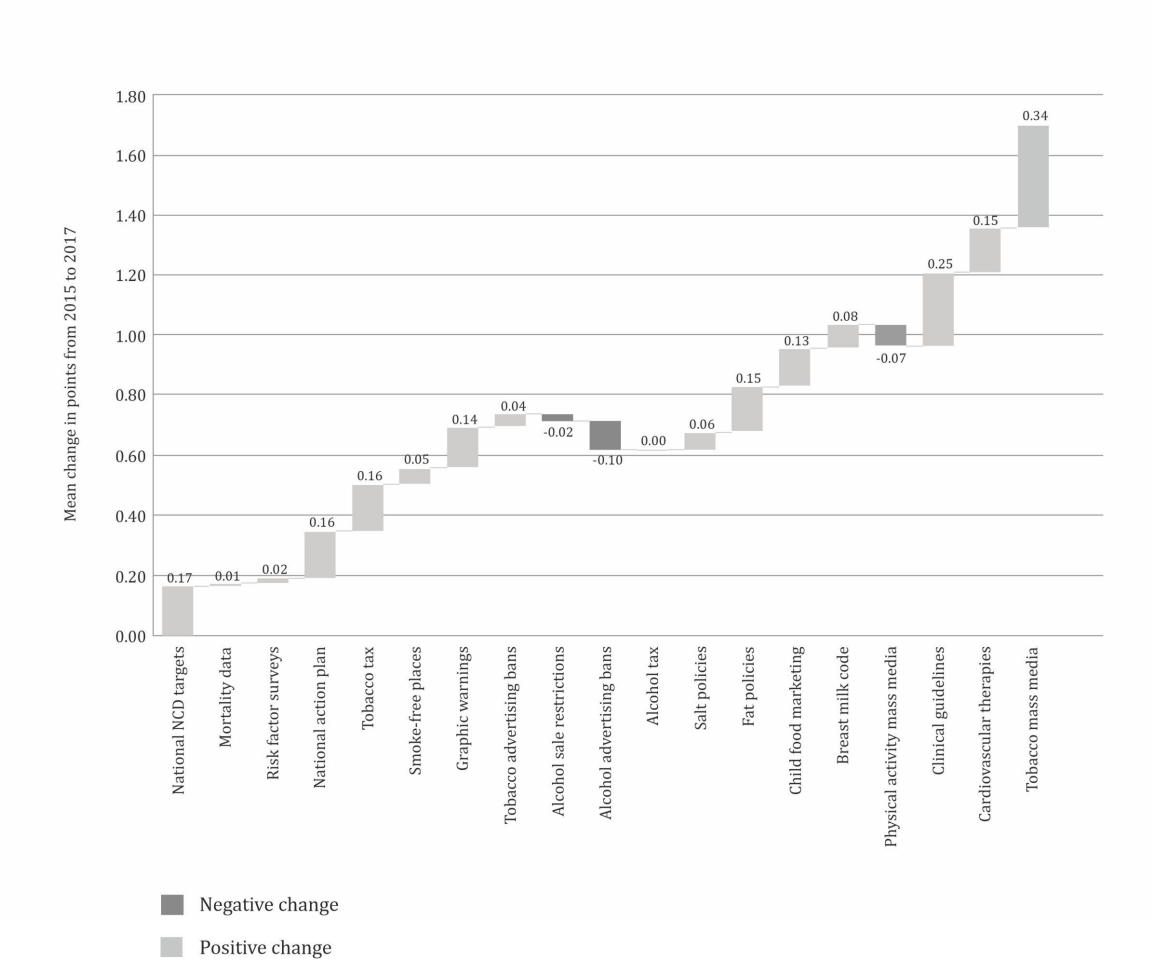


Figure 10 - Waterfall chart showing the relative contribution of each policy to the overall increase in mean implementation score between 2015 and 2017.

Note: Without the new tobacco mass media indicator overall aggregate policy implementation score rose by just under 1.4 points between 2015 and 2017. If we include the new tobacco indicator then the mean score rose by 1.7 points.

Source: Allen (2020)

In 109 of the 151 countries under study (72% of the total sample), there was an increase in aggregate implementation scores; in 32 of the countries (21%) there was a regression and in 9 countries (corresponding to 7%) there was no change. Apart from alcohol measures, in which there has been a stable shift or decline, among countries showing improvement, gains were evenly distributed among policies. On the other hand, for countries showing regression, the withdrawn policies were linked to national plans, physical activity and marketing policies (Figure 11).

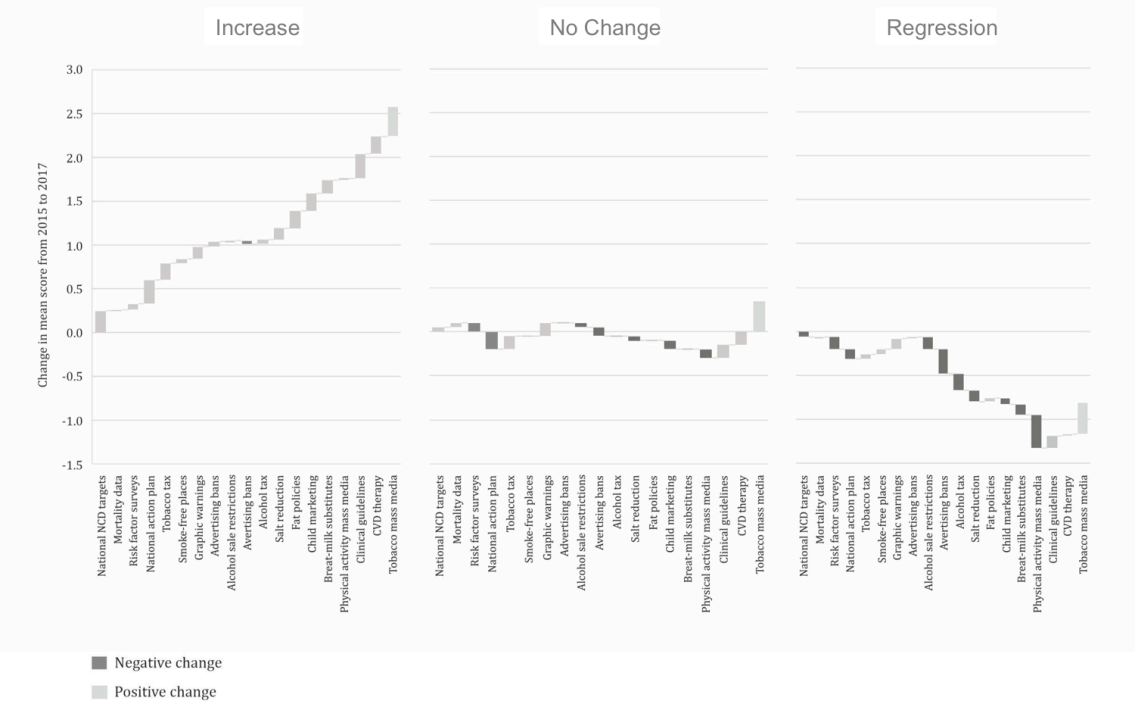


Figure 11 - Changes in individual mean scores for each policy for countries whose overall implementation improved (left), stayed the same (centre), and regressed (right) from 2015-2017.

Notes: Each bar represents a change in mean individual policy score over time. The base of 'tobacco mass media' marks the aggregate change in overall score from 2015 to 2017 in each graph.
Source: Allen (2020)

Policy implementation and geopolitical characteristics

In general, in each country, there was a positive linear correlation (R^2=0.53) between the aggregate score for the 2017 policy implementation and the percentage of deaths resulting from NCDs. I also observed a weak negative association (R^2=0.09) between the risk of premature NCD mortality and the implementation score. Regarding other explanatory variables under analysis, the strongest linear correlation was observed for the human capital indicator (R^2=0.54), as illustrated in Figure 12. The second strongest linear correlation, with a value very close to the previous one (R^2=0.53), was observed for the percentage of deaths resulting from NCDs. Although with variable effect sizes, in simple linear regression all explanatory variables showed a statistically significant association with political implementation at level α=0.05, as shown in Table 6.

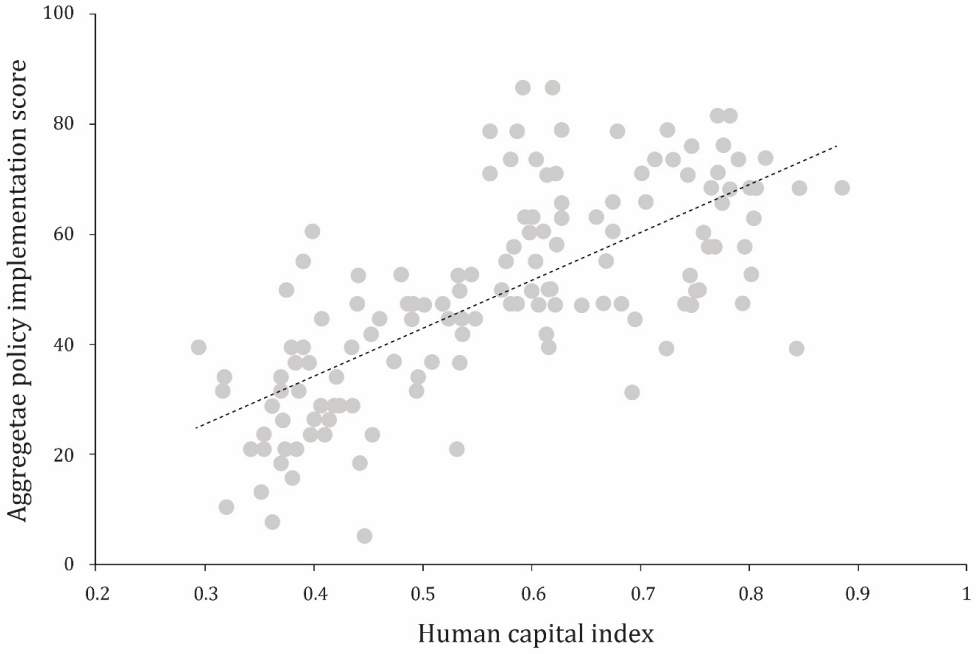


Figure 12 - Aggregate policy implementation score and human capital index.

Source: Allen (2020)

After performing the multiple linear regression, from all studied variables, human capital was the only one remaining significant at the α=0.05 level. In addition, 60.3% of the variation observed in the aggregate scores for the year 2017 was explained by the multiple linear regression model (R^2 = 0,603, p <0,001), as observed in Table 6. Therefore, if in a given country the percentage of deaths caused by NCDs or the human capital index is known, then it will only be possible to explain another 6-7% of the variation in policy implementation score, even when all other variables are added.

Table 6 - Regression analyses for 2017 aggregate score and seven explanatory variables.

	Simple linear regression (unadjusted)				Multiple Linear Regression (adjusted)		
	Effect	**95% CI**	**Rsq**	**p**	**Effect**	**95% CI**	**p**
Percentage of deaths caused by NCD	0.11	0.09 to 0.12	0.53	**<0.001**	0.02	-0.04 to 0.08	0.508
Risk of premature mortality	-0.18	-0.28 to -0.09	0.09	**<0.001**	-0.01	-0.10 to 0.09	0.901
Human Capital Index	16.32	13.84 to 18.80	0.54	**<0.001**	17.21	5.84 to 28.59	0.003
Democracy Index	0.71	0.46 to 0.97	0.18	**<0.001**	-0.12	-0.47 to 0.23	0.502
Region			0.45	**<0.001**			
Europe & Central Asia	ref			ref	ref		
Latin America & Caribbean	-2.13	-3.58 to -0.68	0.68	0.004	-0-20	-2.04 to 1-63	0.826
Middle East & North Africa	-0.65	-2.15 to 0.86	0.86	0.397	0.78	-1.11 to 2.67	0.414
North America	0.50	-3.65 to 2.66	2.66	0.754	-1.31	-4.23 to 1.62	0.379
South Asia	-1.70	-4.19 to 0.79	0.79	0.180	2.44	-0.40 to 5.28	0.0092
Sub-Saharan Africa	-5.88	-7-05 to -4.72	4.72	**<0.001**	-0.59	-3.61 to 2.43	0.700
East Asia & Pacific	-1.71	-3.21 to -0.2	0.20	**0.027**	-0.03	-1.76 to 1.70	0.973
Tax burden			0.37	**<0.001**			
Bottom quartile	ref				ref		
Third quartile	0.44	-1.13 to 2		0.584	0.80	-0.64 to 2.24	0.271
Second quartile	2.73	1.19 to 4.27		**0.001**	1.69	-0.14 to 3.52	0.070
Top quartile	1.84	0.27 to 3.40		**0.022**	0.27	-1.74 to 2.28	0.790

Missing data tax burden	-3.03	-4.47 to -1.60		**<0.001**	0.85	-1.02 to 2.72	0.369
Income group			0.41	**<0.001**			
Low	ref				ref		
Lower-middle	1.90	0.53 to 3.28		0.007	-0.90	-2.39 to 0.59	0.235
Upper-middle	4.43	3.08 to 5.89		**<0.001**	-0.86	-3.00 to 1.29	0.430
High	5.83	4.54 to 7.11		**<0.001**	-1,97	-4,99 to 1.05	0.199

Source: Allen (2020)

Sensitivity Analysis

To perform the sensitivity analysis, the model applied in all 151 countries under study was re-run. In simple linear regression, all variables remained with a significant value and the general model explained 61.1% of the variance found in the aggregate scores for the year 2017 ($p<0.001$).

There is a high degree of collinearity between the variables since only human capital remained significant when $\alpha=0.05$. Also, tests assessing collinearity validated that not only human capital but also the region of Europe and Central Asia and the percentage of deaths resulting from NCDs had variance inflation factors (VIF) greater than 10. After removing these variables and running the model again, the value of R^2 fell to 55.7% ($p<0.0001$), all VIF values diminished to scores <5.5, and at the 0.05 level, three additional predictors became significant; upper-middle-income countries ($B=0.31$, $p=0.044$), the region of Sub-Saharan-Africa ($\beta=-3.72$, $p=0.001$), and also the region of Latin American and the Caribbean ($\beta=-1.907$, $p=0.029$).

Finally, to evaluate variations in aggregate scores between the years 2015 and 2017, it was necessary to run a multiple linear regression model. Besides explaining 18.3% of the variance ($p=0.06$), the model also presented two predictors as significant at the $\alpha=0.05$ level; Latin America and Caribbean region were the most significant ($p=0.038$), followed by the second tax tier ($p=0.049$).

Discussion

In 2017, just under half of the policies recommended by the WHO, for the purpose of controlling and preventing NCDs, were implemented by most countries. In addition, between the years of 2015 and 2017, there was a drop in the number of countries that implemented restrictions on sales and advertising of alcohol, as well as physical activity mass media campaigns. Regardless, the global taxation of alcohol has not changed in terms of implementation rate and there has even been an increase in mean scores for the remaining NCD policies. Between the years of 2015 and 2017, additional measures were introduced in more than 70% of countries and policies most frequently implemented were related to clinical guidelines, risk factor surveys and graphic warnings on tobacco packaging.

Based on WHO mortality statistics (Bennett et al., 2018)**,** the NCD Countdown 2030 showed that the rates of decline in mortality resulting from NCD have high variability worldwide. In addition, in low- and middle-income countries, cardiovascular disease appears to be the leading cause of premature death, although it is worth noting that there is a limitation in the confidence of this finding due to weak mortality data collection systems. Also, while there is widespread use of graphic warnings on tobacco, my analysis reveals that alcohol-related measures are weakly implemented and that tobacco taxation and mass media policies are only implemented in their entirety in less than a third of countries.

According to a simple linear regression, policies were more widely implemented in rich democratic countries, which have high levels of non-premature mortality from NCDs and human capital, in contrast to low-income authoritarian states, which in turn had a

lower implementation of policies and higher rates of premature mortality from NCDs and low human capital.

Regarding business-friendly libertarianism, even though tax burden is a flawed proxy, for a significant amount of countries I have not been able to find alternative measures to quantify this factor. Furthermore, the Heritage Foundation is philosophically opposed to elevated tax levels, although it is not obvious that tax burden data is affected by this bias.

One may question about any association, correlation or impact of potential combined effects of such NCDs policies implementation on the referred countries' income or economies. Unfortunately, the present research was not designed to answer such question. Correlations between NCD policy implementation and GDP (among other variables), using a cross-sectional 'snapshot' have been looked for. Only correlations and not causality were identified. It could be that these high-performing countries implemented CVD, salt, fat, and child marketing policies decades ago and have indeed reaped some kind of economic reward that is now reflected in high GDP and high implementation scores. To answer that question, one would need a completely different study design, looking at how NCD policy implementation has changed over time, and the association between rising implementation and economic factors. Such study would still only be observational, so one would still not be able pin causality down. Furthermore, a considerable amount of confounding factors would be at play. Nevertheless, NCD policy implementation data with any degree of uniformity or consistency has not routinely been gathered over the past few decades, so such a new study design would involve scouring international policy archives.

Regarding the aggregate policy implementation scores, 60.3% of the variance was explained by the original multiple linear regression model, which is a cross-sectional analysis and identifies associations instead of causality. As for the aggregate scores for the year 2017, 55.7% of the variance was explained by the model, after removing the colinear variables. Regardless of this, since there is still little research on this subject, it is not clear which factors may influence the remaining variation in the scores of 40-50%. In this model, the factors incorporated were weak predictors of variation in scores for the years 2015 to 2017.

In this context, the negative association (R^2=0.09) between the risk of premature NCD mortality and the NCD implementation score was an interesting finding that deserves further discussuion. One might be loosely expecting that countries with weak NCD policies would have high rates of premature deaths. Either because absent policies leave populations exposed, or because countries with the highest burdens tend to be poor and have fewer human, financial, and administrative resources to implement policy. However, one could also argue that countries with the highest burden of premature deaths would have the biggest incentive to implement NCD policies, and after all many of these policies are relatively easy to introduce, especially in comparison with other forms of health reform like setting up primary care services. It could be reasoned that countries with low premature mortality rates have no real reason to implement unpopular policies such as alcohol taxation. Therefore, it might not be worth expending such political capital. In the end, the data suggest that there is no real association between implementation and premature death. This could be a result of all of the above factors cancelling each other out, or none of them, or something else entirely. Again, with an observational snapshot such as the one performed in this chapter's research one can only speculate. A longitudinal analysis of countries with high and low rates of NCD premature deaths, and the interaction with

policy implementation over time would be the best way to study this relationship in future studies in this area.

Interestingly, a relevant aspect influencing whether a government commits resources in implementing NCD policies (or in manipulating data to give the appearance that NCD measures are being implemented) is the concept of 'political will'. In the future, research may allow the identification of a set of metrics that are both objective and internationally comparable to allow the quantification of this factor, by approaches such as media analysis. Another example of a potential predictor, that is equally difficult to quantify, is the influence of industry.

This chapter correlated NCD policies implementation with a range of geopolitical variables, including NCD mortality burden and the risk of premature NCD mortality in a given country. The usage of these 2 indicators was decided according to the WHO procedures. These are the two NCD outcomes presented in the WHO NCD progress monitors. Furthermore, according to personal discussions with high-level political leaders and policy makers in Portugal, premature mortality was considered the most important variable to focus on. The confounding factors that link with implementation and with premature NCD mortality, also link with NCD diagnosis. Thus, apart from adding additional complexity to data collection, since the main indicators available in the WHO NCD progress monitors don’t include diagnosis policies, it was assumed that there was not much to be gained by focusing on them.

It should be noted that this study has some limitations, namely in terms of aggregate scores that measure the extent and not the effectiveness of policies, even though policies are not similarly effective at combating NCDs. Radically different policy scenarios might be assumed to be equivalent by giving 0.5 points to cover all degrees

of 'partial implementation', which is inaccurate. Since the research was conditioned by the information available, the approach employed by the WHO was adopted in this matter.

For all cases, there was a shift for several indicators of the criteria used by the WHO in 2017 regarding the 'full' or 'partial' implementation that will have resulted in miscalculating the progress in the affected policy areas. According to internationally approved legislation, it is appropriate for tobacco taxation thresholds to increase over time, however, this research highlights why it is important to encourage the WHO not to change the objectives set for other policies as it could undermine the fair assessment of progress. It is interesting to note that in each instance the mortality data shown on each progress monitor was a few years old, which limits the reliability and usefulness of this factor in the regressions. Assuming that, in countries that were lacking data on a policy, and that consequently the WHO was not able to verify their existence, there was a greater likelihood that the policy was not implemented rather than to have been implemented, a zero value was assigned to all countries where there was no data policy available. This assumption may underestimate the average scores. In 2017, only 3.8% of all policy measures were influenced by missing data. Regarding the tax burden metric, the missing data constituted a major problem. At the expense of discarding country-level data, I managed to keep all countries in the analysis, since I decided to make a statistical shift by transforming the continuous tax burden into ordinal categories.

A second limitation relates to comparability of the data across countries. Among countries data quality is variable given that the outcome variable of interest is self-reported. The implication is that the observed differences of the extent of the implementation of best buys may reflect differences in reporting or differnces in

subjective country self-assessments rather than actual implementation differences. While this is a plausible limitation WHO's efforts on data validation partially mitigate these potential differences. Nevertheless, further research should focus on developing a common set of indicators that elicit the extent of implementations so that countries are compared on objective measures and these should be triangulated with other sources of country data.

Another limitation has to do with unobservable cofounders. While we control for a broad range of factors that can impact implementation I cannot rule out that some of the variables of interest are actually capturing unobserved factors.
For example, the implementation of policies was positively associated with human capital and it was in simple regression that the greatest explanatory power was observed.

Human capital Index is a composite indicator combining child mortality, stunting, adult survival, expected years of schooling, and harmonised educational test scores. 2017 scores from the World Bank database were used as described in the methods section. In simple linear regression, we found a strong correlation between Human Capital Index and policy implementation (R^2=0.54). Human Capital Index remained a significant predictor of implementation even when all of the other variables were added into the model ($p<0.003$). It could be however that human capital is capturing the effect of other develpment indicators aligned with NCD death rate, GDP, and world region. Therefore, it may be agued that this says less about political will than it does about having basic institutional infrastructure in place. Nevertheless, even the availability of basic institutional infrastructure shall be

fundamentally based on political will (and low political volatility) in the first place. That said, one may question the reason why some countries are more developed than others and what role does political will play in such development. The data used in this shapter only show that more developed countries are more likely to implement NCD policies. However, these data is not suitable to clarify why.

Furthermore, it is hardly surprising that investment in NCD prevention is more prone to happen in countries with educated and healthy populations, just as it is not surprising that there is evidence of collinearity for this variable. Also, in addition to being based on a philosophical framework that considers social development in terms of economic productivity, the World Bank's human capital index has been criticized for combining weak data from a few countries (Allais, 2012; Nature, 2018). In addition, the aim of this experimental observational research is to identify geopolitical correlations rather than causes.

Using a similar method Gravely et al. (2017) correlated the implementation of five Framework Convention on Tobacco Control (FCTC) articles with the alteration in smoking prevalence in 126 countries**.** Hiilamo and Glantz (2018), in turn, used regression to evaluate the association between tobacco tax rates and the FCTC ratification for 104 countries**;** and, to evaluate whether the implementation is associated with an overall degree of social and financial growth, they used the 'State Fragility Index' from Marshall and Cole (2014). Moreover, despite having only five African countries in their work, to evaluate the implementation of NCD prevention policies in line with the WHO's 'Best Buys', Juma et al. (2018) adopted a qualitative approach. To evaluate the implementation of 'Best Buys' in seven countries in South-East Asia, Tuangratananon et al. (2019) used, along with other resources, the 2017

NCD progress monitor, which are part of a recent analysis of NCD national action plans. Several implementation gaps were found in uneven progress, due to factors such as limited funding, the lack of standardized monitoring and evaluation processes, weak institutional capacity and weak intersectoral coordination. This analysis carries slightly different political messages since it considered macro-level variables on a global instead of a regional scale.

It is important to note that NCD policy implementation is not necessarily expensive, even though financial and human resources are useful. One example is Moldova, which occupies the 12th global position for NCD policy implementation, despite being in 130th position in relation to gross national income among the 151 countries under study. In addition, Iran and Costa Rica, two middle-income countries, achieved the highest aggregate implementation scores. In NCD policies, not only do fiscal policies generate revenue but also they are highly cost-effective (Roth et al., 2018)**.** Nonetheless, at the top of the implementation table, countries with the highest incomes were overrepresented, while countries with the lowest incomes had lower gross implementation scores. At the regional level, even after controlling for economic and social development, Sub-Saharan countries ranked much worse than European countries. In turn, in the last ten places were countries like Nigeria, Botswana and Rwanda, considered the traditional 'darlings' of global health. This emphasises how vital it is to provide technical and financial support to African countries, mainly because they have the greatest burden of premature mortality and morbidity. In the future, it will be important to assess how Moldova and Costa Rica are able to achieve such positive performances by examining domestic factors that have allowed these positive outliers. According to personal communication with the Moldovan government’s head of policy analysis, two seemingly relevant internal factors are the government's high-level commitment and intense technical support from the WHO.

When it comes to implementing NCD policies, I found weak evidence to back up the shared hypothesis that centre-left nations with elevated levels of civic participation and social solidarity are likely to outperform more libertarian policies. Although the second-highest aggregated implementation score was obtained by Norway, and in 16th place in the classification was Finland, countries such as Sweden, Denmark and Iceland as well as other socio-political cousins such as the Netherlands were unable to reach the top 20. In turn, the USA ranked 50th out of the overall 151 countries under study, due to its poor performance in market-related policies. Nevertheless, other countries that had a good reputation for business managed to perform well, such as Ireland which ranked 26th, Singapore which ranked 27th, and the United Kingdom, led by conservatives, which came joint second.

Policy implications at the national level

Portugal showed an important implementation score improvement from 2015 to 2017. In fact, it went up from 61.1% to 76.3%. This trend allowed Portugal to move from the 34th position, when comparing to all the other 150 countries analysed, to the 11th position. This improvement was mostly based on improvements in the following policies' implementation scores: National Action Plan, Tobacco Graphic Warnings, Tobacco Mass Media, Alcohol Taxation, and Cardiovascular Therapies. In 2017, Portugal's implementation scores were mostly aligned with the mean implementation score of the 20 Top Performing countries, with an exception: no implementation of fat policies. This was the only area in which Portugal was aligned with the mean implementation scores of the worse performing countries worldwide. This fact suggests that the Healthy Nutrition area may be among the policy areas where Portugal has important opportunities for improvement in terms of policy implementation.

Policy implications at the global level

Over time, the typical country is gradually improving and has managed to implement just below half of the NCD policies recommended by the WHO. The least commonly implemented measures are related to market policies, in particular those associated with mass media as well as alcohol and tobacco, together with policies related to the provision of cardiovascular therapy. In this context, it is essential to carry out research that allows for the examination of regional and domestic factors that may help to promote or that may be preventing implementation. The research shown and discussed here highlights a positive association between the WHO's Best Buys Policies' implementation scores and lower NCD-related premature death rates. Also, a negative association between high policy implementation rates and NCD-related premature death risk was identified. Thus, it is clear that if political leaders are really looking to protect their citizens' lives and wellbeing, investing in raising their countries policy implementation levels is a must. However, some may say that implementation levels are lower in underprivileged economies because they are expensive. The findings show that this argument doesn't stand because there are good examples of countries that actually perform very well in terms of policy implementation scores while showing very low gross national income. In fact, NCD policy implementation is not expensive, thus, it a pathway assessable to all. Even though there are no robust indicators to assess it, it seems clear that 'Leadership' and 'Political' will play an essential role in the process of bringing a cheap and highly effective policy kit, like the WHO's 'Best Buys', from concept to reality. Therefore, political leaders that don't commit to this tool to protect their citizens' health, shall be held accountable by international institutions.

Chapter 3

Setting a policy framework: The Portuguese Integrated Strategy for Healthy Eating

Introduction

NCDs are preventable, as well as their outcomes. In fact, according to the literature, to improve health and therefore prevent NCDs, collaboration between different sectors is important. Another important aspect to consider is the risk factors for these diseases (OECD, 2017).

With that in mind, Health in All Policies (HiAP) is an approach to public policies that aims to enhance health equity and the state of health of populations. Thus, as stated by the WHO, HiAP often seeks synergies, considers the health consequences of decisions and avoids impacts that could be harmful to health. With HiAP it is possible to increase accountability of policymakers, based on the effects that policies might have in health. Considering HiAP when developing new policies not only contributes to sustainable development but also raises the awareness of the implications that health determinants, well-being and health systems might have on public policies (WHO, 2013d).

This approach to public policies recognises that NCDs are incredibly complex and closely associated with major current health challenges and social determinants. In addition to these, other macro phenomena can be considered, namely political systems, development and economic policies or even social norms as they may influence the social determinants associated with NCDs (WHO, 2014a).

The HiAP approach can be beneficial when applied to complex and tangled problems namely the increase in costs associated with medical assistance along with the

increase of inequality and health inequity. Also, ageing populations – often associated with the growth of chronic diseases – or even the strains brought forth due to limited resources are also complex problems that might benefit from an HiAP approach. Moreover, this type of approach can also help achieve effectiveness through collaboration between sectors. In addition to promoting the discussion of ways to solve challenging problems, by sharing resources and reducing redundancies, it also helps in identifying problems faced by diverse entities. This is particularly relevant especially in scenarios of reduced revenues and/or budget when faced with the certainties of governments at all levels. The literature includes several examples of an extensive tradition of effective intersectoral public health collaboration, which are fundamental components of the HiAP approach (Rudolph et al., 2013).

Some of the guiding principles necessary to be successful at the HiAP approach are the promotion of intersectoral collaboration – through the engagement of stakeholders from diverse areas – and the promotion of health sustainability and equity. Moreover, another key factor for success is the development of new governmental structures that enable the implementation and operationalization of these approaches (Rudolph et al., 2013).

According to the WHO resolution WHA67.12, ministries of health are asked to take effective measures regarding the social, environmental and economic determinants of health, and to advocate health and its promotion as a priority (WHO, 2014a)**.** All ministries of health and analogous bodies need to work on common health determinants in order to promote the HiAP approach regardless of differences in administration and/or political structure. To do so, they should evaluate possible social changes that make it possible to identify and prioritize evolving health issues,

promote the development of additional scientific knowledge, and consider the influence of other sectors on health.

Negotiations between stakeholders from different government or non-government sectors should be facilitated in order to supervise and evaluate policy implementation and establish adequate mechanisms and structures to engage society as a whole and across governments.

Health should be included in the mentality and general political imperatives, in line with global social objectives. A clear government mandate and political will are needed to deploy HiAP. The commitment to both collaborative and participatory approaches to policymaking and governance recognizes the benefits of a relationship between health and other sectors. While other sectors can help the aims of health, in turn, the health sector can meaningfully contribute to the goals of other sectors. It is essential to take this into account in order to build more effective governments and to convince public officials to adopt rational and analytical approaches at the expense of outdated tools and techniques (Farrell & Goodman, 2013).

The need to implement key measures to promote healthy eating habits is emphasized by the context of nutritional epidemiology in Portugal. Furthermore, as discussed in Chapter 1, according to the 2017 NCD monitoring reports were released by the WHO (2017c), Portugal underperforms in what concerns certain Healthy Eating related WHO 'Best Buys'. Thus, there is an obvious opportunity for targeted policy implementation improvement. Over the last few years, numerous actions have been considered as part of the National Program for the Promotion of Healthy Eating (Graça et al., 2016). While positive outcomes resulted from this vertical program, these were not substantial enough to have an impact on the existing epidemiology of NCDs. In order

to improve the implementation of policies aiming to improve dietary patterns and therefore to achieve more effective health goals, it would be necessary to adopt a more intensive, broad and intersectoral approach. In the context of these challenges, HiAP was considered the best option.

The interests of various government sectors such as industry, agriculture and the economy typically clash with the promotion of healthy eating. For this reason, it is essential to seek common ground among the diverse government sectors so that countries can give priority to the health status of their population at the expense of other interests that may arise. In this regard, the Portuguese government has promoted healthy eating, recognizing this measure as a priority (Portugal, 2015)**.** Thus, to affirm the commitment to common health goals, particularly in the area of nutrition, the Ministries of Finance, Education, Internal Affairs, Economy, Health, Agriculture and Oceans of Portugal consented to join forces and know-how. In the last two decades, this was the first time such initiative was possible, due to the need for political commitment to face the predominant health and social challenges that might arise. Also, it requires delicate handling of the complexity of commonly opposite interests of different sectors in order to find common ground where both parties can agree, which was another obstacle that conditioned the launch of this initiative (Goiana-da-Silva, 2018a).

As it was widely discussed over the introduction Chapter of this thesis, unhealthy eating habits are among the most important risk factors for NCDs. Such risk factor is impacted by several individual and social determinants as well as by different stakeholders. Taking obesity as a reference, the fact is that no country in the world has completely reversed its levels in three decades because the systemic and institutional drivers of obesity remain unchanged. (Campbell et al., 2021) Highest on

this list of systemic drivers is commercial influence on the public policy process (Swinburn et al. 2019).

The EU has recommended a protocol for reformulation action around a four-stage process: to gather data, reformulate, educate consumers and monitor and evaluate (EU Annex 2015). To date, no country has completed these four steps. In recent years, for example, the EU Joint Action on Nutrition and Physical Activity (responsible for obesity policy-making in Europe) observed "no major progress has been made" in EU's efforts to reduce and prevent obesity (JAPNA 2017).

Despite statements from high level policy-makers, such as Joint Action on Nutrition and Physical Activity, that too little is being achieved, and too slowly, the depth and pace of reformulation impact has been deemed to be satisfactory. (Campbell et al., 2021) Some recent research has calculated the costs of delay when a mandatory requirement becomes voluntary. For example, a recent study estimated the public health impact of the 2011 "Responsibility Deal" (Campbell et al., 2021) – where the food industry and the UK government entered into public-private partnerships, marking the end of the UK's mandatory reduction of salt. It estimated that 10,000 cases of heart disease and stroke and 1,500 cases of cancer could have been avoided in England if the government had not switched to a voluntary deal with the food industry to cut salt in food in 2011 (Laverty et al. 2019). Similar costs of delay are highly likely in respect of food reformulation.

As it will be discussed over the following Chapters, there is no "silver bullet" able to tackle such health challenge like obesity or any other NCDs risk factor alone. If one aims to maximize the impact of different policies addressing unhealthy eating, it must integrate them in an articulated manner. On other words, neither mandatory/taxation

policies, nor self-regulation policies have been able to solve the problem of unhealthy eating and overweight when implemented alone. And these are precisely the different kind of policy approaches that generate hard discussions between the health sector representatives, which see the negative externalities of the consumption of unhealthy food every day while healthcare needs associated to NCDs keep growing, and other government sectors like economy or agriculture, which tend to behave like food industry representatives. Therefore it is easy to understand that the health sector tends to prefer policies with quicker results, such as taxation, (disregard their impact on the food industry). On the other hand, sectors like economy and agriculture defend self-regulation policies that tend to pledge their sector's industries. In this context, a HiAP approach, like the one driven by Portugal in order to develop consensus around EIPAS, had the challenge of looking for a balance and integration between taxation/mandatory policies and voluntary/self-regulation policies. In this context, the concept of co-regulation may worth some attention. Co-regulation implies that the food Industry is engaged and commited to collaborate in healthy nutrition innitiatives defined by the Government, however not merely in a self-regulation perspective. The Government then shall play a supervising and accountability role among sich private players, through a co-regulation role.

Finally, since it was obvious that the Health Sector alone was not able to tackle the problem of NCDs and their risk factors over the last decades, it was time to understand that any solution that didn't involve the food industry sector would be aimed to fail again. To bring the food industry sector on board, to be part of the solution and not only a driver of the problem was an opportunity brough by the HiAP approach but also a challenge fro the development of an actionable strategy such as EIPAS.

• **Hypothesis**

The HiAP Approach is an effective tool to convert the WHO recommended policies into implementation driven national policies.

Objectives

This chapter aimed to describe and critically analyze the process that led to the launch of the first Integrated Strategy for Healthy Eating in Portugal.

Methods

Agenda setting and diagnosis

In 2012, the first national food and nutrition program in Portugal, the PNPAS [*Plano Nacional de Promoção da Alimentação Saudável*], was launched. As one of the eight priority national programs established by the Directorate-General for Health, this program was established to pursue 5 objectives: (1) to improve awareness regarding food determinants, consequences and consumption by the Portuguese population; (2) to adjust the availability of specific foods in public settings; (3) to provide information and encourage the population on the buying, storage and preparation of healthy food; (4) to recognize and encourage actions between sectors that promote the consumption of food with good nutritional quality, in an articulated manner with additional sectors; and (5) to enhance the credentials of the diverse professionals who, given their relevance, can influence knowledge, attitudes and behaviours on nutrition. In the first two years and at different levels, several actions were implemented. One of the main triumphs of this program was the creation of a novel communication approach to disseminate accurate information on nutrition and food. The preferred channels to disseminate information were the website (www.alimentaosaudavel.dgs.pt), the blog (Nutrimento Blog at www.nutrimento.pt), digital channels and social networks (Twitter and Instagram). Reference manuals –

such as posters and guidelines – and podcasts were also included as part of the communication strategy for health and education institutions as well as for professionals.

In addition, there has been significant growth in the amount of accessible information related to food consumption, nutritional status, their determinants and health outcomes throughout the life cycle (Graça et al., 2016). In order to directly assemble or aggregate data at different levels, PNPAS has developed a set of actions. Some examples include: (1) the deployment of a child obesity monitoring system; (2) the development of research to evaluate consumers' understanding of nutrition labelling; (3) a study on the incidence of trans fatty acids in foods of the Portuguese market; (4) the deployment of a surveillance system on nutrition uncertainty in Portugal; (5) the development of a project aimed at preventing obesity through the mapping and dissemination of good practices in community intervention projects; and (6) the provision of technical support to assist in the development of the national nutrition and food survey 2015, following a 40-year gap deprived of data about the food consumption of the Portuguese population.

For the successful planning of the policies within the Integrated Strategy for the Promotion of Healthy Eating (EIPAS) [*Estratégia Integrada para a Promoção da Alimentação Saudável*], it was essential to collect data through the efforts of PNPAS. Numerous partnerships were established in the 2012-2016 period with several different stakeholders. Nevertheless, complications in getting an official commitment from the whole government to the goals of a Public Health Programme marked the initial years of implementation of the PNPAS. Among the different sectors of the government, more than a few policy disparities were recognized, which compromised

the effective implementation of many interventions, with special relevance for those that were associated with the encouragement of healthier eating environments. Hence, there was an imperative need to improve articulation among the Ministries of the Portuguese Government, in an effort to align and enhance the various approaches associated with nutrition at the national level (Graça et al., 2018).

Policy development process

The promotion of healthy eating was recognized as a priority for the Portuguese government (Portugal, 2015a). Hence, the Ministries of Finance, Education, Internal Affairs, Economy, Health, Agriculture and Oceans of Portugal agreed to work together and share their knowledge by committing to common health goals – particularly those related to nutrition. However, in the last two decades, this was the first time such initiative took place due to the high complexity involved in handling generally opposite interests from different sectors. The process leading to the publication of Order No. 11418/2017 of the Portuguese Official National Gazette is presented in Figure 13.

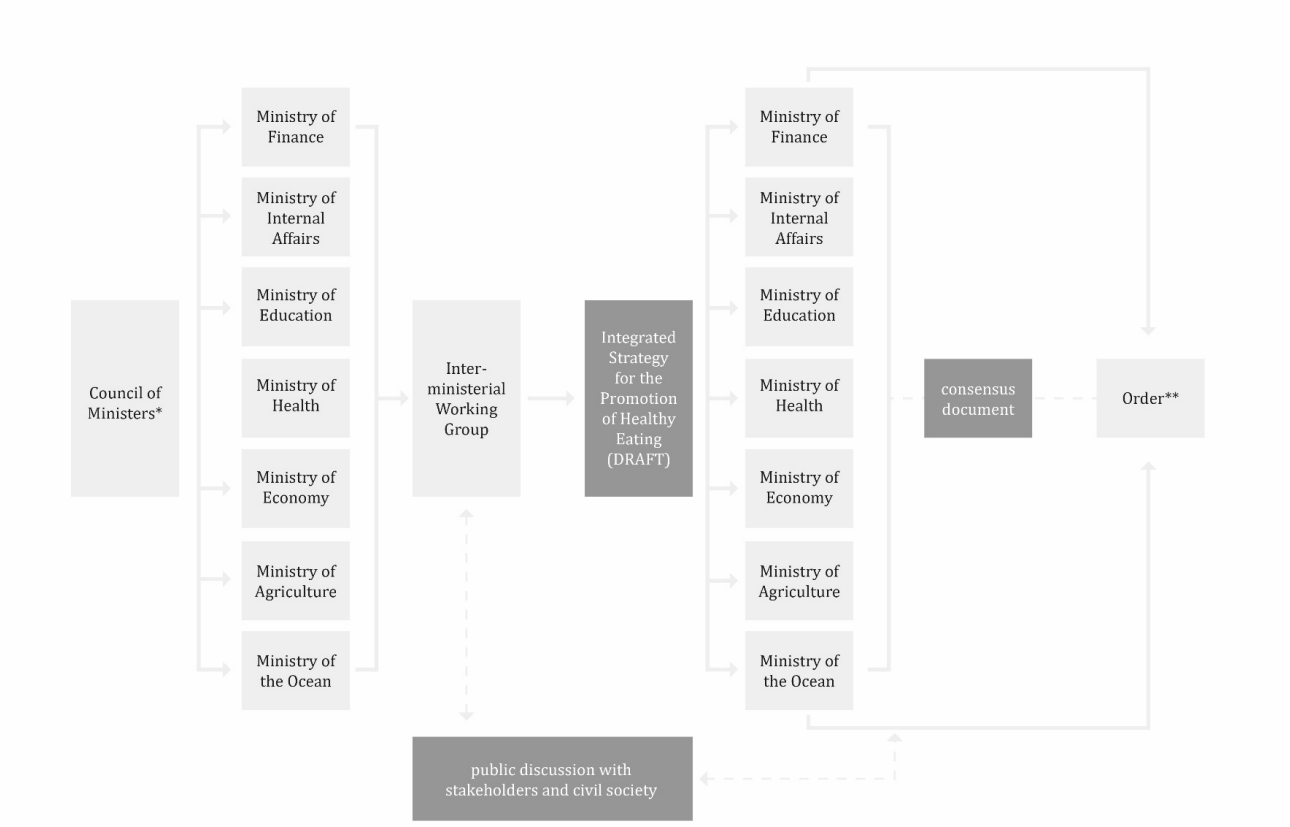


Figure 13 – The process leading to the publication of order No. 11418/2017.

Source: Goiana-da-Silva (2018a)

The creation of an interministerial working group made up of representatives from the country's Ministries of Finance, Education, Internal Affairs, Economy, Health, Agriculture and Oceans was endorsed by the Portuguese Council of Ministers through Deliberation No. 334/2016, on September 15, 2016. The aim was to promote healthy eating based on the creation of a national strategy in this regard (Portugal, 2016a).

By the end of November 2016 and after the Council of Ministers had deliberated, the contributing Ministries allocated substantial time to choosing their representatives, establishing their main priorities and goals, determining the general negotiation approach and, lastly, creating the working groups.

The first meeting took place at the headquarters of the Ministry of Health on December 5, 2016, and aimed to plan the work to be undertaken, by establishing the monitoring process, recognizing the foodstuffs to be monitored, clarifying the scope for each public entity involved and by setting the overarching goals (Goiana-da-Silva, 2018a)**.**

The following four objectives were addressed at all meetings (Goiana-da-Silva, 2018a):

1. Modify the accessibility of nutritional products with an elevated amount of fat, sugar and salt content.
2. Enhance the quality of accessible information regarding the hazards associated with fat, sugar and salt consumption.
3. Recognize and encourage intersectoral and cohesive measures to fat, sugar and salt consumption, in the sectors of education, economy and agriculture.
4. Enhance the credentials and approaches used by professionals who have the capability to influence consumers regarding eating and purchasing behaviours.

A representative from the Health Ministry coordinated all meetings. It should be noted that the group considered not only the representatives of the ministries mentioned above but also contributions from national associations of consumers and the food and distribution industry. The Secretary-General of the Health Ministry played an important role in ensuring all the administrative and logistical processes necessary for the meetings. In order to define a strategy that could promote healthy eating and prevent and control NCDs, a total of 10 meetings were held by the interministerial working group from December 2016 to July 2017. The final draft of an integrated healthy eating strategy was delivered by the group to Members of the Government

around six months after its first meeting. In order to enlarge the possibility of external contributions by civil society, the public consultation was submitted by the government on 1 August 2017 and subsequently submitted to document review. Recommendations and remarks were provided by health authorities, various non-governmental organizations and by several members of civil society. In order to be assessed on their relevance and feasibility, a total of sixteen position reports were submitted and forwarded to the interministerial working group. For all approved contributions to be included, an initial strategy proposal was then revised and adapted accordingly. Later, in October 2017, a final version of the strategy, duly revised and approved by consensus, was again sent to the government. Subsequently, the consensus document came to be the foundation for the outlining of an official order in a process headed by the Ministry of Health and started after the consensus version of the strategy was sent (Goiana-da-Silva, 2018a). After numerous months of work between representatives of many sectors of Government, on 29th December 2017, the EIPAS was published (Portugal, 2017).

Results

EIPAS structure

There were four areas of strategic intervention in the EIPAS, namely: (1) to develop environments conducive to healthy eating, by endorsing the reformulation of specific types of food that are rich in fat, sugar and salt, and also through the adjustment of the kinds of food supplied or sold in the several public places; (2) to encourage and inform citizens to select healthier food choices, by improving their availability and quality for consumers; (3) to encourage healthy food choices through the promotion and improvement of consumer literacy; and (4) to encourage entrepreneurship and

innovation aimed at promoting healthy eating. For each strategic area, different actions were defined, totalling 51 actions (Graça et al., 2018).

Strategic area 1 – create healthier food environments

The first strategic area of the EIPAS aims to promote the reformulation of certain types of food, as well as to adapt products which are supplied and sold in specific public places, to modify the environment in which consumers choose and buy food. This strategy is designed to promote the consumption of foods with a lower content of trans fatty acids, sugar and salt, by improving the availability and composition of food regarding those factors, but also through prices, access and attractiveness that promotes the choice of healthy foods. There are four priority areas for intervention in this first strategic area: (1) supervision of the nutritional properties of food; (2) execution of proposals on food product reformulation; (3) enhancement of food accessibility in specific public places; and (4) enrichment of food availability in the catering sector. A total of 20 different actions were proposed to accomplish these objectives, as shown in Table 7.

Table 7 - Overview of measures planned as part of axis 1 of EIPAS.

Axis 1: Change the environment where people choose and buy food	
Measure 1	Monitoring the salt content in bread and breakfast cereals, meat and meat products, ready-to-eat meals, chips and other snacks, sauces, ready-made soups, cheeses and canned fish and restaurant-prepared meals.
Measure 2	Monitoring the sugar content in non-alcoholic beverages, dairy products, biscuits and sweet desserts, pastries, breakfast cereals, ready-to-eat meals, sauces, ice cream and canned fruit.
Measure 3	Monitoring the *trans* fatty acid content in biscuits, pastries, chips, breakfast cereals, chocolate spreads and margarines.
Measure 4	Promoting the adequacy of nutrient profiles for certain categories of foods.
	a) Low-Salt foods should not contain more than 0.3 grams of salt per 100 grams or millilitres of finished product.
	b) In soups and prepared meals, the salt content should not exceed the reference value of 0.2 grams of salt per 100 grams of finished product.
	c) Low-sugar foods should not contain more than 5 grams of sugar per 100 grams of finished product (for solids), of 2.5 grams of sugar per 100 millilitres (for liquids).
	d) Both for fats intended for production of other food products and for the finished product, *trans*-fatty acid content should not exceed 2 grams per 100 grams of fat.
Measure 5	Based on the WHO Recommendations, proposing goals for the reformulation of food products in collaboration with the production and distribution industries.
	a) Lowering the per capita daily salt intake to 5 grams by 2020.
	b) Lowering the per capita daily sugar intake to 50 grams and 25 grams for children by 2020.
	c) Lowering the intake of *trans* fatty acids to as close to zero as possible by 2020.

Measure 6	Expanding Order No. 7516-A/2016 of 6 June 2016, promoting the provision of healthy food in automatic vending machines, to all State Administration services and agencies.
Measure 7	Proposing the installation of free water dispensers or distributing water from the public network in all State Administration services and agencies, as well as all other services under public management.
Measure 8	Offering water, fruits and/or vegetables, preferably in line with seasonal availability and production proximity, at all public events organised by State Administration services and agencies.
Measure 9	Further expanding existing guidelines for the provision of food, originally conceived by the Ministry of Education, to all levels of education and teaching, including higher education.
Measure 10	Developing and implementing guidelines for the provision of food in social welfare institutions, in particular those providing services for the elderly.
Measure 11	Promoting public purchasing of food products from short food supply chains as well as integrated and organic production methods.
Measure 12	Promoting the use of iodized salt at canteens and cafeterias beyond those located in schools.
Measure 13	Encouraging fruit and vegetable consumption in schools, increasing the number of beneficiaries of the School Distribution Scheme.
Measure 14	Encouraging the consumption of food categories directly related to the prevention of NCD, namely fresh fruits and vegetables.
Measure 15	Encouraging the removal of salt dispensers from tables in mass catering establishments by proposing that they only be provided when requested by the customer.
Measure 16	Promoting and broadening the scope of best practices related to the guidelines for tenders contracting school meal services.
Measure 17	Encouraging the agriculture and food industry to reduce food portion sizes and pre-packaged drinks.
Measure 18	Encouraging the availability of menus adapted to the most prevalent pathologies.
Measure 19	Expanding policies limiting the volume and supply of individual sugar packets to all entities involved in refining and distributing sugar.
Measure 20	Encouraging restaurants to refrain from providing "free refill" soft drinks.

Source: Goiana-da-Silva (2018a)

Strategic area 2 – improve the quality of and consumer accessibility to healthy food choices

The focus of the second strategic area of the EIPAS is to empower and inform consumers to choose healthier foods, by improving the accessibility and quality of information to which citizens have access. To this end, it intends to facilitate citizens' access to quality information and to assist them in making responsible decisions regarding food, through the identification of relevant initiatives and activities. There is a lot of information concerning food and nutrition, although it remains a challenge for consumers to recognise reliable information offered by autonomous and trustworthy authorities, such as the State, which must play a decisive part in this subject. There are five priority areas for intervention in this second strategic area: (1) enhancement of the nutritional classification of the various food products; (2) constrain the promotion of unhealthy food products to children; (3) encouragement of messages regarding nutrition and food in public organizations; (4) execution of local strategies for the stimulation of healthy eating; and (5) spreading good habits to improve healthy eating. A total of 11 different actions were proposed to accomplish these objectives, as shown in Table 8 (Graça et al., 2018).

Table 8 - Overview of measures planned as part of axis 2 of EIPAS.

Axis 2: Improve the quality and accessibility of information available to consumers	
Measure 1	Encouraging the use of additional nutritional information models on food labels to facilitate consumer choices.
Measure 2	Encouraging the inclusion of trans fatty acid content on nutrition labels on food product packaging.

Measure 3	Encouraging the adoption of measures that limit advertising of food products containing excessive salt, sugar and fat to children.
Measure 4	Encouraging the limitation of marketing and promotion of food products containing excessive salt, sugar and fat during sporting, cultural, recreational and other events involving minors.
Measure 5	Encouraging the use of digital media to disseminate quality messages on healthy eating.
Measure 6	Promoting the involvement of local authorities in providing information on healthy eating.
Measure 7	Developing literacy initiatives on healthy eating at points of sale, in collaboration with the agriculture and food industry.
Measure 8	Promoting the insertion of short messages on healthy eating into all periodical publications produced by the participating Ministries.
Measure 9	Developing a platform for the promotion and monitoring of all measures within EIPAS.
Measure 10	Promoting the incorporation of healthy eating initiatives into local authorities' programmes for the promotion of public health, physical activity and healthy ageing.
Measure 11	Promoting a communication campaign on healthy eating, including information on nutrition labels.

Source: Goiana-da-Silva (2018a)

Strategic area 3 – promote and develop literacy for consumers' healthy food choices

The focus of the third strategic area of the EIPAS is to enable citizens, regardless of their level of literacy, to have the capacity and autonomy to make healthy food choices. For this to happen, health professionals, as well as those from other sectors, must be trained to encourage healthy eating behaviours in the populations they work with. There are four priority areas for intervention in this third strategic area: (1) upgrading the literacy of the population regarding food and nutrition from a young age; (2) recommending the Mediterranean diet, with emphasis on the inclusion of seafood in traditional Portuguese food; (3) upgrading the communication for the general population regarding food and nutrition; and (4) expanding the awareness of

nutrition in a diverse group of professionals along with their empowerment. A total of 14 different actions were proposed to accomplish these objectives, as shown in Table 9.

Table 9 - Overview of measures planned as part of axis 3 of EIPAS.

Axis 3: Promote and develop literacy and autonomy for the exercise of healthier consumer choices	
Measure 1	Promoting food literacy among pregnant women and parents and educating them about the importance of dietary habits in the first 1 000 days of a child's life.
Measure 2	Promoting food education strategies in schools through the promotion of the Mediterranean diet, food preparation and through better knowledge about the food production cycle.
Measure 3	Improving training of social workers who are responsible for managing food distribution programmes for low-income and less educated populations.
Measure 4	Improving training of tourism and catering professionals, in particular on the dangers of diets with excessive salt, sugar and trans fatty acids.
Measure 5	Promoting initiatives encouraging knowledge about the Mediterranean Food Chart.
Measure 6	Promoting initiatives encouraging local production and consumption.
Measure 7	Developing initiatives to complement the distribution of milk, fruits and vegetables in schools, reinforcing the School Distribution Scheme.
Measure 8	Promoting the training of canteen and cafeteria staff on healthy eating for local authorities.
Measure 9	Increasing public awareness of and knowledge about the Mediterranean diet.
Measure 10	Increasing training of canteen and cafeteria staff on incorporating fish, fruits and vegetables into meals.
Measure 11	Promoting communication campaigns to raise public awareness of the risk of excessive salt and sugar consumption.
Measure 12	Promoting initiatives that encourage healthy eating among university students.
Measure 13	Training health professionals on the importance of educating parents about the benefits of breastfeeding.
Measure 14	Training health professionals, teachers and parents on how to cultivate a preference for healthier foods in minors.

Source: Goiana-da-Silva (2018a)

Strategic area 4 – promote innovation and entrepreneurship focused on the area of healthy eating promotion

The focus of the fourth strategic area of the EIPAS is to take advantage of the

entrepreneurial capacity that already exists in the Portuguese economy and in small companies to identify initiatives that intend to change behaviours, knowledge and attitudes towards healthy eating. There are three priority areas for intervention in this fourth strategic area: (1) the use of digital media for the encouragement of healthy eating; (2) the reorientation of investigations regarding financial priorities; and (3) the upgrading of supervising systems regarding nutritional composition and food consumption. A total of 5 different actions were proposed to accomplish these objectives, as shown in Table 10 (Graça et al., 2018).

Table 10 - Overview of measures planned as part of the axis 4 of EIPAS.

	Axis 4: Promote innovation and entrepreneurship on encouraging healthy eating
Measure 1	Building an information website on fish and its nutritional value, recommending its inclusion in school meals.
Measure 2	Promoting the use of digital media in public institutions (i.e. waiting rooms, service counters) to encourage healthy eating.
Measure 3	Proposing alignment between national priorities in terms of promoting healthy eating and funding opportunities for state-funded laboratories.
Measure 4	Proposing the development of innovative and sustainable monitoring systems for analysing food intake.
Measure 5	Developing a digital platform allowing free and universal access to nutritional information on food to promote entrepreneurship.

Source: Goiana-da-Silva (2018a)

Discussion

Follow-up

The Portuguese Government decided to extend its responsibilities, regardless of whether the original working group was created with the singular objective of promoting healthy eating among the population, based on the development of a national strategy that integrates different sectors. Therefore, due to the fruitful work that resulted in the publication of the EIPAS, there was an expansion of the functions

of this group that counted on the collaboration of representatives from all government ministries and representatives from other complementary sectors, to include implementation and monitoring. The Ministry of Health was elected responsible for coordinating the group's monthly meetings and works (Goiana-da-Silva, 2018a; Portugal, 2016a).

Political priorities and challenges

On 29 December 2017, the EIPAS was published, as previously mentioned. In order to accelerate the creation of specific policies, some of the 52 political guidelines contained in the EIPAS are somewhat ambiguous to allow agreement between sectors that have a history of conflict. However, prioritization is crucial so that by 2021 it is possible to achieve the full implementation of the EIPAS' political orientation. According to personal insights, there is a set of policies considered particularly challenging by some of the main political leaders who implement the Interministerial Strategy at the Ministry of Health, as is the case with Fernando Araújo, who served as Secretary of State for Health in the Portuguese Government when the EIPAS was published. For these reasons, in the first year after the publication of the EIPAS, the most challenging policies, which were considered a priority for implementation, were as follows (Goiana-da-Silva, 2018a):

1. Implementation of a Sugar-Sweetened Beverages (SSBs) Tax tackling all sweetened drinks, for instance, energy drinks, syrups, soft drinks, powdered juice concentrates and sweetened or flavoured waters;

2. Reformulation of processed food to lower the amounts of trans fat, sugar and salt in a significant way, by elaborating a co-regulation agreement with all the Portuguese Food Sector;

3. Selection and persuasion towards the implementation of a single Front of Pack Labelling System in Portugal;
4. Review and improve legislation concerning the highest amount of salt allowed to be added to bread sold in Portugal;
5. Improve the eating habits among children by stimulating the implementation of school-based programs.

Accountability

As previously mentioned, to ensure that the entities involved were accountable and to be able to measure results, the EIPAS working group decided to increase its responsibilities, ensuring the continuous collection of information related to all of the EIPAS policies either implemented or in progress. Thus, according to the official order of implementation that has been determined by all Ministries, the working group submits a semi-annual public report regarding these data (Goiana-da-Silva, 2018a).

Limitations

The objective of this study was to describe the process of development and preliminary implementation of EIPAS using a descriptive approach based on existing official documents and my personal assessment as an active stakeholder in the development of this strategy. As such the assessment may be biased in that it does not use objective data collected within a broader theoretical work for the assessment of strategy development and implementation. Noatably, while my own involvement in the strategy development enabled the collection of valuable data to a level that is not normally available for research, the fact that I had a dual role (as researcher but also an active stakeholder in the strategy development) may imply that the assessment is biased towards my own beliefs.

Policy implications at the national level

Over time, those responsible for formulating health policies have mostly considered the sector accountable for treating diseases. For this reason, less than 1% of the Portuguese NHS budget is currently allocated to disease prevention and health promotion, both of which have been repeatedly ignored. Side by side with a low budget available to invest in resources dedicated to implementing strategies like the EIPAS, the volatility of the annual funding for public health provided by the Portuguese Government is a clear challenge for any medium/long term strategy implementation. Thus, both raising the budget available to the health promotion and disease prevention sector and developing a multiannual funding commitment for the Portuguese NHS and all its sectors to be endorsed by all parties and national political actors may be a wise pathway to take.

Despite the commitment to the implementation of the EIPAS having been demonstrated by the Portuguese Government in the early stages, it may be a challenge to maintain the existing efficacy of the EIPAS's implementation, as well as its speed and effectiveness. Given that long-term considerations can be replaced by short-term political goals, regarding a country's health care system, the greater its politicization the lesser its likelihood of effectiveness (Yeo, 2015).

As such, present and future governments must stay committed to long-term national policies with a clear vision, to avoid the prioritizing of disease treatment over prevention. Moreover, in the future, societies may be threatened by overwhelming health care challenges, unless problems that might arise are predicted and planned accordingly (Goiana-da-Silva, 2018a). If the implementation of the EIPAS is successful over the next few years, we may expect to see Portugal continue to improve its WHO

recommended NCD policy implementation scores thanks to the healthy nutrition policy indicators.

Policy implications at the global level

As referred over Chapter 1, the most important health challenges health systems face nowadays are not linked to any single disease or problem. In fact, they are related to the inability of governments to tackle multifactorial health issues like NCDs. More widely beyond NCDs, looking to the history of human kind, it is easy to realise that countries became very good at addressing specific health problems with vertical approaches such as vaccines or antibiotics. However, behavior related diseases, because they tend to be impacted by areas that go well beyond the health sector showed to be the hardest to address. The HIV pandemic is a good example of an infectious disease that, due to its behavioural determinants, was never actually solved (even though the health sector was able to develop and provide access to prevention methods and even treatment). However, the problem is multifactorial and multisecorial, therefore, unless all the different sectors directly and indirectly involved in such pandemic are commited to find a joint solution, it will be impossible to find by the health sector alone. Assuming that HIV alone has not yet been resolved worldwide, it will not be hard to understand that NCDs, being a larger group of diseases associated with multiple risk factors and impacted by several other sectors from society rather than health, shall be an even harder problem to tackle. Once again, vertical approaches relying only in the Health sector would not be effective.

This is why HiAP showed itself as a promising approach to multifactorial health hazards. HiAP is an approach to public policies across sectors that systematically takes into account the health implications of decisions, seeks synergies, and avoids harmful health impacts in order to improve population health and health equity. It

improves accountability of policymakers for health impacts at all levels of policy-making. It includes an emphasis on the consequences of public policies on health systems, determinants of health and well-being. Governments have a range of priorities in which health does not automatically gain precedence over other policy objectives.

The challenges of a HiAP approach are evident in many countries experiences in addressing NCDs. While health in all policies has been widely advocated as a key strategy to promote better nutrition, the implementation of best buys has been challenging across countries. At EU level several strategic policy documents fail to consider Health in all policies reflecting the challenges in implementation of this vision as well as the lack of sectorial and member states coordination on strategic investment and regulation that can enable HiAP successful implementation (Djojosoeparto et al., 2020).

The implementation of best buys is also challenging at national level. (Greszczuk, 2019)

For example, the Pennsylvania Fresh Food Financing Initiative a state level public private partnership developed to improve access to healthy and affordable food did not include a robust framework for impact evaluation nor a strategic plan for long term financial viability beyond the initial government funding. These challenged the continuation of the initiative beyond the political cycle and during the financial crisis in the US. (Greszczuk, 2019)

In 2011 the Hungary the ministry of health launched a tax on sugar and salt in pre-packed foods and beverages to encourage better diets and product reformulation. From the onset the legislation was strongly opposed by the food industry that responded by replacing taxed ingredients with unhealthy alternatives that were not

covered by the tax legislation. The lack of fruitful engagement with the industry towards developing a shared consensus of the scope of the policy as well as shared ownership of the strategic goal of promoting healthier diets has led to the industry gaming the policy by exploiting the legislation loopholes to their own benefit and in detriment to population health. It also resulted in the Hungarian government needing to make several revisions to the initially proposed piece of legislation (Greszczuk, 2019).

Also the experiences from countries like Ireland, Australia, New Zealand or Mexico highlight some valuable learnings and consequences of not developing health policies with a strong HiAP backbone (Harrington et al., 2020).

Against this backdrop, EIPAS is important reference case of interministerial, multirectoral national strategy that underpins best practices in targeting unhealthy nutrition as specific NCDs risk factor.

Furthermore, the uniqueness of the EIPAS strategy is the fact that it includes actionable measures and policies with different targets, scopes and ranges. Since the impact of such policies is recognized to be limited when they are implemented alone (as I shall be showing and discussing over the next Chapters of this Thesis), a strategy that integrates them together is believed to promote a potential sinergectic impact in public health.

That said, HiAP approaches such as the EIPAS might be clever routes for Ministries of Health worldwide to take in order to implement more horizontal health policy approaches through the commitment of other Government Sectors regarding health promotion and disease prevention strategies. This sort of multisectoral initiatives may

help governments reach higher WHO ‘Best Buys’ implementation scores by overcoming the lack of national consensus around certain polemic policies.

It is usually said that it is hard to evaluate the things you don’t measure or quantify. Thus, assuming the public accountability may play an essential role in keeping future political leaders committed with this sort of medium/long term strategies, indicators and regular evaluation checkpoints for public scrutiny should be defined from the beginning and, if possible, be part of the strategies themselves.

Chapter 4

Fiscal Policies: the sugar-sweetened beverages tax

Introduction

Currently, in many developed countries, including Portugal, obesity has reached such high levels that it is considered an epidemic. In Portugal alone, 34.8% of the population is in a situation of pre-obesity and 22.3% of the Portuguese population has already passed this threshold, and are considered obese (Oliveira et al., 2018). Moreover, in Portugal, this problem has reached such high proportions that 4 out of 10 children are overweight (Jorge, 2019) and, at European level, it is the country with the highest incidence of diabetes (Barreto et al., 2016).

In addition, both obesity and other adverse health-related outcomes have been associated with excessive intake of food products rich in free sugars, particularly sugar-sweetened beverages (SSBs) (Johnson et al., 2009; Luger et al., 2017; Malik, Schulze & Hu, 2006; Woodward-Lopez, Kao & Ritchie, 2011). Due to the bad health consequences, according to the WHO, this type of sugar should not exceed 10% of the total daily energy intake (WHO, 2015b). SSBs should be avoided, as they do not present any nutritional benefit other than hydration and are related to health problems, namely weight gain (Woodward-Lopez, Kao & Ritchie, 2011).

With this in mind, and in alignment with the WHO's NCD Best Buys and Recommended Policies (WHO, 2017a), numerous interventions in the area of public health have sought to reduce the intake of SSBs. Taxes have been applied on SSBs, which has proven to be an effective method in reducing consumption of this type of food product and – according to empirical and modelling studies – has helped in reducing the incidence of overweight, especially in the younger sections of the population (Cabrera Escobar et al., 2013; Briggs et al., 2013a; Briggs et al., 2013b).

According to the Food and Agriculture Organization of the United Nations (FAO, 2016), information about a country's food system is obtained through its food balance sheets. These food balance sheets allow the evaluation of changes in the type of food consumed, trends in the food supply at the national level and the extent to which food supplied is in line with nutritional requirements. Considering the information provided by the Statistics Portugal Food Balance Sheet, during the period 2013-2014, the per capita availability of sugar in Portugal was 34.4 kg/year, which translates to 375 kcal of sugar per day (Statistics Portugal, 2014). Compared with the maximum sugar intake recommended by the WHO, these data reveal that in Portugal the availability of sugar per capita is practically double, which emphasises the urgent need to create interventions in the area of public health to tackle this problem.

Also, and according to data from the *Inquérito Alimentar Nacional e de Atividade Física* (IAN-AF) 2015–2016, the recommended daily sugar intake is estimated to be exceeded by approximately 24.4% in the Portuguese population, and individual consumption is close to 31.2 grams/day (Marinho et al., 2019)**.** More worrying is the fact that these levels of consumption are even higher in the younger sections of the population, especially the age group of adolescents, in which 49.1% of girls and 51.1% of boys ingest more than the recommended dose of 200 kcal of sugar per day (Marinho et al., 2019). Furthermore, between the years of 1990 and 2012, the consumption of SSBs doubled in Portugal (Statistics Portugal, 2014) and in the period 2015-2016 more than 220g per day of SSBs and juices were consumed by 18% of the population, whereas in adolescents this percentage was even higher (42%). Also, about 25% of the population that regularly consumes this type of drink admits consuming about 660ml of SSBs per day (equivalent to 2 cans) (Lopes et al., 2018). According to several studies, it is not only adults who consume this type of soft drinks,

but also very young children. In fact, in Portugal, a cohort study revealed that these drinks are consumed weekly by 88% of children aged 4 and by 35% of children aged 2 (Vilela et al., 2014).

To be able to respond to the high levels of consumption of SSBs at the national level, on 1 February 2017, the Portuguese government decided to include in the State Budget for 2017 the introduction of a special consumption tax charged on SSBs (Portugal, 2016b). This levy, called the 'sugar tax', allowed a window of 2 months during which drinks that were already in stock were not taxed. This tax referred to all drinks that had added sugar or other sweeteners, thus covering all SSBs. On the other hand, drinks with nutritional value, such as fruit juices, milk or other dairy alternatives - rice, soy, hazelnut, almond or coconut drinks, etc. - as well as beverages considered food supplements or considered food for special dietary needs, were not covered by this tax. It should be noted that alcoholic drinks were not covered.

For beverage concentrates, the taxable unit accounted for the sugar content of the reconstituted drink. For the remaining SSBs, the taxable unit was hectolitres of the final product sold. Moreover, according to the sugar content in the beverages, the tax was structured into 2 tiers to encourage reformulation by changing beverages from the highest level of taxation to the lowest. For this, drinks that had high sugar levels (equal to or greater than 80 grams per litre) were taxed at 16.69€/hectoliter of finished product, while drinks with lower sugar content (up to 80 grams per litre) were taxed at 8,22€/hectoliter of finished product.

There are two fundamental processes for reducing sugar consumption through this type of beverage. The first concerns initiatives such as the reformulation of products, by which it is possible to reduce the amount of sugar available on the market. The

second is related to the decrease in consumer demand, which is achieved by increasing the price of these products – promoting the choice of healthier alternatives – and by increasing awareness of the negative impact that SSBs have on health.

According to preliminary data regarding the implementation of the sugar tax in Portugal (Goiana-da-Silva, 2018b; Goiana-da-Silva, 2018b), there was a significant impact on the SSB market due to the introduction of this levy, which resulted in an estimated 7% drop in sales. In addition, there was a reduction of around 11% in energy intake from SSBs, due to the reformulation of several products. Interestingly, it appears that 27 deaths caused by excessive sugar consumption might have been avoided or postponed due to reduced sales (decreased consumption) and reformulation (reduced energy density) of these products (Goiana-da-Silva, 2019d). This research intends to analyse in more detail the health benefits resulting from the sugar tax, through the evaluation of its impact on the incidence of obesity.

According to meta-analysis from 2016 (Vilela et al., 2014), the ratio between energy intake from SSBs and total food consumed (in grams) – called SSBs energy density – measured as the dietary energy density (DED) of SSBs, is associated with both excess adiposity (OR 1.27, 95% CI 1.04–1.55) and increased body mass index (BMI) (odds ratio [OR] 1.13, 95% CI 1.00– 1.27). Taking this into account, it would be expected to see a reduction of the DED in the population, as a result of the sugar tax. Therefore, this work also modelled the impact of reformulation alone on the incidence of obesity, given that it is often argued that voluntary reformulation may result in similar benefits. Importantly, this estimate does not consider any reduction in sales that may result from the taxation of SSBs. Furthermore, as with the demand for this type of beverage – which can be affected by both the product formula and price – it is difficult

to fully separate the impact of each factor involved so that it can be assessed individually.

Despite it being challenging to directly measure the effect of populational interventions on health outcomes due to the various cofounding factors involved, these types of interventions have repeatedly proven to be more effective than those directed at individuals (Zulman et al., 2008). One example is the difficulty in distinguishing the effect of SSB taxation from other factors that may be affecting obesity levels in the population. In this sense, statistical modelling is often used as a method to determine the impact of an intervention at the population level. By calculating the potential impact fraction (PIF), it is possible to estimate the proportional reduction in obesity levels that result from a specific intervention at a population level rather than at an individual-level (Drescher & Becher, 1997). Here the PIF is used to quantify avoided cases of obesity resulting from the reduction of DED.

- **Hypothesis**

Mandatory regulations such as the Sugar-Sweetened Beverages Tax are effective in tackling NCD.

Objectives

The aim of this chapter is to estimate how the impact of the reduction in sales (or consumption) and the reformulation of products – both resulting from the sugar tax implemented in Portugal – impacted the incidence of obesity across different age groups.

Methods

For these following sections, the methodology used is as described in Goiana-da-Silva et al. (2020b).

Data sources

To carry out this work, several sources of information were used, including: (i) data regarding tax revenues from 2017 to 2018 offered by the Portuguese Ministry of Finance/Tax and Customs Authority; (ii) data regarding individual dietary consumption available from IAN-AF 2015–2016 (Lopes et al., 2018a; Lopes et al., 2018b); (iii) data from GlobalData provided by the Portuguese Association of Non-Alcoholic Drinks (PROBEB), regarding the annual sugar content of SSBs according to each product; (iv) Nielsen Consumer Panel data from the period of 2013 to 2018 (delivered by PROBEB) comprising sales of SSBs in the Portuguese market; and (v) data on obesity incidence according to age group from several Portuguese cohorts, including EPIPorto (Ramos, Lopes & Barros, 2004), EPITeen (Ramos & Barros, 2007), and Generation XXI (Freitas, Moreira & Santos, 2018; Larsen et al., 2013).

In order to create a monthly sales panel, sales and tax revenue data were used. Subsequently, to estimate the trend for DED, this information was linked to data from both SSBs sugar content and individual diet. Finally, an estimate was made regarding the impact of DED from SBBs on the incidence of obesity in individuals belonging to different age groups.

Trends of SSBs sales and sugar content

The information collected regarding SSBs tax revenues from the Tax and Customs Authority and information regarding retail sales from the Nielsen Consumer Panel were used to estimate the trends in sales of SSBs (in volume). The Nielsen Consumer

Panel comprises monthly information regarding retail sales at the product level, for instance, total sales (€) and volume sold (litres). The data is then structured according to the segment, beverage carbonation, brand, sub-brand, producer, category, flavour and market share of the product. Importantly, since it only reports aggregate sales of specific items, the Nielsen Consumer Panel does not have information regarding the demographics of buyers of certain products.

For this analysis, a sample that covered the period between 2013 and 2018 was used, excluding all brands that are considered white-label brands and selecting all private label brands, which comprises around 67% of the Portuguese SSBs market share. Note that white labelling is when a company uses branding requested by the buyer/retailer instead of the branding of the producer itself on the final product. The sample under study included 125 commercial brands and 5,030 products. Regarding Portugal, the Nielsen Consumer Panel registers a total of 100% of hypermarket sales (100/100), a total of 96% of big supermarkets sales (410/427), 89% of small supermarkets sales (1,013/1,130), close to 3% of traditional local stores sales, and also around 0.76% of hotels, restaurants, and coffee shops sales (550/72,538).

Given that only 67% of the market is covered by Nielsen data, despite having more detail than tax revenue data, the latter was used since it covers all SSBs sales in the Portuguese market, 100% of the Portuguese SSBs market share, albeit at an aggregated level. These data were used to calibrate the Nielsen data and consist of monthly tax revenues per taxation tier (drinks with less than 80g of added sugar per litre and drinks with at least 80g of added sugar per litre). It should be noted that the tax revenue data is only available from January 2017 – when the tax was implemented – until 2018 and for this reason, it was not possible to use this type of data for all analyses performed.

Furthermore, sales data was compared to data from GlobalData regarding sugar content to estimate the trend of the sugar content of SSBs. Importantly, the data set provided by GlobalData includes evolution data communicated directly by each of the SSBs producers to GlobalData during the period between 2013 and 2018 and contains the sugar and energy content evolution for each SSBs brand, sub-brand, and flavour identified in the Nielsen retail sales data.

From the year 2016, data related to SSBs' sugar and energy content (grams/100 ml) from GlobalData were combined – by brand and flavour descriptors – with the SSBs consumption of every single person, from IAN-AF 2015–2016 (Lopes, 2018a; Lopes, 2018b). The data available from IAN-AF 2015–2016 were used to establish the baseline of total food consumption and the equivalent data on the average sugar and energy intake from SSBs along with the consumption of this type of beverages. Succinctly, the Portuguese population aged 3 to 84 years was included in the survey through a representative sample selected from the national health registry by multistage sampling. Using two 24-hour recalls with an interval of 8 to 15 days, data were collected from 5,811 individuals regarding complete dietary data, which were complemented by a food propensity questionnaire. Subsequently, according to the previously established baseline, the average sugar and energy consumption from SSBs was estimated according to the reduction rate observed either in sugar content or in retail sales data (GlobalData) in the subsequent years. Finally, to estimate the baseline DED according to age group, the total quantity of food consumed by each individual was used.

Obesity incidence

In order to estimate the incidence of obesity, data from Portuguese cohorts conducted with individuals of different age groups, including adults (EPIPorto) (Ramos, Barros & Lopes, 2004), adolescents (EPITeen) (Ramos & Barros, 2007) and children (Generation XXI) (Freitas, Moreira & Santos, 2019; Larsen et al., 2013) were used. The first cohort (EPIPorto) included a study population of 2,485 adults aged between 18-90 years at baseline living in the city of Porto, recruited during the period of 1999–2003 by random digit dialling. In turn, the EPITeen cohort has a study population of adolescents, including those born in 1990 and attending public and private schools in Porto, Portugal, during the period of 2003–2004. For this cohort, 2,159 adolescents who had 13 years of age at baseline were recruited. Finally, Generation XXI is a birth-based cohort comprising a total of 8,647 live new-borns registered during the period between April 2005 and August 2006 at public maternity units from the metropolitan area of Porto, Portugal.

Data analysis

To be able to evaluate the impact of the sugar tax that was implemented in Portugal on the incidence of obesity, its impact on consumption was estimated, which is represented by sales. Subsequently, these estimated consumption values were used to calculate how the DED evolved during the period from 2016 (reference year for pre-taxation) to 2018 (post-taxation).

In order to be able to estimate the individual DED, as well as the number of cases prevented in three counterfactual scenarios and the PIF, data was obtained on: (1) trends in SSBs' consumption proxied by market data; (2) the association between obesity and DED, using literature sources; (3) individual dietary intake, namely the total amount of food consumption as well as sugar and energy from SSBs, to estimate

the DED; (4) incidence of obesity in individuals belonging to different age groups. Using information from the IAN-AF 2015–2016 (Lopes, 2018a; Lopes, 2018b), the baseline DED was calculated from SSBs at an individual level, taking into consideration the total SSBs energy intake (kcal/gram) by an individual divided by the total amount of food consumed by the same individual (in grams), using the formula that follows:

$$\mathrm{DED}_i = \frac{\text{SSB energy intake}_i}{\text{total amount of food consumption}_i}$$

In the estimate, the consumption of SSBs was considered by brand. In the case of beverages with missing information related to the brand (18.9% of the cases), multiple imputations were made and the joint prevalence of the five numbers generated was considered. Regarding the first, the inputted values were generated in accordance with the prevalence of brands within each kind of drink. In addition, to join the prevalence of each brand from each imputed dataset into the global multiple imputation estimates and the corresponding associated standard error, the rules of Rubin was used (Marshall et al., 2009).

Regarding the counterfactual scenarios mentioned above, the first, taking into account the baseline information on individual consumption (IAN-AF 2015–2016), keeps the volume consumed constant, considering only the reduction in sugar content resulting from the reformulation of the product that took place in 2017. On the other hand, as described below, the second counterfactual scenario, based on the observed retail sales data obtained from the Nielsen Consumer Panel of total SSBs sales, includes changes in both sugar content and SSBs sales volume calibrated with information from tax revenues. Finally, the third counterfactual scenario, using only information related to tax revenue, includes changes in both sugar content and SSBs sales volume. Taking this into consideration, it was expected that of the three

counterfactual scenarios, the second would be closest to the predictable natural trend of consumption from the taxation policy. Also, regarding the impact of tax policy, the first counterfactual scenario is the one that provides the least potential value, while the third scenario is the one that provides the greatest potential impact.

In order to obtain the trend of SSBs sales volume, a trigonometric linear regression model (model 1) was used since there is a seasonality effect of the sales volume of SSBs (V_t) from both the Nielsen market and tax revenue data. Importantly, this model has been separately applied to data from the Nielsen market and tax revenue. The formula of the model is described below:

$$V_{td} = \beta_{0d} + \beta_{1d} Y_t + \beta_{2d} \sin\left(\frac{M_t - 1}{12} 2\pi\right) + \beta_{3d} \cos\left(\frac{M_t - 1}{12} 2\pi\right) + \epsilon$$

In this formula V_{td} stands for data source, where d represents the sales from the Nielsen market data ($d = m$) and from the tax revenue data ($d = r$). The estimation of the linear trend by year is given by the first and second terms of the formula ($\beta_{0d} + \beta_{1d} \times Y_t$). On the other hand, the estimation of the seasonal trend by month, $s(M_{td})$, is given by the third and fourth terms of the formula, as follows:

$$\left(s(M_{td}) = \beta_{2d} \sin\left(\frac{M_t - 1}{12} 2\pi\right) + \beta_{3d} \cos\left(\frac{M_t - 1}{12} 2\pi\right)\right)$$

Using the estimated coefficients from model 1, a linear projection was adopted for the missing tax data in the period regarding pre-taxation. Likewise, using those estimated coefficients, a linear projection was assumed for the period after 2017, given that the market data was not complete for 2018. Moreover, a calibration was performed to represent the total volume for the Nielsen market data. Despite allowing for a more disaggregated analysis, the Nielsen market covers only 67% of the market data, representing only private label products. On the contrary, assuming that the payment

of taxes and tax declaration is complete and accurate, tax revenue data, also referred to as tax data, represent all SSBs.

Using the following model, it was possible to estimate the calibration of the Nielsen market data **($\widehat{V}_{tm}$)**:

$$V_{tr} = \beta_{0c} + \beta_{1c}\widehat{V}_{tm} + \epsilon \text{ (model 2)}$$

In order to estimate the percentual variation in the volume of SSBs sales corresponding to the period between 2016 (baseline pre-taxation year) and 2018 (post-taxation year), the $\widehat{\beta_{0m}}$, $\widehat{\beta_{1m}}$, , $\widehat{\beta_{0c}}$ and $\widehat{\beta_{1c}}$ were used to calibrate the Nielsen market data. Afterwards, those estimates were used in the counterfactual scenario 2, from the period ranging from 2016 to 2018 **($PPVSSB_2$)**, as follows:

$$\begin{aligned} \text{PPVSSB}_2 &= \frac{\widehat{V}_{tr=2018}}{\widehat{V}_{tr=2016}} \times 100 = \frac{\widehat{\beta_{0c}} + \widehat{\beta_{1c}}(\widehat{V}_{tm=2018})}{\widehat{\beta_{0c}} + \widehat{\beta_{1c}}(\widehat{V}_{tm=2016})} \times 100 \\ &= \frac{\widehat{\beta_{0c}} + \widehat{\beta_{1c}}(\widehat{\beta_{0m}} + \widehat{\beta_{1m}}2018 + \text{s(Month} = 6))}{\widehat{\beta_{0c}} + \widehat{\beta_{1c}}(\widehat{\beta_{0m}} + \widehat{\beta_{1m}}2016 + \text{s(Month} = 6))} \times 100 \end{aligned}$$

After calibrating ($\widehat{\beta_{1c}}$ x $\widehat{\beta_{1m}}$,), to calculate the 95% confidence intervals (CIs) for the estimate regarding the reduced sales volume of SSBs, the Sobel formula was used (Marshall et al., 2009)**.**

In order to estimate the percentual variation of SSBs sales volume using tax revenue information from the period between 2016 (baseline pre-taxation year) and 2018 (post-taxation year), the estimated $\widehat{\beta_{0r}}$ and $\widehat{\beta_{1r}}$, from model 1 were used. Afterwards, those estimates were used in the counterfactual scenario 3, from the period ranging from 2016 to 2018 **($PPVSSB_3$)**, as follows:

$$\mathrm{PPVSSB}_3 = \frac{\widehat{V}_{tr=2018}}{\widehat{V}_{tr=2016}} \times 100 = \frac{(\widehat{\beta_{0r}} + \widehat{\beta_{1r}} \times 2018 + \mathrm{s}(\mathrm{Month} = 6))}{(\widehat{\beta_{0r}} + \widehat{\beta_{1r}} \times 2016 + \mathrm{s}(\mathrm{Month} = 6))} \times 100$$

Moreover, using the estimated coefficients from models 1 and 2, a linear projection was assumed for the period following 2017.

Also, by multiplying SSBs individual intake over $PPVSSB_2$ and $PPVSSB_3$, the SSBs individual intake was estimated for counterfactual scenarios 2 and 3, respectively. As explained above, these projections were used to compute the SSBs DED. Using the 5th, 25th, 50th, 75th and 95th percentiles, obtained from usual intake distribution (SPADE) (Fletcher, Frisvold & Tefft, 2010a), the SSBs DED was then divided into 6 categories. Afterwards, to estimate the relative risk (RR) for each DED category, the SSBs DED was used according to the following formula:

$$\mathrm{RR}(x) = exp(ln(a) \times x)$$

In this formula, $\boldsymbol{x}$ stands for the value of DED regarding the upper limit of the category. This applies for all categories apart from the last, for which $\boldsymbol{x}$, instead of the upper limit, stands for the lower limit plus the amplitude of the previous interval. Finally, $\boldsymbol{a}$ stands for the association between obesity and DED. This information was retrieved from a meta-analysis that merged data from 23 prospective cohort studies (a = 1.13) (Rouhani et al., 2016).

Subsequently, using the RR shift formula, it was possible to compute the PIF, using the RRs estimates, according to the following formula:

$$\mathrm{PIF} = \frac{\sum_{c=1}^{n} p_c \mathrm{RR}_c - \sum_{c=1}^{n} p_c \mathrm{RR}_c^*}{\sum_{c=1}^{n} p_c \mathrm{RR}_c}$$

In this formula, p_c stands for the proportion of the population in category c, RR_c is the RR for category c for the baseline of SSBs DED and RR_c^* stands for the RR of category c for the counterfactual scenario of the dietary intensity that is related to the consumption of SSBs. With the following formula it was possible to calculate the number of prevented cases:

$$n = \text{PIF} \times N \times I_p$$

In this formula, n stands for the number of individuals in the study population. This information, sorted by age category, was obtained from census data. Meanwhile, I_p stands for the incidence of obesity in the study population. This information, along with the respective 95% Cis, was obtained from the previously mentioned Portuguese cohorts (Camões et al., 2010; Larsen et al., 2013; Ramos & Barros, 2007; Ramos, Lopes & Barros, 2004).

Importantly, there is no assumption of additional reformulations or changes beyond the taxation of SSBs in the estimates made for the number of obesity cases prevented. It should also be noted that this work does not have a prospective study protocol. Additionally, there were no data-driven changes to the analyses, and all analyses have been carried out in accordance with what was originally planned. Finally, although revisions were made to the manuscript, according to the suggestions provided by the reviewers, these did not change the nature, or the scope of the analyses carried out.

Results

Using market data, a significant quadratic trend of the average energy intake from SSBs ($p < 0.001$) by SSBs product is evident, as illustrated in Figure 14. Considering the period between 2013 and 2018, it appears that until 2016 the average estimates

exhibited very stable behaviour. However, since then there has been a decrease, going from 24.3 kcal/100ml in 2016 to 21.2 kcal/100ml in 2018. Moreover, it was possible to verify that the linear trend (in kcal/100 ml/year) observed until the year 2016 was not significant (β = −0.14, 95% CI −0.43 to 0.14), through the application of a linear spline with a knot in the year 2017. On the other hand, from 2016 till 2018 there is a significant linear decrease (β = −3.34, 95% CI −4.64 to −2.03).

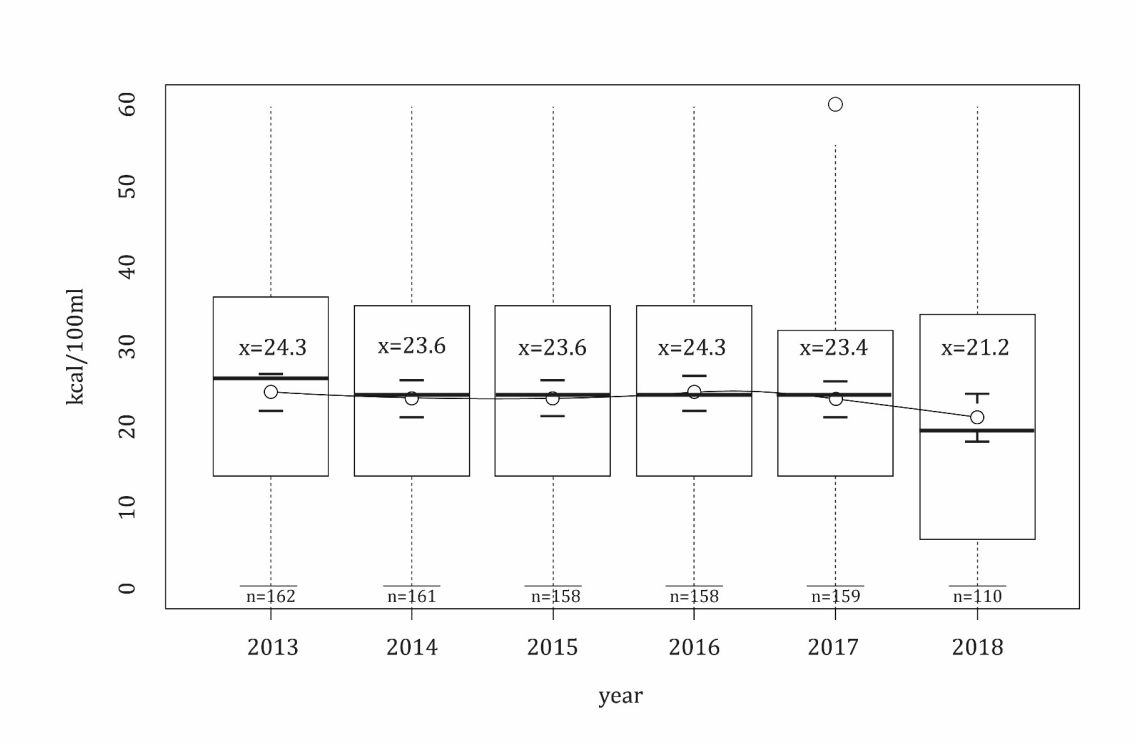


Figure 14 - Time trend of the average energy intake from SSBs (in kcal/100ml) per SSB product, using market data.

Source: Goiana-da-Silva (2020b)

In turn, Figure 15 illustrates the time trend of the total sales of SSBs according to different data sources. In a first step, the sales volume measured by Nielsen market data regarding the period between 2016 and 2018 (solid red line) was used along with the corresponding values estimated by model 1 (dashed red line). However, to have a more accurate projection for the entire period under analysis (dashed dark grey line), and given that only 67% of the market is covered by the Nielsen Consumer Panel, data from tax revenues for the years 2017 and 2018 in model 1 (solid black line) were

also used. Finally, model 2 comprises calibration of market data to the total sales volume using tax information (dashed light grey line).

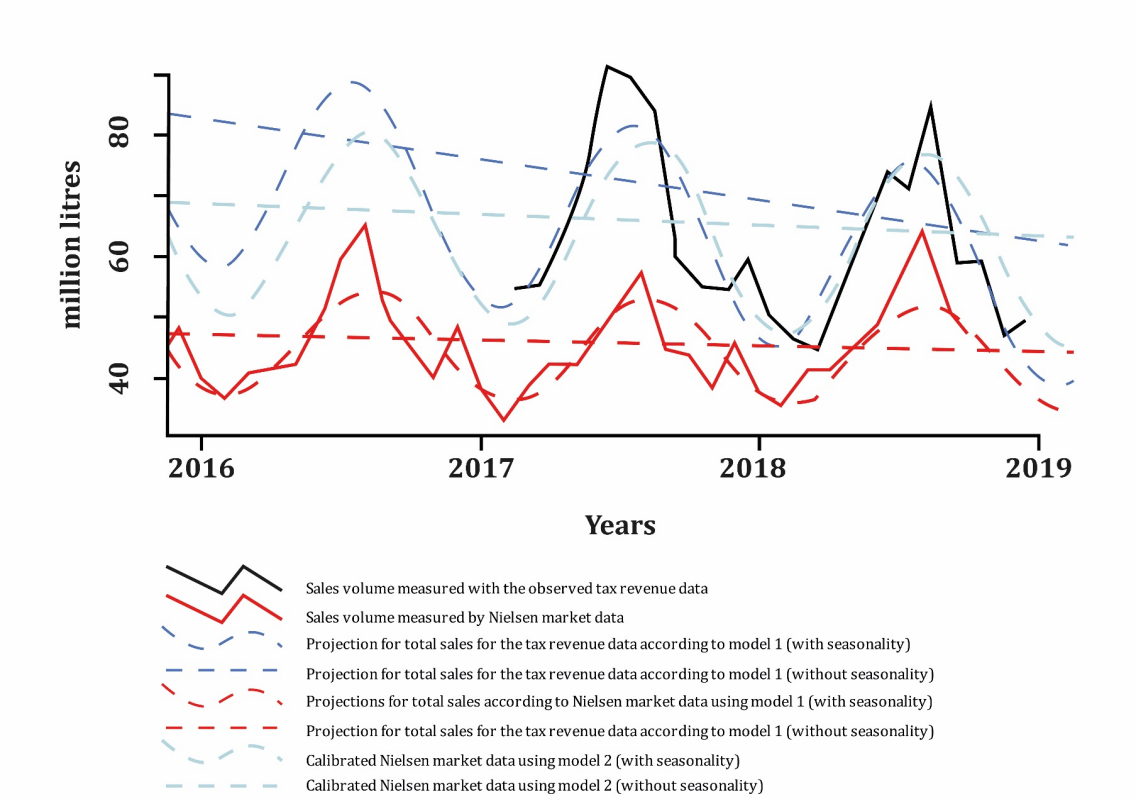


Figure 15 - Time trend of total sales of SSBs according to different data sources.

Notes: Time trend of sales of SSBs measured with the observed tax revenue data, only available post-tax (solid black line), and measured by Nielsen market data, available for the entire period 2016-2018 (solid red line); projections for total sales from the tax revenue data according to model 1 (dashed dark grey line with and without seasonality); projections for total sales according to market data using model 1 (dashed red line with and without seasonality); and calibrated Nielsen data from model 2 (dashed light grey line with and without seasonality). Dashed curves represent the data with seasonality, while straight lines represent data without seasonality.
Source: Goiana-da-Silva (2020b)

It should be noted that the final trends in these estimates were adjusted since seasonality has shown to have a strong impact on the observed temporal trend for SSBs consumption, as shown in Figure 15. After taking this seasonality effect into account and making the necessary adjustments, it was possible to observe a decrease

of 0.95 million litres per year (95% CI 0.16 to 1.74), using market data (linear red line), while a reduction of 6.58 million litres per year (95% CI 0.25 to 12.90) was observed, using tax data (linear blue line). There was also a reduction of 1.73 million litres per year (95% CI 0.20 to 3.25), regarding the calibration of market data (linear green line). Taking all this into account and comparing with the baseline consumption data of IAN-AF 2015–2016, it appears that these results correspond to a percentage reduction in consumption of 21% for tax data and 11% for market data.

Distributed according to the age group, Table 11 shows the percentage of DED from SBBs, both for the baseline year (2016) and for the 3 counterfactual scenarios previously mentioned (2018). Starting by considering the baseline year of 2016, which was the beginning of the study, the median DED had a higher value (1.24%) in the age group corresponding to adolescents (10 to <18 years). Regarding the 3 different counterfactual scenarios of the year 2018, the adolescents' age group continues to show the highest estimates of DED from SSBs. However, as expected, these estimates decrease as a result of either product reformulation or sugar reduction (1.19%), as well as the result of product reformulation and sales reduction (1.07% in the case of scenario 2 and 0.94% in scenario 3).

Table 11 - Dietary energy density from SSBs in 2016 (baseline) and 2018 (counterfactual scenarios), by age group.

Scenario and age group	Dietary energy density from sugar-sweetened beverages (%)					
	Mean	5th percentile	25th percentile	50th percentile	75th percentile	95th percentile

2016 (baseline)						
Total	1.13	0.00	0.03	0.38	1.52	4.63
0 to <10 years	0.92	0.00	0.02	0.26	1.18	04.01
10 to <18 years	1.93	0.04	0.41	1.24	2.70	6.15
18 to <65 years	1.24	0.00	0.07	0.51	1.70	4.83
≥65 years	0.42	0.00	0.00	0.02	0.31	2.32
2018 (counterfactual 1)*						
Total	1.09	0.00	0.03	0.37	1.47	4.48
0 to <10 years	0.89	0.00	0.02	0.25	1.14	3.88
10 to <18 years	1.87	0.03	0.39	1.19	2.60	5.96
18 to <65 years	1.20	0.00	0.06	0.49	1.64	4.67
≥65 years	0.41	0.00	0.00	0.02	0.30	2.24
2018 (counterfactual 2)**						
Total	0.98	0.00	0.03	0.33	1.32	4.02
0 to <10 years	0.80	0.00	0.02	0.23	1.02	3.48
10 to <18 years	1.68	0.03	0.35	1.07	2.34	5.36
18 to <65 years	1.07	0.00	0.06	0.44	1.47	4.19
≥65 years	0.37	0.00	0.00	0.01	0.27	2.01
2018 (counterfactual 3)***						
0 to <10 years	0.71	0.00	0.02	0.20	0.90	03.06
10 to <18 years	1.48	0.03	0.31	0.94	2.06	4.71
18 to <65 years	0.95	0.00	0.05	0.39	1.30	3.69
≥65 years	0.32	0.00	0.00	0.01	0.23	1.77

*Counterfactual 1 considers sugar reduction due to product reformulation.

**Counterfactual 2 considers sugar reduction due to product reformulation and sales decrease, using market data adjusted by tax information.

***Counterfactual 3 considers sugar reduction and sales decrease, using only unadjusted tax information.

Source: Goiana-da-Silva (2020b)

As shown in Table 12, regarding the first counterfactual scenario, only the reformulation of SSBs was considered – mainly in terms of reducing sugar levels – to estimate the number of cases of obesity prevented and the PIF, by age group. Considering the PIF, it was higher in the age group of adolescents (0.012%), translating into the prevention of 0.76 cases of obesity per year. On the other hand, in the age group of adults spanning from 18 to < 65 years, the impact fraction was 0.008%, corresponding to a higher number of yearly prevented cases of obesity (6.83). Moreover, a similar trend was observed when the PIF was estimated considering the reduction in sugar content and sales, both for the counterfactual scenario 2 - using market data adjusted according to tax revenue information and for the counterfactual scenario 3 using only tax information. Considering the age group of adolescents, in the counterfactual scenario 2, the PIF was 0.045%, corresponding to 2.93 cases of obesity prevented per year, while in the counterfactual scenario 3 the PIF was 0.089%, corresponding to 5.82 cases of obesity prevented per year. Finally, taking into account the counterfactual scenario 3, the age group with the lowest PIF (0.023%) was that of the elderly aged 65 and over. On the other hand, following the group of adolescents, the age group with the highest FIP was that of adults (0.062%), followed by children (0.049%).

Table 12 - Potential impact fraction (PIF) and prevented obesity cases due to the decrease in sugar content of SSBs (counterfactual 1) and due to decreases in sugar content and consumption volume (counterfactuals 2 and 3).

Scenario and age group	Cohort Study	Obesity incidence /100 persons/year (95%CI)	National population size*	PIF (%)	Prevented obesity cases per year
Counterfactual 1					
0 to <10 years	GXXI	1.76 (1.62, 1.90)	913,211	0.006%	0.98

10 to <18 years	EPITeen	0.61 (0.43, 0,83)	1,076,983	0.012%	0.76
18 to <65 years	EPIPorto	1.36 (1.06, 1.72)	6,115,151	0.008%	6.83
≥65 years	EPIPorto	2.62 (1.82, 3.61)	2,194,959	0.003%	1.83
Total					10.39
Counterfactual 2					
0 to <10 years	GXXI	1.76 (1.62, 1.90)	913,211	0.024%	3.91
10 to <18 years	EPITeen	0.61 (0.43, 0.83)	1,076,983	0.045%	2.93
18 to <65 years	EPIPorto	1.36 (1.06, 1.72)	6,115,151	0.032%	26.24
≥65 years	EPIPorto	2.62 (1.82, 3.61)	2,194,959	0.013%	7.29
Total					40.37
Counterfactual 3					
0 to <10 years	GXXI	1.76 (1.62, 1.90)	913,211	0.049%	7.82
10 to <18 years	EPITeen	0.61 (0.43, 0.83)	1,076,983	0.089%	5.82
18 to <65 years	EPIPorto	1.36 (1.06, 1.72)	6,115,151	0.062%	51.35
≥65 years	EPIPorto	2.62 (1.82, 3.61)	2,194,959	0.023%	13.34
Total					78.33

*Counterfactual 1 considers sugar reduction due to product reformulation only.

**Counterfactual 2 considers sugar reduction due to product reformulation and sales decrease, using market data adjusted by tax information.

***Counterfactual 3 considers sugar reduction and sales decrease, using only unadjusted tax information.

Source: Goiana-da-Silva (2020b)

Discussion

The data obtained through the analyses carried out show that there was a reformulation of products to reduce levels of sugar content, and there was also a decrease in the number of SSBs sales. Thus, the SSBs tax that was implemented in Portugal managed to fulfil its objective. In addition, according to the modelling analyses carried out, in the medium and long term it is estimated that there will be a positive effect on the incidence of obesity in the population, resulting from the sugar tax that was implemented in Portugal. Not only was there a 3.1 kcal per 100 ml reduction of the average SSBs' energy density, but it was also estimated a 21% drop in the volume of SSBs sales, which corresponds to 6.6 million litres per annum.

Nevertheless, several factors can determine the extent to which this fiscal intervention can impact health outcomes such as obesity. Some of these factors include: the level of consumption of SSBs, the price of these products, obesity prevalence, the initial baseline tax, and the magnitude of the tax. Considering the observed market changes, in the medium term, it is estimated that 40 to 78 new cases of obesity in Portugal might be prevented every year, thanks to the reduction in sugar intake resulting from the implemented tax.

Nevertheless, these numbers must be criticaly analysed. In fact, counterfactual 3, that results in the biggest number of estimated averted cases of obesity, uses aggregate tax data rather than product level sales, therefore such data does not enable to measure at product level the amount of sugar reduction nor change in volumes consumed. What was done was to consider the average sugar reduction observed in Nielsen across all products and that was applied to the tax data. However, that can lead to biased estimates in what sugar reduction and volumes of products sold variantions were by product. Therefore, it is likely that the bias resulting from counterfactual 3 is towards an overestimation of the total sugar reduction/consumed because some products that we know are high volume in terms of sales are likely to have experienced a sugar reduction that is below the average of the reduction across all products (e.g., Coca Cola original). Therefore, counterfactual 2 is believed to be the closer to the reality.

Furthermore, it should be noted that although this numbers look small, they show that even by impacting the consumption of a single group of unhealthy products, it is possible to improve the health status of citizens, and more precisely the yonger generations. Therefore, this finding supports the idea that tackling unhealthy diets must allways be a multiple policies approach. Therefore, sugar tax applied to SSBs

shall only be a starting point. Nevertheless, preventing obesity in the early stages of life cicles may have important impacts on National Health Services savings. This is because obese citizens shall have bigger lifetime spending with health care (both directly and inderactly related to obesity and overweight) than normal weight citizens. The savings resulting from obesity prevention are not limited to the health sector. They also impact labour absentism reduction, work productivity improvements, among others. Future studies shall analyse the real annual and lifetime spendings of an obese patient in Portugal and their impact on the Portuguese NHS budget. This will allow to better compare the economic burden of taxation policies and the social savings decorring from them.

It is important to stress that the projected impact of the levy implemented in Portugal - mediated through reduced consumption and reformulation of product - is in fact 4 to 8 times greater than what would be with only the reformulation. This finding is very relevant if one takes into consideration that an augument often used by the SSBs industry in order to disregard the need for fiscal policies is the assumption that they can achieve similar results to taxation by voluntary product reformulation. Such comparison between the health outcomes of product reformulation only and product refeormulation associated with volume consumption decrease was not find in the available literature, and therefore it is an important innovation.

Regarding the fraction of dietary energy resulting from SSBs, it is in the age group of adolescents (10 to <18 years of age) that the greatest contribution of these drinks to energy consumption is observed. Likewise, it is in this age group that the decrease in obesity incidence is more pronounced. Therefore, adolescents had the highest fraction of dietary energy resulting from SSBs but also the lowest baseline incidence of obesity. Finally, the group of children (0-10 years old) and the group of the elderly

(≥65 years old), which had low baseline intake of SSBs but the highest baseline incidence of obesity, showed the lowest projected impact.

Comparison with other research

Studies evaluating the effectiveness of the levies implemented on SSBs in several countries, both before and after the introduction of taxes, use substantially different methods from each other. To assess the effectiveness of a sugar tax, most studies conducted to date focus on changes in SSBs' prices and sales (Alvarado et al., 2019; Barrientos-Gutierrez et al., 2017; Caro et al., 2018; Capacci et al., 2019; Falbe et al., 2016; Fletcher, Frisvold & Tefft, 2010a; Fletcher, Frisvold & Tefft, 2010b; Lee et al., 2019; Teng et al., 2019; Vall Castell, 2018). In turn, the approach of studies with children, adolescents and adults conducted in the USA, combines SSBs sales data with information gathered from the National Health and Nutrition Survey, namely direct measurements of BMI. Moreover, in the US studies, the variation in calorie intake from SSBs was assessed (Fletcher, Frisvold & Tefft, 2010a; Fletcher, Frisvold & Tefft, 2010b). In Mexico, the impact on the prevalence of obesity in the population following the implementation of the sugar tax in that country was evaluated using estimates that resulted from converting sales data into calories combined with BMI. This is the only study that assessed how taxes can trigger a reduction in sugar intake, and that combined these estimates with obesity results on a national scale.

In 2013, a meta-analysis on sugar taxes was published showing mixed results, with two of the studies selected for the meta-analysis reporting an increase in obesity indicators resulting from taxes, while the remaining 6 studies reported a decrease (Cabrera Escobar, 2013). Another 2013 study, this time in the UK, predicted a 0.9% decrease in the prevalence of overweight and a 1.3% reduction in the prevalence of obesity through the modelling of a 20% tax, and showed a more pronounced effect in

the younger sections of the population, comparable to the results of this study (Briggs et al., 2013). It should be noted that the sugar tax was only implemented in the United Kingdom after this study was carried out, and therefore the results of the implementation of the tax are still unknown. In 2016, to assess the effectiveness of the sugar tax at combating the obesity burden in middle-income countries, a review was made that took into account 3 studies: 1 from South Africa and 1 from India – both modelling studies – and 1 experimental study from Peru. The first two studies showed a 3% decrease in overweight prevalence and obesity, while the latter – a more experimental study - showed an increase of 0.9%. Contrary to what happened in the studies from South Africa and India, the study carried out in Peru had a sample that included only women aged between 19 and 49 years old and therefore was not representative of the whole population. While the two modelling studies applied a tax of 20%, in the Peruvian study this rate was only 10%, which has previously been shown to be ineffective (to be effective, the tax must be greater than 20%) (Encarnação et al., 2016). With this in mind, at least some of the discrepancies noticed in the findings can be explained.

A modelling study carried out in Germany showed a decrease of 4% in overweight and of 3% in obesity, resulting from the implementation of a 20% tax on SSBs, with the biggest benefit being estimated for men aged between 20 and 29 years old (Schwendicke & Stolpe, 2017). Consistent with the present research, in a study carried out in Mexico, models were also defined to predict changes in obesity by comparing the caloric intake from SSBs, before and after the implementation of taxes. According to this Mexican study, it is expected that in 2024 – 10 years after the implementation of the tax – there will be a 2.54% drop in the prevalence of obesity, with a greater impact on adults aged 20 to 35 years old (Barrientos-Gutierrez et al., 2017).

Australia is currently one of the countries in which the application of a tax on SSBs is being considered. A study carried out in that country showed the impact on weight loss in the entire population, through the use of a 20% tax to model potential health benefits, which again proved to be most effective in the younger sectors of the population (Lal et al., 2017).

Compared with modelling studies conducted in other countries, the results of the present study predict a lesser effect of the SSBs tax on obesity in Portugal, which may be due to the price elasticity of demand (PED).

Regarding SSBs, in order to be able to produce a potential impact on demand through price changes, there must be a 20% price increase. However, previous studies have shown that PED values for food are very low. In Portugal, the SSBs price increase resulting from the tax that was implemented was below this limit. According to a study previously carried out by Santos et al. (2018), which aimed to evaluate the SSBs average prices in Portugal during the period between 2016 and 2017 showed that, although statistically significant, the increase in the average prices of SSBs was only 18%, not reaching the required 20% threshold. In that study, an increase of + 0.2€/litre was observed in the average price of SSBs, from 2016 to 2017 (1.1 €/litre to 1.3 €/litre, respectively). Similar results were found in another study carried out in Portugal on the price increase of SSBs. This study covered a longer period of analysis (between February 2015 and January 2018) and, using the SSBs' tax level, provided disaggregated data. The results pointed to an average price increase of about 19% for beverages with a sugar content lower than 80 grams/litre, while beverages with more than ≥80 grams/litre of sugar had a 16% average price increase (Gonçalves & Santos, 2019).

Strengths and limitations

Given that the effectiveness of fiscal interventions in public health has been the focus of political discussion, it is essential to find out in which ways these measures can have an impact and report those effects. The strongest point of this study relies on the ability to estimate changes in the incidence of obesity according to the age group in Portugal, through the creation of models for this purpose. This was only possible because it considered how the reformulation of SSBs and the decrease in their sales volume impacted the changes in sugar consumption by the population. Another strong point of the study was the generation of specific estimates of the impact in the different age groups since individual consumption data from a representative national sample were used, instead of using only market data.

In epidemiological studies, it is difficult to assess in an observable and direct way how changes in a risk factor can result in prevented cases of diseases. Regarding the sugar tax, the greatest difficulty is to show that, regardless of other changes that may exist in the environment, the new cases prevented can be attributed to the tax that was implemented. The estimate of the reduction in obesity resulting from the decrease in both availability and sugar consumption from SSBs can be made through the model used, the PIF, and through similar modelling tools that are often used to evaluate the impact of interventions across the population.

Since this study includes data from several sources, with methodological differences, there may be an accumulation of bias in the analyses performed. Some of the data needed to be imputed, since some of these data sets were not complete. However, data imputation was only required in less than 20% of cases. Depending on the source, there were differences in sales estimates and, therefore, in the availability of sugar from SSBs in the Portuguese market. Compared with the reduction in sales and

consequent prevention of new cases of obesity estimated through market data from Nielsen, the estimated results using the tax payment data source were higher, even after they were calibrated. Nevertheless, market data were in line with the data on individuals' consumption, and variations in tax data and market data were consistent with one another.

Importantly, given the impossibility of knowing the trend by age from the retail sales data, the same trend was assumed regardless of age group. Therefore, assuming the proportional reduction of the trend observed in the retail sales data, the trend in consumption was estimated using the data regarding individual consumption from the national food survey as a baseline. Moreover, given that the information available in both retail sales data and tax data for 2017 is only about non-concentrated drinks, that was the information used for this study.

Another limitation is the fact that the models generated do not consider substitution effects. This means that the impact of SSBs on the incidence of obesity can be overestimated, given that part of the consumption of this type of beverages can be replaced by the consumption of other drinks that, although not subject to tax, also contain calories, namely milk drinks and fruit juices. That said, given the impossibility of assessing the extent to which the consumption of SSBs was replaced by other drinks, and what the nature of those drinks was, it was assumed that in the event of a decrease in the consumption of SSBs the replacement drink was water.

It is also important to discuss the fact that the present research assumes that levels of SSBs consumption among the Portuguese population shall not go back to their pre-taxation levels. However, comsumers tend to progressively loose their sensitivity to

price changes over time. Therefore, unless the taxation levels are regularly reviewed and improved, this policy may loose its impact on consumption decrease.

Furthermore, and building on the fact that the methodology used in this chapter was original, and built on mathematical innovations and developments made in collaboration with the team of statisticians from Instituto de Saúde Pública da Universidade do Porto, the connection established between one taxation policy and its impact on obesity was an absolute innovation in this field. However, in order to be used as a reliable modeling tool by other countries, validation would be needed. Such validation process, that could perhaps be done by confronting the modelled projections with real world obesity incidence data in Portugal over the next years, or by using similar data inputs to the ones gathered for Portugal. Anyway, such validation process would require further research and resource allocation that was not possible or timely in the context of this PhD Thesis. Nevertheless, a carefully designed validation process shall be considered in future research in this area.

Policy implications at the national level

Throughout this chapter, it was possible to obtain strong evidence that the reduction in the DED associated with the consumption of SBBs, resulting from the reformulation of this type of beverages and from the decrease in their sales, is strongly connected with the Portuguese SSBs tax. Compared to the reformulation alone, the impact on reducing obesity was much greater when there was also a reduction in sales of SSBs, probably resulting from the increase in the price of these beverages. These findings are in line with existing evidence that suggests a higher effectiveness of fiscal interventions, compared to voluntary industry measures (Cobiac, Vos & Veerman, 2010)**.** Thus, according to its worrying prevalence of obesity, Portugal should prioritize the implementation of policies that are quick to implement and able to produce larger

impacts over other more consensual but less effective measures. Governments must stay vigilant against private interests that always aim to lobby against taxation policies. Furthermore, it is important to note that food taxes tend to lose impact on reformulation and sales over time, thus Governments should regularly update them, always improving the tax burden of the worst nutritional products, as Portugal has already done in 2019. Moreover, given the large scale of the problem of obesity, and that the present study made it possible to estimate the prevention of up to 78 cases of obesity per year resulting from the implemented Portuguese SSBs tax, it can be said that fiscal measures are worthwhile for Portugal. However, the limited number of prevented cases of obesity highlights the facts that these measures should not be seen as a universal cure. That is why it is essential that in solving this complex system problem they are seen as a complementary measure to several other unhealthy nutrition prevention measures.

Policy implications at the global level

With this study, it was possible to add evidence from Portugal to the global understanding of the impact of levies applied to SSBs, both in terms of reducing the consumption of these drinks, as well as in decreasing their average sugar and energy content. In addition, the tax policies implemented should mainly prevent obesity in younger individuals, since they are the ones who consume SSBs in greater quantity. Both the reduction in sugar consumption and the decrease in sales of SSBs were significantly accelerated after the implementation of the SSBs tax. Also, the effect on the incidence of obesity in the Portuguese population would have been much less if there had been only the reformulation of SSBs, without decreasing the SSBs sales volume. Thus, countries must prioritize the implementation of such fiscal measures, even if the self-regulation pathway commonly proposed by the industry players seems to be more unanimous.

Finally, even though this chapter stresses the effectiveness of taxation in preventing NCDs, it is important to reinforce that the isolated impact of such policies is limited. For this reason, although they are increasingly popular, for a successful fight against epidemics of NCDs, governments must prioritise continuous and integrated multisectoral interventions aimed at improving the eating habits of the population.

Chapter 5

Self Regulation Policies: the food reformulation agreement

Introduction

In 2017, from the Portuguese population of 10,291,027 inhabitants, 96,587 deaths resulted from NCDs, corresponding to 88% of the national absolute mortality (IHME, 2017). With this in mind, with 2010 as the year of reference, Portugal made a commitment to the United Nations Sustainable Development Goal (SDG) target 3.4, to fulfil the voluntary goal aiming to reduce premature deaths resulting from NCDs by a quarter before 2025, and also the goal that aims to reduce those deaths by a third by the year 2030 (Lopes et al., 2017a; Ministério da Saúde, 2018; OECD, 2010).

Mortality and morbidity in Portugal due to NCDs are related to dietary risk factors, which are preventable (IHME, 2017; Ministério da Saúde, 2018). For this reason, allied with the fact that the prevalence of these diseases has been increasing significantly, in 2012 the Portuguese government decided to take measures and introduced the National Programme for the Promotion of Healthy Eating (PNPAS) (Graça & Gregório, 2013; DGS, 2012). According to national data, in the 2015-2016 period, about 2,600,000 Portuguese (corresponding to 24% of the population) exceeded the limits for free sugar consumption recommended by the WHO, with the average daily intake of free sugars in this period being 35g/day. The age group of adolescents was the one in which non-compliance was most prevalent (48.7%, corresponding to 422,000 individuals), followed by children (48.4%, corresponding to 380,000 individuals), with little difference between the two. Considering the upper limits recommended by the WHO for daily sodium consumption, 8,283,000 Portuguese (corresponding to 76.4% of the national population) exceeded these limits. On the other hand, in a more positive note, only 43,000 Portuguese (0.4% of the national

population) consumed trans fatty acids (TFAs) as more than 1% of the total energy intake (Lopes et al., 2017a).

As mentioned in Chapter 3, in 2017 the Portuguese Government implemented a sugar tax on SSBs, according to their sugar content (Goiana-da-Silva, 2018b). Consequently, one year after the implementation of the sugar tax in Portugal, preliminary results showed a reduction from 30.92kcal/100mL to 27.45kcal/100 mL in the average energy content of SSBs, which translates into a drop of 11%. In addition, there was a decrease in sales of SSBs from 538 million litres in 2016 to 503 million litres in 2017, corresponding to a 7% drop in sales volume (Goiana-da-Silva, 2018b). Given the success that resulted from the implementation of the sugar tax (Goiana-da-Silva, 2018c), the Portuguese government decided to go further, proposing a salt tax to be levied on processed foods. However, this proposal was rejected by the Portuguese parliament and, instead, members of parliament recommended the introduction of a co-regulation agreement with the food industry, similar to what happened in several other countries (Chauliac & Hercberg, 2012; He, Brinsden & MacGregor, 2014; Jones et al., 2016; Public Health England, 2017; Sodium initiatives, 2018; Trevena et al., 2014; Wyness, Butriss & Stanner, 2012). According to this agreement, food reformulation goals were to be defined by the government, which would also commit to carrying out a process of monitoring for accountability on the industry side. In the case of non-compliance with the objectives inherent to these measures, the government should implement stronger measures that might help to reformulate these products, namely through taxation.

All processed foods with a high content of either TFAs, sugar or salt, were subject to public liability guidelines as well as reformulation goals, according to the agreement outlined by the Portuguese Ministry of Health (Magnusson & Reeve, 2015). For the

elaboration of these guidelines, an analysis of the population's consumption patterns was taken into account (Casaet et al., 2016; Cobiac, Vos & Veerman, 2010)**,** along with recommendations of the European Commission's High-Level Group on Nutrition and Physical Activity (European Commission, 2009; European Commission, 2011a; European Commission, 2011b). As for the categories of food that needed reformulation, an agreement was reached between the consumer protection association, the nutritionist college, and the Portuguese nutrition association, which were the main stakeholders in the process. Since at least 80% of the market share is represented by processed foods, to define the goals for the year 2021, the assessment made in December 2017 regarding the nutritional content of these products would be considered as the basis.

Moreover, both the final reformulation target for each food sector as well as the annual milestones regarding the reduction of TFAs, sugar and salt in processed foods were established by the ministry of health, after due consultation with representatives of the food and health authorities, researchers, health professionals as well as other experts in the field. These preliminary objectives are shown in Table 13. To define the values of each of these objectives, recommendations from both the WHO (2015c) and the High Level Group on Nutrition and Physical Activity of the European Commission (EC) (Public Health England, 2017a; Public Health England, 2017b) as well as the experience of the United Kingdom, were taken into consideration. Hence, it was defined that by 2021 the reduction targets would include a limit of 2g of TFAs for every 100g of fat present in products such as margarine and vegetable fat, a 20% decrease in the sugar content of processed foods, as well as a 16% decrease of salt. In addition, the Portuguese government proposed that by 2021 a limit of 1g of TFAs should be adopted for every 100g of fat in pastry products, as well as a 30%

reduction in the salt content in bread, equivalent to a maximum level of 1g of salt per 100g of bread.

Table 13 - Preliminary objectives of the 2015 co-regulation agreement between the Portuguese government and the food industry for reducing sugar, salt and trans-fatty acids in processed food.

Nutrient	Food products to reformulate	Nutrient reduction target by year*			Total Reduction by 2021
		2019	2020	2021	
Sugar	Breakfast cereals; cookies and biscuits; chocolate milk; yogurt; soft drink; fruit juice	5%	7%	8%	20%
Salt	Bread (toast); breakfast cereals; cheese; cookies and biscuits; potato chips and other snacks; processed meats (ham); ready-to-eat soups	4%	5%	7%	16%
	Bread	10% (1.2 g salt per 100 g bread)	10% (1.1 g salt per 100 g bread)	10% (1.0 g salt per 100 g bread)	30%
Trans fatty acids	Cookies and biscuits; fat spreads	<2 g trans fatty acids per 100 g of fat			
	Pastries	<2 g trans fatty acids per 100 g of fat		<1 g trans fatty acids per 100 g of fat	

*All percentage reductions are based on baseline levels from December 2017.
Source: Goiana-da-Silva (2019d)

- **Hypothesis**

Voluntary Self-Regulations such as Food Sector Reformulation Agreements are effective in tackling NCD.

Objectives

This chapter aims to create a model to predict the number of premature deaths resulting from NCDs that could be avoided if a co-regulation agreement between the government and the industry was established to promote food product reformulation. For the modelling, an assumption was made that the preliminary goals established for food reformulation were fulfilled.

Another objective of this chapter was to evaluate whether Portugal will be able to meet the established SDGs that aim to reduce 25% of premature mortality resulting from NCDs by 2025, increasing this reduction to 33% by 2030.

Methods

In the following sections, the methodology used is as described in Goiana-da-Silva et al. (2019d).

Study Design

In order to estimate the number of deaths that could be prevented in the year under study assuming that the co-agreement goals were fully met, demographic data, data related to mortality by NCDs and data on food consumption for the year 2016 were used. Additionally, the impact of the reformulation of food products regarding the mortality trends was also modelled, along with the tendencies in the mortality by NCDs in Portugal during the period spanning from 1990 to 2030.

Data Sources

To undertake this study, data regarding the food consumption of the population aged between 15 and 84 years, obtained from the Portuguese National Food, Nutrition and

Physical Activity Survey carried out from October 2015 to September 2016 were used (Lopes et al., 2017a). The information collected by this survey included both regional and national data regarding physical activity, eating habits and anthropometrics from a sample considered representative of the Portuguese general population aged between three months and 84 years (Lopes et al., 2018b). Through multi-stage sampling, participants were selected from the national health register and 5811 individuals participated in food consumption interviews, evaluated by a 24-hour recall (Lopes et al., 2017b).

In addition, data from the period between 1990 and 2016 were provided by the Portuguese directorate general of health, regarding the population's sexual distribution, age (divided into age groups of five years each), and the annual number of deaths resulting from the four main NCDs. Regarding the latter, it is important to note that deaths attributed to NCDs are codified by the ministry according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10), as follows: malignant neoplasms (codes C00–C97); circulatory system diseases (I00–I99); chronic respiratory diseases (J30–J98); and diabetes (E10–E14).

Data Analysis

Modelling changes in nutrient consumption

To be able to convert data regarding food consumption into the intake of fat (% of total fat/day), total energy (kcal/day) and sodium (g/day), the Electronic Assessment Tool for 24 hours recall (eAT24) software was used (Lopes et al., 2017b). Then, in order to remove intra-individual variability, with the purpose of estimating the population's usual intake of nutrients, the Statistical Program to Assess Dietary

Exposure software was used (Dutch National Institute for Public Health and the Environment, Bilthoven, Netherlands) (Dekkers et al., 2014).

Assuming that the objectives of the co-regulation agreement established by the government were entirely attained, the projected daily dietary intakes of nutrients was calculated using a formula that merged the nutrient concentration present in the industry co-regulation agreement (c_f) with the information regarding consumption, obtained from the national survey conducted in 2015–2016 (Goiana-da-Silva, 20198d), as shown below:

$$y_{id} = \sum_{f} x_{idf} \cdot c_f \qquad (1)$$

In this formula, the percentage of fat, total energy or sodium of individual i at day d, is given by the expression y_{id}, while the consumption of individual i at day d of food item f is given by the expression x_{idf}.

Using updated nutrient concentrations from the food reformulation process, the intakes of fat, total energy and sodium by the population were estimated based on the consumption levels of each food for the period 2015-2016.

Modelling changes in premature mortality

Moreover, to be able to create models that allow the prediction of the reduction in deaths caused by NCDs in individuals aged between 30 and 69 years (premature deaths), the Preventable Risk Integrated ModEl, Nov. 2017 version was used, which is an open-source statistical tool that enables the creation of models for NCDs (Scarborough et al., 2014). This statistical tool, which has been widely used by the WHO to assist Member States in prioritising policy options related to NCDs, estimates

the impacts associated with changes in nutrition policies implemented by governments. Using this tool, in addition to a counterfactual scenario, users insert baseline data regarding behavioural risk factors – which in this particular case are related to nutritional intake – as well as data on population structure and mortality rates to obtain a model that, based on results of meta-analysis previously carried out at an international level, is able to predict changes in mortality for any of the 24 possible NCDs (Scarborough et al., 2014). However, the strength of association established between specific nutrient intake and its impact in mortality for each NCD identified in such meta-analysis varied. The strongest assotiation established was between salt intake and mortality due to CVDs. Therefore, variations in salt intake shall have stronger impacts on CVD driven mortality comparing to other NCDs considered. In the present study, given that a cross-sectional modelling tool was used, it was only possible to compare a counterfactual scenario with a historical scenario. As such, a model was created that allowed the calculation of the expected number of deaths that would be observed in 2016, by comparing a counterfactual scenario where there was a reduction in the consumption of TFAs, sugar and salt by the population, with a historical scenario comprising data related to the dietary consumption and population mortality rate in 2016.

Therefore, with the model created for this study, it was possible to estimate the number of deaths that would be avoided in 2016, assuming that there would be full compliance with the co-regulation goals established. Considering the goals previously identified and listed in Table 13, and assuming their accomplishment, in the model created for this study TFAs were completed eliminated, reduced the population's sugar consumption by 20% and the salt consumption by 16% (30% for bread). Moreover, the percentage of total energy originating from total fats was calculated to model the impact of reducing TFAs. In turn, to model the impact of sugar reduction, the caloric content of foods listed in Table 13 has been reduced by 20%. In order to determine

the 95% CI for the point estimates of the number of avoided deaths resulting from NCDs, the Monte Carlo simulation was used, which uses uncertainty parameters based on associations between disease outcomes and diet-related risk factors (Scarborough et al., 2014).

Using linear projections based on estimates from weighted and unweighted exponential and linear regression models to project premature mortality resulting from NCDs by 2030, it was possible to model the change in the risk of premature mortality caused by NCDs for the period between 1990 and 2016. In order to carry out this analysis, more recent data received a greater weight than older data, thus the weights were calculated and exponentially distributed in order to be inverse over time, being subsequently optimized in order to have a minimum distance between the two most recent data points and the projections made. Finally, the projection with the reduction of deaths from NCDs, calculated through the Preventable Risk Integrated ModEl, was also redone to evaluate how the co-regulation agreement established with the industry would affect Portugal's trajectory in this matter.

Results

The values regarding projections for 2016 in the case of full compliance with the established food reformulation goals were verified, as well as the baseline data associated with the average fat, energy and salt intake retrieved from the 2016 Portuguese National Food, Nutrition and Physical Activity Survey, are shown in Table 14. According to the model created, a reduction in the average total fat intake as a percentage of total energy per day from 30.4% (standard deviation, SD = 4.8) to 30.3% (SD = 4.8), a reduction from 1911 kcal/day to 1897 kcal/day in mean total energy intake and a reduction from 7.6 g/day (SD = 2.3) to 7.1g /day (SD = 2.2) in the average salt intake are expected.

The projected average number of deaths caused by NCDs that would be avoided in Portugal in 2016, if the goals established for reduction of TFAs, sugar and salt intake by the population were met, by behavioural risk factor, disease, age and sex of individuals, are shown in Table 14. According to the results presented in Table 15, the reduction in deaths caused by cardiovascular diseases would be much higher than those caused by either diabetes or cancer, and the highest proportion of the reduction in deaths caused by NCDs would occur in adults over 75 years.

Table 14 - Projected daily intake of salt, total energy and total fat by age and sex in Portugal in 2021 if a co-regulation agreement on the nutrient content of processed food were implemented.

Age and sex	Sample, no.	Population, no.	Mean (SD) salt intake, g/day		Mean total energy intake, kcal/day*		Mean (SD) total fat intake, % total energy/day	
			Baseline	Projected	Baseline	Projected	Baseline	Projected
Total	4 067	9 494 698	7.6 (2.3)	7.1 (2.2)	1 911	1 897	30.4 (4.8)	30.3 (4.8)
Male, years								
15–19	152	292 936	8.5 (2.4)	8.0 (2.2)	2 355	2 325	30.2 (4.4)	29.8 (4.4)
20-24	125	413 473	8.9 (2.4)	8.3 (2.3)	2 429	2 400	30.0 (4.4)	29.8 (4.4)
25-29	115	258 286	9.1 (2.5)	8.5 (2.3)	2 459	2 431	29.8 (4.4)	29.7 (4.4)
30–34	139	321 783	9.2 (2.5)	8.6 (2.4)	2 456	2 430	29.7 (4.4)	29.6 (4.4)
35–39	157	338 404	9.3 (2.5)	8.7 (2.4)	2 423	2 401	29.4 (4.4)	29.4 (4.4)
40-44	187	503 264	9.3 (2.5)	8.7 (2.4)	2 380	2 360	29.1 (4.4)	29.2 (4.4)
45-49	155	379 035	9.3 (2.5)	8.6 (2.4)	2 331	2 313	28.9 (4.4)	29.0 (4.4)
50-54	166	446 686	9.1 (2.5)	8.5 (2.3)	2 258	2 243	28.5 (4.4)	28.6 (4.4)
55–59	173	403 022	9.0 (2.4)	8.3 (2.3)	2 185	2 174	28.1 (4.4)	28.3 (4.4)
60–64	154	396 197	8.7 (2.4)	8.1 (2.3)	2 114	2 106	27.8 (4.4)	27.8 (4.4)
65–69	169	390 285	8.4 (2.4)	7.8 (2.2)	2 027	2 021	27.3 (4.4)	27.3 (4.3)
70–74	93	188 581	8.1 (2.4)	7.5 (2.1)	1 952	1 949	26.9 (4.4)	26.8 (4.3)
75–79	80	145 870	7.7 (2.2)	7.0 (2.0)	1 859	1 859	26.4 (4.3)	26.0 (4.3)
80-84	50	119 865	7.2 (2.1)	6.6 (2.0)	1 775	1 777	25.9 (4.3)	25.3 (4.3)

85+**	NA	NA	7.2 (2.1)	6.6 (2.0)	1 775	1 777	25.9 (4.3)	25.3 (4.3)
All ages	1915	4 597 687	8.9 (2.5)	8.2 (2.3)	2 241	2 223	28.8 (4.5)	28.7 (4.5)
Female, years								
15–19	183	270 998	6.8 (1.8)	6.4 (1.7)	1 803	1 784	31.8 (4.9)	31.8 (4.9)
20-24	147	348 323	6.8 (1.8)	6.4 (1.7)	1 774	1 756	32.0 (5.0)	31.9 (4.9)
25-29	143	278 977	6.7 (1.8)	6.4 (1.7)	1 741	1 725	32.0 (5.0)	31.9 (4.9)
30–34	182	368 473	6.6 (1.8)	6.3 (1.7)	1 705	1 690	31.9 (4.9)	31.8 (4.9)
35–39	195	434 452	6.6 (1.8)	6.2 (1.7)	1 674	1 660	31.8 (5.0)	31.7 (4.9)
40-44	248	574 407	6.5 (1.8)	6.1 (1.7)	1 643	1 631	31.6 (5.0)	31.5 (4.9
45-49	190	422 300	6.4 (1.7)	6.0 (1.6)	1 612	1 601	31.3 (4.9)	31.3 (4.9)
50-54	204	493 009	6.4 (1.7)	5.9 (1.6)	1 586	1 576	31.1 (4.9)	31.0 (4.9)
55–59	172	343 994	6.3 (1.7)	5.8 (1.6)	1 558	1 549	30.7 (4.9)	30.7 (4.9)
60–64	130	293 724	6.2 (1.7)	5.7 (1.6)	1 534	1 527	30.4 (4.9)	30.3 (4.9)
65–69	142	481 403	6.2 (1.7)	5.6 (1.6)	1 509	1 502	29.9 (4.9)	29.9 (4.9)
70–74	105	259 438	6.1 (1.7)	5.5 (1.5)	1 489	1 483	29.5 (4.9)	29.5 (4.9)
75–79	73	193 218	6.0 (1.7)	5.4 (1.5)	1 469	1 463	29.1 (4.8)	29.1 (4.9)
80-84	38	134 295	6.0 (1.6)	5.3 (1.5)	1 447	1 442	28.5 (4.9)	28.6 (4.8)
85+**	NA	NA	6.0 (1.6)	5.3 (1.5)	1 447	1 442	28.5 (4.9)	28.6 (4.8)
All ages	2 152	4 897 011	6.4 (1.8)	6.0 (1.7)	1 636	1 623	31.1 (5.0)	31.0 (5.0)

*The model used to estimate deaths averted due to food reformulation does not use SD of mean total energy intake in the calculations.

**For the age group 85+ years the same estimates from previous age group (80-84 years) were used, as the Portuguese National Food, Nutrition and Physical Activity survey only included the population up to 84 years old.

Notes: The proposed co-regulation agreement between the Portuguese Ministry of Health and the food industry sets targets of reducing sugar by 20%, salt content by 16% (30% for bread) and <2g trans-fatty acids per 100g of fat in a range of products by 2021. The projected (counterfactual) values assumed that all the co-regulation targets set by the Ministry of Health were fully met. Dietary estimates were weighted according to a complex sampling design, considering stratification by the seven Portuguese geographical regions and the cluster effect for the selected primary healthcare units.

Source: Goiana-da-Silva (2019d)

Table 15 - Projected mean number of deaths from NCDs averted in Portugal in 2016 if targets for the reduction of sugar, salt and trans-fats intake by the population were achieved, by age, sex, disease and behavioural risk factor.

Variable	Population aged >15 years, no.	No. of deaths averted or delayed		
		2.5th percentile	Mean	97.5th percentile
Total	8 873 828	494	800	1106
By age and sex				
Age <75 years	7 819 807	178	248	318
Males	4 148 778	138	272	409
Females	4 725 050	355	527	701
Males aged <75 years	3 746 359	114	164	215
Females aged <75 years	4 073 449	63	84	104
By disease				
All cardiovascular disease	8 873 828	384	693	999
Coronary heart disease	8 873 828	92	156	221
Stroke	8 873 828	123	233	341
Heart failure	8 873 828	82	144	210
Aortic aneurysm	8 873 828	3	7	11
Pulmonary embolism	8 873 828	2	6	13
Rheumatic heart disease	8 873 828	0	1	3
Hypertensive disease	8 873 828	77	145	213
Diabetes	8 873 828	40	57	70
Chronic obstructive pulmonary disease	8 873 828	0	0	0
Cancer	8 873 828	18	24	30
By risk factor				
Diet (excluding obesity)	8 873 828	224	530	840
Diet (including obesity)	8 873 828	449	800	1106
Fruit and vegetables	8 873 828	0	0	0
Fibre	8 873 828	0	0	0
Fats	8 873 828	-4	−1	2
Salt	8 873 828	224	531	841
Physical activity (excluding obesity)	8 873 828	0	0	0
Physical activity (including obesity)	8 873 828	239	274	305
Obesity	8 873 828	239	274	305
Alcohol consumption	8 873 828	0	0	0
Smoking	8 873 828	0	0	0

Notes: The proposed co-regulation agreement between the Portuguese Ministry of Health and the food industry sets targets of reducing sugar by 20%, salt content by 16% (30% for bread) and <2g trans-fatty acids per 100g of fat in a range of products by 2021. The reduction in premature mortality attributable to NCDs that would be observed if the co-regulation agreement targets set by the Ministry of Health were fully met were modelled. The population of

Portugal in 2016 was 10 309 537. All individuals older than 15 years (8 873 828 people) were included in this modelling exercise. The results were obtained from Monte Carlo analysis (10 000 simulations).

Source: Goiana-da-Silva (2019d)

Table 16 - Projected number of deaths from NCDs averted in Portugal in 2016 if targets for the reduction of sugar, salt and trans-fat intake by the population were achieved, by sex, disease and nutrient.

Variable	No. of deaths					
	All deaths attributed to NCD*			Premature deaths attributed to NCD**		
	Baseline	Projected	Averted (95%CI)	Baseline	Projected	Averted (95%CI)
Total	54 745	53 947	798 (483 to 1 107)	17 633	17 386	248 (178 to 318)
By sex						
Male	27 699	27 427	272 (132 to 409)	11 744	11 580	164 (113 to 214)
Female	26 424	25 898	526 (348 to 698)	5 899	5 815	84 (63 to 104)
By disease						
Cardiovascular disease	11 732	11 040	692 (377 to 999)	2 085	1 899	186 (117 to 256)
Diabetes	4 280	4 219	61 (40 to 71)	944	920	24 (19 to 29)
Chronic obstructive pulmonary disease	2 789	2 789	0 (0 to 0)	518	518	0 (0 to 0)
Cancer	2 335	2 310	25 (18 to 31)	1 162	1 147	15 (10 to 19)
By nutrient* **						
Salt reduction	NA	NA	610 (215 to 840)	NA	NA	NA
Sugar reduction	NA	NA	261 (238 to 305)	NA	NA	NA
Trans-fatty acid	NA	NA	0 (0 to 0)	NA	NA	NA

elimination							

*Deaths attributable to the four major NCDs were modelled.

**Premature deaths were those occurring in 30-69 years olds.

***Deaths related to sugar and trans-fats using the change in energy intake were modelled. Due to the design of the Preventable Risk Integrated Model tool, it was not possible to obtain estimates of the total number of baseline or counterfactual deaths attributable to the individual nutrients.

Notes: The proposed co-regulation agreement between the Portuguese Ministry of Health and the food industry sets targets of reducing sugar by 20%, salt content by 16% (30% for bread) and <2g trans-fatty acids per 100g of fat in a range of products by 2021. The reduction in premature mortality attributable to NCDs that would be observed if the co-regulation agreement targets set by the Ministry of Health were fully met were modelled. The population of Portugal in 2016 was 10 309 537. All individuals older than 15 years (8 873 828 people) were included in this modelling exercise.

Source: Goiana-da-Silva (2019d)

According to the model, if the goals established for food reformulation were fully met, in 2016 it would be possible to avoid a total of 798 deaths caused by NCDs (95% CI: 483 to 1107). It should be noted that, of the total number of deaths prevented in 2016 resulting from NCDs, 248 were premature (95% CI: 178 to 318). In addition, among the various NCDs, cardiovascular diseases were the ones that showed the greatest reduction, totalling 692 avoided deaths (95% CI: 377 to 999). Comparing the prevented deaths according to gender shows that food reformulation prevents 526 deaths in women (95% CI: 348 to 698), while in men this number is lower (272 deaths avoided; 95% CI: 132 to 409). Regarding the reduction in TFAs, sugar and salt intake, the first made no contribution to the prevention of deaths caused by NCDs. However, sugar helped prevent 261 deaths (95% CI: 238 to 305), while salt showed the greatest contribution to the prevention of deaths resulting from NCDs, accounting for 610 avoided deaths (95% CI: 215 to 840).

As shown in Figure 16, during the period between 1990 and 2010 there was a drop in the risk of premature death caused by NCDs from 17.5% to 11.1%, however, between 2010 and 2016, this value remained stable. In accordance with the SDGs, the goal is to reduce deaths from NCDs 8.3% by 2025, while it is 7.8% by 2030. However, based on current trends, it is estimated by the weighted projection that the

probability of death will be 11%, both for 2025 and 2030. Moreover, the model created for the present study shows that, if the established goals of food reformulation had been fully met, in 2016 it would have been possible to reduce the risk of death from NCDs to 10.7%, avoiding a total of 248 premature deaths. Both the new projection and the current weighted trend are unable to meet the agreed deadlines regarding the SDGs. In fact, the unweighted projection was the only one able to meet the SDG targets set for 2025 or 2030. Also, considering current trends, data from recent years collected by the WHO suggested that there would be no additional decrease in the risk of premature deaths from NCDs (Silva da Costa., 2018).

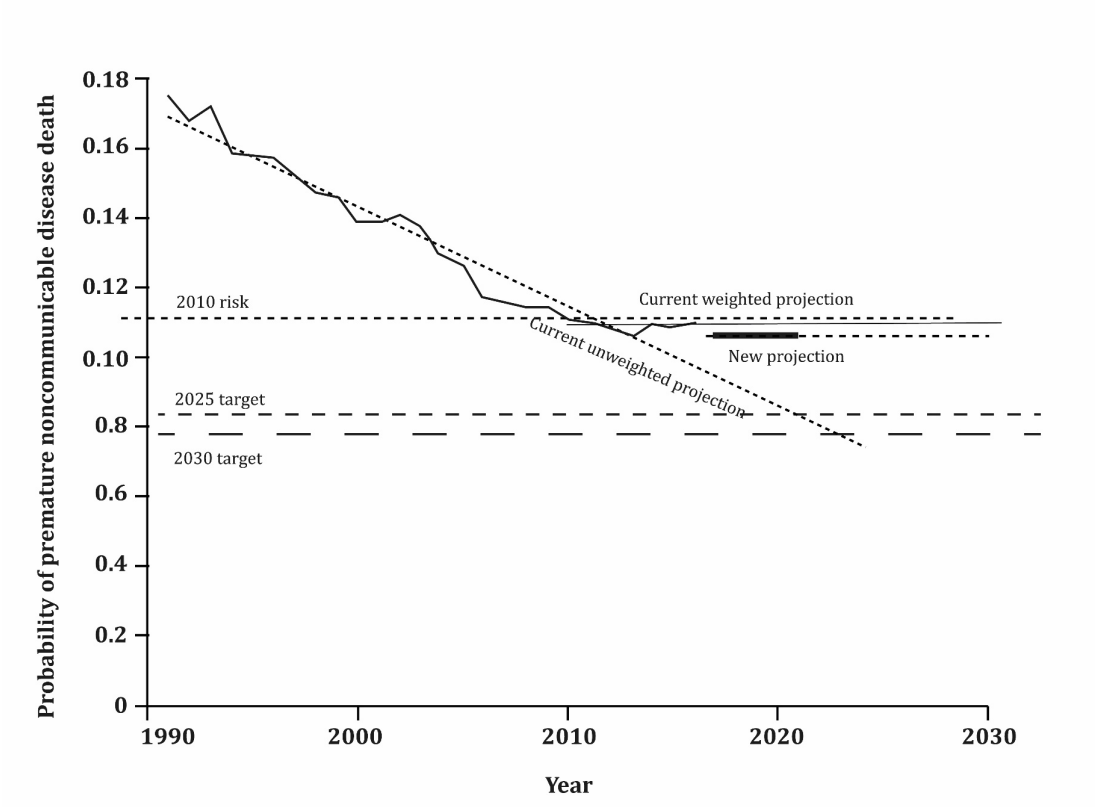


Figure 16 - Historic and projected risk of premature deaths from NCDs in Portugal compared with sustainable development goal targets for 2025 and 2030.

Notes: The chart line shows the actual data for the probability of premature NCD caused mortality from 1990 to 2016 (latest available data). The 2010 risk is the baseline from which the 2025 and 2030 targets were calculated. The unweighted regression line suggests that Portugal will meet both targets before 2025. However, the weighted projection that accords more value to recent data suggests that the risk of premature mortality has stopped declining and will increase towards the 2010 level over the coming 15 years. If the industry co-regulation targets were met in full in 2016 then the risk would be lower but not significantly. Even with these reductions in deaths, the trend will still not reach the 2025 or the 2030 targets.
Source: Goiana-da-Silva (2019d)

Discussion

According to the model created for this study, it was possible to predict that if the goals established with the food industry regarding the co-regulation agreement on the nutrient content of processed food were met, in line with the reduction of TFAs, sugar and salt in the Portuguese population, it would be possible to avoid a total of 798 deaths caused by NCDs in 2016, of which 248 were premature. However, considering the targets set by the United Nations for 2025 and 2030 regarding the reduction of premature deaths caused by NCDs, this number is insufficient to achieve them or even to significantly change trends related to premature deaths in the Portuguese population.

The Global Burden of Disease (GBD) project of the Institute for Health Metrics and Evaluation also publishes mortality projections for NCDs (IHME, 2018)**.** It should be noted that the age groups used for these projections differ slightly from those used for the present study. However, comparing the projections from the three scenarios with those obtained by the model of the present study, both the GBD project's best and the reference scenarios are located between the projections of weighted and unweighted linear regression of this study. On the other hand, the worst scenario is similar to the current weighted linear regression projection of this study. Furthermore, until 2020 there is not much variation in the GBD forecast scenarios, with only a significant difference in the scenarios after 2020. Although it is not clear how the Institute generates its best scenario, one of the several potential public health interventions

underway that can help move current trends to the best scenarios, includes the goals established for the reformulation of TFAs, sugar and salt in processed foods.

Results regarding the promotion of food reformulation through voluntary agreements established with the industry were published by several countries (Chauliac & Hercberg, 2012; He, Brinsden & MacGregor, 2014; Jones et al., 2016; Public Health England, 2017b; Sodium initiatives, 2018; Travena et al., 2014; Wyness, Butriss & Stanner, 2012). However, most of these studies did not assess the impact of reformulating processed foods on health outcomes, but rather on nutrient intake. The assessment of the Australian Food and Health Dialogue targets showed that, between 2010 and 2013, there were modest reductions in the sodium content in processed meats (8%; from 1215 to 1114 mg/100 g), in breakfast cereals (25%; from 316 to 237 mg/100 g) and in bread (9%; from 454 to 415 mg/100 g)(Travena et al., 2014). In turn, studies in the United Kingdom reveal that product reformulation strategies can be quite effective in significantly reducing the salt content of foods. In fact, between 2004 and 2011 salt reductions of 25% were observed in sweet biscuits (from 0.77 to 0.58 g/100 g), with these reductions being even more significant in breakfast cereals where they reached 57% (from 0.95 to 0.41 g/100 g) (He, Brinsden & MacGregor, 2014).

Out of all of the interventions implemented, those aimed at reducing the salt content in food tend to show good results regarding health outcomes (Chauliac & Hercberg, 2012; Gillespie et al., 2015; Nghiem et al., 2015; Nghiem et al., 2016; Wilson et al., 2016). According to a modelling study carried out in Argentina, it would be possible to prevent 19,000 deaths from all causes over a decade, by reducing 5-15% of the salt content in foods such as cookies, cereals, soups, pizzas and pasta, cheeses and dairy or even processed meats (Konfino et al., 2013). Also, a study from the USA in which

modelling was carried out using data from the Framingham Heart Study, showed that it would be possible to increase quality-adjusted life-years by 2.1 million over current adult lifetimes, if a food reformulation program was adopted to reduce sodium intake by 9.5% (Smith-Spangler et al., 2010)**.** Moreover, implemented since 1989, the Australian program to reduce the salt content in processed foods has shown the potential to prevent a total of 5300 disability-adjusted life years (Cobiac, Vos & Veerman, 2010). Also, several researchers say that reformulation should focus on categories of packaged foods (Wilson et al., 2016). The health benefits inherent to the reformulation of food products are reinforced by the results of these studies, which are also in line with previous work. However, it is important to note that the results of previous modelling studies suggest that voluntary agreements are not as capable of generating health gains as mandatory approaches (Cobiac, Vos & Veerman, 2010; Gillespie et al., 2015; Wilson et al., 2016). In fact, an Australian study estimated that mandatory measures could generate health gains 20 times greater than voluntary interventions (Cobiac, Vos & Veerman, 2010).

The present study has some limitations, regardless of the significance of the data for the implementation of policies involving healthy eating. One is associated with the fact that the weighted trend lines of this study were generated using the same statistical approach applied by the Ministry of Health in order to routinely assess the projections of mortality. Given that the oldest data are heavily discounted by this formula, an excessively pessimistic weighted projection may have been obtained. Regardless, overall, this is the standard approach chosen for both national plans and publications (DGS, 2015a; DGS, 2016; Jakab, 2018). It is also important to note that, although the slow rate of decline in deaths from NCDs may be artefact, both the impact of the Portuguese financial crisis in 2011-2014 and hindered improvements in mortality from

cardiovascular diseases and cancer (Ministério da Saúde, 2018) may justify the decrease in decline rate.

Another limitation of this study is related to the Preventable Risk Integrated ModEl, a cross-sectional model whose weaknesses and strengths are well documented (Scarborough et al., 2014). An example is the fact that the present study does not reflect how the reduction in TFAs, sugar and fat consumption is associated with a decrease in morbidity. For this reason, it was not possible to capture in the analysis how the decrease in sugar content of processed food would affect diabetes or childhood obesity. Also, even though deaths could have been prevented due to the complete elimination of TFAs in processed foods, the modelling tool used in this study did not detect any prevented deaths related to this factor, which may be associated with the very low intake of TFAs in Portugal (Lopes et al., 2018b)**.** Another aspect to be mentioned is the fact that the impact of the reformulation of processed foods has not been analyzed in deaths resulting from all NCDs, but only from the four main NCDs, which has led to an underestimation of the true number of deaths avoided. In addition, it was only possible to obtain estimates of reduced mortality and morbidity associated with NCDs until 2030, it being impossible to obtain such information beyond that period.

This shows that the applied model is unable to estimate the real impact of food product reformulation on health, making only underestimations. Moreover, the underestimation of prevented deaths caused by NCDs may also result from the fact that this modelling tool only allows for estimating the impact of TFAs through changes in the percentage of total energy from total fat, rather than allowing this estimate to be made directly through changes in TFAs.

The biggest limitation lies in the fact that the model does not have the capacity to project how many lives would have been saved during the launch period, limiting itself to forecasting the number of deaths caused by NCDs that would have been avoided if the targets had been fully met in 2016 – the year of study. In fact, assuming all other factors were constant, each year where the consumption of TFAs, sugar and salt was reduced, in line with the co-regulation goals, it is likely that 248 premature deaths resulting from NCDs would have been prevented.

Finally, the fact that data from the most recent national dietary survey, applying self-reported assessment, were used as baseline parameters may have led to an underestimation of the true levels of consumption, mainly for salt. Considering that urine excretion for 24 hours is the gold standard for assessing salt levels, it is recommended that the Portuguese Health Ministry employs 24-hour urine excretion values to monitor and evaluate the outcomes from the food reformulation agreement established with the industry.

Policy implications at the national level

Co-regulation agreements related to salt content had previously been tried by the Portuguese Health Ministry. However, there was no evidence of the effective reformulation of processed foods, largely because of inadequate monitoring and the lack of tools to allow an objective assessment (DGS, 2015b). Therefore, it is essential that any present and future initiative in this area is properly backed with high-quality data collection for future impact assessment and follow-up.

The modelling exercise (Scarborough et al., 2014) described in this chapter suggests that fully meeting the targets initially suggested by the Ministry of Health (before negotiations with the food industry) would prevent 798 premature deaths from NCDs

per year (Goiana-da-Silva, 2019d). However, it is essential to stress that even by adopting such ambitious reformulation targets, Portugal is unlikely to achieve the WHO's target of reducing premature deaths attributable to NCDs by one third by 2030.

After one year of negotiations, the agreement was finally signed in April 2019. However, in the meantime, between our calculations were made and the actual agreement signature, the Food Industry representatives have been able to persuade the Ministry of Health not only to delay the agreement targets deadline from 2021 to 2022 but also to lower the initial reformulation targets. Since the final agreement targets are actually much less ambitious than the preliminary ones on which all the calculations made in this chapter were made, the health impact of the agreement will be considerably smaller.

The projection that voluntary industry agreements will prevent premature deaths is supported by previous evidence suggesting that voluntary industry action can achieve health gains. Nevertheless, voluntary action will also be insufficient on its own and must be complemented with other public health interventions in order to substantively improve population health outcomes (Cobiac, Vos & Veerman, 2010). In fact, the literature strongly suggests that mandatory approaches generate larger health gains than voluntary agreements (Cobiac, Vos & Veerman, 2010; Gillespie et al., 2015). Cobiac and colleagues (2010) and Scarborough et al. (2014) estimate that health gains from mandatory measures could be 20 times higher than voluntary interventions (Goiana-da-Silva, 2019d).

It seems that the consensus reformulation agreement targets achieved after negotiations with the food industry may not be ambitious and timely enough, neither

to have an effective impact on the NCDs epidemic, nor to allow Portugal to achieve the WHO's food reformulation targets by 2030. Further research analysing the impact of the Portuguese Government's flexibility during the negotiations with the processed food industry representatives would be important in order to promote accountability, to inform other policy makers facing similar negotiations and to conclude if such a limited agreement was a worth-while enterprise.

Given that the evidence suggests that even the stronger voluntary targets that were originally proposed would only prevent a small minority of diet-related deaths, it seems that the Government should immediately consider the urgent implementation of other EIPAS mandatory policies, including those that cover food served in cafeterias, canteens, restaurants and hotels as one of the leading sources of sugar, salt and TFAs in Portugal.

Policy implications at the global level

Although this study estimates that it is possible to prevent deaths from NCDs through co-regulation agreements, their overall impact on the prevention of premature deaths resulting from NCDs is relatively small. Thus, governments should choose to push for mandatory regulations every time they are realistic options in the national political contexts, as Portugal tried to do with its "salty snacks tax". This is because they tend to be more effective and faster at producing health gains for the populations and pushing for industry food reformulation.

When governments engage in self or co-regulation agreements with the food industry, special attention must be taken to the negotiation expertise of government officials in charge of representing the public interests. Less experienced and less politically backed negotiators may be too flexible and even weak at the negotiating table. When the health gains potentially achieved by a consensual self-regulation agreement with

the industry are much less than the ones potentially achieved by mandatory legislation, governments should consider stepping back. This is because the priority for Ministries of Health must always be to protect citizens' health and not to reach comfortable and consensual solutions.

An effective strategy to mitigate risk factors and improve health, through the change of food environments, may involve the establishment of co-regulation agreements with the food industry aimed at reformulating the content of TFAs, sugar and salt in processed foods, subject to strict government monitoring. However, as previously mentioned, it is important to note that these strategies are insufficient in themselves and should not be seen as a single solution, but as part of the solution along with interventions to improve population health and food consumption patterns.

Chapter 6

Mandatory Policies: Regulating salt content in bread

Introduction

Worldwide, one of the biggest challenges for public health, and the main cause of death, is cardiovascular disease (CVD) (WHO, 2017d). In the Portuguese population, 42.2% of individuals have hypertension (Polonia et al., 2014) – one of the risk factors for CVD – and, of all deaths, 29% result from this type of disease (EOHSP, 2017). According to previous studies carried out by the GBD, in the Portuguese population, the loss of healthy life years is highly associated with unhealthy diets (DGS, 2018b).

Regarding the value of daily consumption of salt per capita, whereas the recommended value by the WHO is under 5g (WHO, 2016a), in the Portuguese population this value is well exceeded, reaching 7.4g (Lopes et al., 2017a; Lopes et al., 2018b). Compared to other eating habits, excessive consumption of salt has the

most adverse consequences. For this reason, it is worrying that Portugal is the European country with the highest salt consumption, with this excessive consumption being more prevalent in men (88.9%) than in women (63.2%) (Lopes et al., 2017a; Lopes et al., 2018b). Excessive consumption of salt also affects the younger strata of the population of both children and adolescents (Correia-Costa et al., 2016; Gonçalves et al., 2016; Sardinha et al., 2012). Given the relevance of excessive salt consumption, the resulting sodium epidemics, and their association with the increase in the prevalence of CVDs, the WHO not only asks for interventions to prevent CVDs but also identifies salt intake as one of the factors on which cost-effective health improvement measures should be developed (WHO, 2016a).

In the Portuguese diet, bread is the second-largest source of salt, according to the results from the latest National Food, Nutrition and Physical Activity Survey (Lopes et al., 2017a; Lopes et al., 2018b). Considering that bread is part of the daily diet of the Portuguese regardless of their socioeconomic group or age, in Portugal about 18.2% of the salt that is eaten daily comes from bread. Compared to cereals, cereal products and tubers, the average daily consumption of bread and crispbread was higher, with a daily frequency of above 95% and reaching a daily consumption of 100.3g per capita (Lopes et al., 2017a; Lopes et al., 2018b). All of these factors reinforce the importance of bread in the strategy for reducing salt consumption.

On the 12th of August 2009, legislation was implemented that is still in force and which limits the salt content of bread in Portugal to a maximum value of 1.4g of salt per 100g of bread (Portugal, 2009). However, it is important to note that this legislation considered neither imported bread nor bread classified as traditional. Bread classified traditional is:

- bread produced at the regional level, with characteristics easily recognizable by consumers, with a protected name and classified as traditional;
- traditional bread, including products to which sausage and meat preparations are added;
- special bread with very specific characteristics, for which the standardization of a general salt limit is not appropriate and for which the use of other ingredients is permitted, as specified in point 5 nº 7º of paragraph nº 425/98;
- bread-related / similar products (ASAE, 2019).

To reduce the salt content consumed daily by the Portuguese, the Ministry of Health also established a self-regulation agreement with bread producers and distributors, setting a salt limit of 1.0g per 100g of bread, as mentioned in Chapter 4. Later, on 13 July 2018, a new law setting maximum levels of salt content in bread was proposed by the Ministry of Health. Subsequently, this law was approved at the Government's Secretaries' of State meeting and duly notified by the Portuguese authorities to the Commission (European Commission, 2018). This new law aimed to not only expand the scope of the legislation to include imported bread but also gradually reduce the maximum salt content allowed in bread, with a deadline in 2022. It was projected that for every 100g of bread there would be a salt reduction from 1.4g to (i) 1.3g of salt before the 1st of January 2019; (ii) 1.2g of salt before the 1st of January 2020; (iii) 1.1g of salt before the 1st of January 2021; (iv) and finally 1.0 g of salt before the 1st of January 2022. Thus, in Portugal, by 2022 the maximum salt content in bread would be 1.0g compared to 1.4g of salt per 100g of bread, as established in the initial legislation of 2009.

The approval of the Integrated Strategy for the Promotion of Healthy Eating (Estratégia Integrada para a Promoção da Alimentação Saudável - EIPAS), published by Order No 11418/2017 on the 29th of December 2017, made it possible to put into practice such a rigorous approach, which involved several government sectors (Portugal, 2017). The strategy was defined according to four major political axes, the first being explicitly related to recommendations aimed at developing measures to reduce the amount of salt ingested by the Portuguese population.

However, since the proposed legislation would constrain free trade between Member States due to the restriction regarding salt content of imported bread, upon deliberation by the EC, it was not accepted. As the WHO is a global agency of the United Nations that aims to coordinate and direct global health, it developed a preliminary assessment regarding the impact of this policy on mortality, which was subsequently shared with the EC. In 2007, The Strategy for Europe on Nutrition, Overweight and Obesity related Health Issues was adopted by the EC. In addition, through the launch of the European Union (EU) Salt Reduction Framework, the need to reform food was also recognized as a way to achieve a reduction in salt intake among populations of the different Member States. This structure also recognized bread as an important target for intervention since it is one of the main sources of salt intake among the population. Regardless, the EC did not consider the evidence presented by this study strong enough and the protection and promotion of public health were surpassed by internal market considerations. Moreover, several sectors showed inconsistencies that were highlighted throughout this process.

- **Hypothesis**

Regulating the maximum amount of added salt on highly consumed products is effective in tackling NCDs.

Objectives

This chapter aims to measure the possible health gains resulting from the newly proposed law, as well as estimate the amount of bread covered by the legislation currently in force.

Methods

For the following sections, the methodology used is as described by Goiana-da-Silva and colleagues (Goiana-da-Silva et al., 2020d).

Data Sources

During this work, no data source was found with information regarding the amount of salt consumed through bread, nor with the total sales volume of bread in Portugal. Therefore, information on this was collected through several sources. Using these data, it was possible to infer some of the variables that were not possible to obtain, regarding salt content of bread and the total sales volume of bread in Portugal.

Bread consumption

The data sources used in this study, as well as the formulas and estimated final values, are illustrated in Figure 17. Through the latest National Food, Nutrition and Physical Activity Survey, information was collected regarding the daily consumption of bread by the Portuguese. According to this survey, 100.3g of bread are consumed daily per capita. Considering that Portugal currently has 10.300.000 people (National Institute of Statistics, 2019), an estimate of the daily intake of bread for the entire Portuguese population was made. Subsequently, by multiplying that value by 365.25

(average number of days per year), the annual intake of bread in Portugal was estimated.

In Portugal, there are two ways of selling bread: pre-packaged or in bulk (in bakeries). To obtain the quantity of pre-packaged bread sold in Portugal, I used data from NIELSEN - a global information and measurement company, which complements sales data with observations obtained in the store. According to these data, 40,040 tonnes (t) of pre-packaged bread were sold in Portugal in 2016 (Nielsen, 2019). Of these, 21,764 tons were imported, according to the National Institute of Statistics (2019). Considering these values, it was possible to calculate the amount of pre-packaged bread produced in Portugal. Finally, I was able to calculate the amount of bread sold in bulk in bakeries, by the difference between the total bread sold in the country and the packaged bread.

It was also necessary to know the proportion of bread classified as traditional, given its exemption from current legislation regarding the maximum salt content allowed in bread. According to AIPAN (National Association of Bread Producers) "traditional bread" constitutes 45% of all bread produced in Portugal (AIPAN, 2019).
To calculate the amount of bread currently exempt from legislation limiting the salt content in bread, data from Portugal referring to the amount of traditional and imported bread was used.

Salt in bread

To assess the salt intake from bread offered in the Portuguese market, it was necessary to start by calculating the amount of salt from all the bread sold in Portugal. For that purpose, data obtained through the National Food, Nutrition, and Physical Activity Survey during the period 2015-2016 was consulted. According to this

research, the average daily salt consumption is 7.4g per capita, and bread is responsible for 18.2% of salt intake by the Portuguese population (Lopes et al., 2017a; Lopes et al., 2018b). In order to estimate the total salt intake per day of the Portuguese, the size of the population was multiplied by the daily salt intake per capita. It was also possible to calculate the total daily intake of salt from the bread by the entire population since data obtained through the research mentioned above showed that 18.2% of salt intake comes from bread. Finally, using this value and multiplying it by the average number of days in a year (365.25), it was possible to estimate the annual intake of salt from bread in the entire population.

Simulations

Subsequently, two simulations (counterfactual scenarios 1 and 2) were used to estimate the overall decrease in salt consumption by the Portuguese population, assuming that all bread sold in Portugal (regardless of whether it is traditional, domestic or imported) complied with the legislation on the limit of the salt content in bread.

Counterfactual scenario 1 – According to this first scenario, it is assumed that all bread products, including those that are either traditional or imported, comply with the legislation establishing a maximum limit of 1.4g of salt per 100g of bread. As in the baseline, it is assumed that 76% of national bakeries produce bread with a salt content under 1g/100g of bread.

Counterfactual scenario 2 – In this second scenario, the maximum salt content of 1.0g/100g of bread is applied to all bread sold in Portugal – whether traditional, national or imported – according to what was proposed for 2022.

Modelling health gains

Finally, for each counterfactual scenario, the impact on mortality was modelled, using as a basis for salt intake the value of 7.4 g per day per capita. For this purpose, a mortality modelling tool – developed at Oxford University and endorsed by the WHO Regional Office for Europe – called PRIME NCD was used, which is described in detail in other bibliographic sources (Goiana-da-Silva, 2019d; Scarborough et al., 2014). Based on the relative risk values of the peer-reviewed meta-analyses, and through the PRIME NCD, it is possible to predict the number of deaths that would occur in the baseline year, assuming that the distribution of daily salt consumption (risk factor) had been different. Additionally, CIs are generated through Monte Carlo analysis.

Sensitivity Analysis

Subsequently, 4 sensitivity analyses were conducted to explain possible biases resulting from the calculations performed in this study.

Sensitivity analysis 1: Proportion of bakeries with 1g of salt per/100g bread

- Sensitivity analysis 1a: There is a possibility of underreporting the proportion of bakeries that use a salt content of 1g/100g of bread by the bakeries' national association. Therefore, I changed the baseline ratio from 76%/24% to 100%/0%, regarding the proportion of bakeries with salt content under 1g/100g of bread.
- Sensitivity analysis 1b: On the other hand, there is also the possibility of over-reporting the proportion of bakeries that use a salt content of 1g/100g of bread by the bakeries' national association. Thus, I changed the baseline ratio from 76%/24% to 50%/50%, regarding the proportion of bakeries with salt content under 1g/100g of bread.

Sensitivity analysis 2: Higher salt intake baseline

Bearing in mind that salt intake levels are generally underreported by participants in the National Dietary Survey, the model in this study could underestimate the number of deaths prevented, if the initial estimate of salt intake was too low. For this reason, I used alternative estimates obtained from the literature regarding salt consumption by the Portuguese population.

Using data about urinary excretion of salt in the Portuguese sample, a PHYSA study carried out in 2011-2012 estimated that in Portugal the standard daily intake of salt was 10.7g per capita (Polonia et al.,2014). For this reason, the analysis was re-run using as a reference value for salt intake 10.7g/day/capita, instead of 7.4g/day/capita, as mentioned above.

- Sensitivity analysis 2a: All bread products reach the salt content threshold of 1.4g/100g of bread and have a daily baseline value of 10.7g of salt per capita.
- Sensitivity analysis 2b: All bread products reach the salt content threshold of 1.0g/100g of bread and have a daily baseline value of 10.7g of salt per capita.

Sensitivity analysis 3: Proportion of salt coming from bread

I also varied the proportion of salt intake through bread by +/- 1%, as it was not possible to find references for alternative values, either from the literature or from other datasets. For the two counterfactual scenarios, two sensitivity analyses were performed. Regarding the first counterfactual scenario 1 (CF1), for both analyses, it is assumed that the products reach the threshold of 1.4g of salt per 100g of bread (sensitivity analysis 3a CF1 and 3b CF1). On the other hand, for the counterfactual

scenario 2 (CF1), for both analyses, it is assumed that the products reach the threshold of 1.0g of salt per 100g of bread (sensitivity analysis 3a CF2 and 3b CF2).

- Sensitivity analysis 3a CF1: All bread products reach the threshold of 1.4g of salt per 100g of bread, with an increase of 1% in the proportion of salt from bread.
- Sensitivity analysis 3b CF1: All bread products reach the threshold of 1.4g of salt per 100g of bread, with a decrease of 1% in the proportion of salt from bread.
- Sensitivity analysis 3a CF2: All bread products reach the threshold of 1.0g of salt per 100g of bread, with an increase of 1% in the proportion of salt from bread.
- Sensitivity analysis 3b CF2: All bread products reach the threshold of 1.4g of salt per 100g of bread, with a decrease of 1% in the proportion of salt from bread.

Sensitivity analysis 4: Lower baseline of daily salt intake

After sensitivity analysis 2 was performed, the proportion of salt intake through bread was also decreased by 1%, as it was not possible to find references for lower values of daily salt intake, either from the literature or from other datasets. Both analyses were performed for both counterfactual scenario 1 and 2.

- Sensitivity analysis 4a: All bread products reach the threshold of 1.4g of salt per 100g of bread, with a decrease of 1% in the baseline of daily salt intake.
- Sensitivity analysis 4b: All bread products reach the threshold of 1.0g of salt per 100g of bread, with a decrease of 1% in the baseline of daily salt intake.

Results

As shown in Figure 17, the Portuguese population consumes a total of 376,221 tonnes (t) of bread per year, of which 4.86% (corresponding to 18,276t per year) is pre-packaged bread produced nationally and 89.36% (corresponding to 336,179t per year) is bread baked fresh at national bakeries. It has also been estimated that 48.18% of all bread sold in Portugal is currently exempt from legislation that defines the maximum salt value in bread, which corresponds to 181,268 t of bread per year.

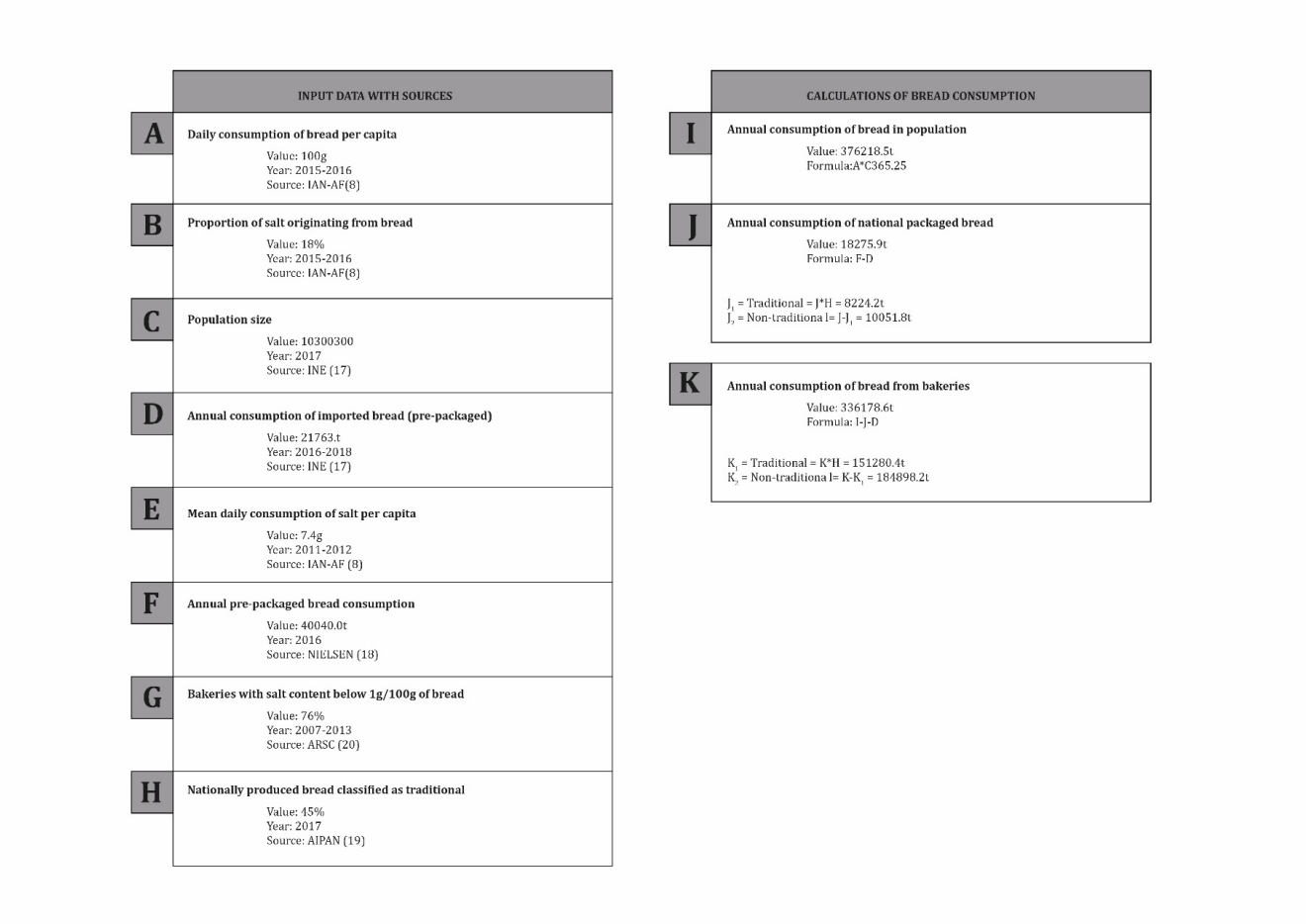


Figure 17 - Illustration of the estimated consumption of different types of bread in Portugal.

Notes: Input variables presented (values obtained by authors in order to perform further calculations) contain information about the data sources where information was obtained and the year to which the value refers. Remaining variables were calculated based on the input variables and are presented with the formula used in the analysis.
Source: Goiana-da-Silva (2020b)

As shown in Table 17, according to the first counterfactual scenario, there would be a reduction of 1.4 t/day of salt consumed in Portugal, translating into a daily decrease of 0.13 g of salt per capita, if all bread sold complied with the current law on the maximum salt content in bread. Using the PRIME NCD modelling tool, while keeping all other variables constant, it was possible to estimate that 107 deaths would be prevented per year (95% CI 43 to 172) if there was a reduction in the daily salt consumption of 0.13g per capita.

On the other hand, according to the second counterfactual scenario, there would be a reduction of 3.6 t/day of salt consumed in Portugal, translating into a daily decrease of 0.35 g of salt per capita, if the limits set by the proposed bill (1g of salt per 100g of bread) were fulfilled. Again, using the PRIME NCD modelling tool, while keeping all other variables constant, it was possible to estimate that 286 deaths would be prevented per year (95% CI 123 to 454) if there was a reduction in the daily salt consumption of 0.35g per capita.

Table 17 – Simulations to estimate the overall decrease in salt consumption by the Portuguese population, assuming that all bread sold in Portugal complied with the legislation on the limit of the salt content.

Simulations	Description	Baseline salt consumption (g/day/capita)	Absolute salt reduction (g/day/capita)	Counterfactual (i.e. new) salt consumption (g/day/capita)	Deaths averted (95%CI)
Counterfactual scenario 1	All products <1.4g salt/100g bread	7,40	0,13	7,27	107 (43 to 172)
Counterfactual scenario 2	All products <1.0g salt/100g bread	7,40	0,35	7,05	286 (123 to 454)
Sensitivity analysis 1a	Proportion of bakeries with	7,40	0,18	7,22	148 (59 to 235)

	<1% salt moves from 76%/24% to 100%/0%				
Sensitivity analysis 1b	Proportion of bakeries with <1% salt moves from 76%/24% to 50%/50%	7,40	0,08	7,32	67 (26 to 109)
Sensitivity analysis 2a	Different baseline (10.7g), all products <1.4g salt/100g bread	10,70	0,73	9,97	592 (243 to 932)
Sensitivity analysis 2b	Different baseline (10.7g), all products <1.0g salt/100g bread	10,70	0,95	9,75	768 (328 to 1,212)
Sensitivity analysis 3a CF1	1% more salt comes from bread	7,40	0,21	7,19	173 (71 to 273)
Sensitivity analysis 3a CF2	1% more salt comes from bread	7,40	0,42	6,98	343 (139 to 542)
Sensitivity analysis 3b CF1	1% less salt comes from bread	7,40	0,06	7,34	50 (20 to 84)
Sensitivity analysis 3b CF2	1% less salt comes from bread	7,40	0,27	7,13	221 (98 to 351)
Sensitivity analysis 4a	Different baseline (1% lower), all products <1.4g salt/100g bread	7,33	0,12	7,21	99 (40 to 160)
Sensitivity analysis 4b	Different baseline (1% lower), all products <1.0g salt/100g bread	7,33	0,33	6,99	271 (111 to 432)

Source: Goiana-da-Silva (2020c)

As it was referred in the methods section, the average overall daily salt consumption by the Portuguese is 7.4g per capita. This refers to the overall daily diet of the

portuguese and all its salt sources. Furthermore, from the referred 7.4g, bread is only responsible for 18.2% of salt intake by the Portuguese population. Thus, building on the team of nutritionists (that collaborated in this study design) input, it was considered that the variations on the bread salt content that would be necessary to achieve higher variations than 1% in the total volume of daily intake of salt per capita (in terms of the overall diet) would not be realistic, because of the flavour variations on bread they would imply. That said, the Preventable Risk Integrated ModEl used to estimate the mortality impacts associated with changes in nutrition policies the the one hereby proposed has limitations and potential bias. Preventable Risk Integrated ModEl was based on results of meta-analysis previously carried out at an international level and is able to predict changes in mortality for any of the 24 possible NCDs. However, the strength of association established between specific nutrients intake and its impact in mortality for each NCD identified in such meta-analysis varied. The strongest association established was between salt intake and mortality due to CVDs. Therefore, variations in salt intake, even if they may seem small like 1%, tend to have strong impacts on CVD driven mortality. This fact may explain important variations on avoided mortality verified during the sensitivity analysis performed.

Discussion

Although current legislation sets a limit on the amount of salt allowed in bread, about 50% of all bread sold in Portugal is exempt from that legislation. Bread classified as "traditional" – considered cultural heritage with a protected name – together with pre-packaged bread are the two main groups of bread not covered by the legislation. However, it would be possible to achieve a 9.9% reduction in salt intake from bread, if the legislation were extended to include all types of bread sold in Portugal. In addition, it would be possible to achieve a 25.7% reduction in salt intake from bread, through the application of a new law that would reduce the maximum permitted salt

content to 1.0g per 100g of bread. Moreover, through the proposed law it would be possible to prevent 286 deaths caused by NCDs in Portugal per year, due to the significant reduction in salt intake from bread.

The implementation of national initiatives that promote salt reduction is recommended to all Member States, by the High-Level Group on Nutrition and Physical Activity of the EC. One of these recommendations was for Member States to focus on the categories of foods recognized as the main sources of salt intake, namely bread, to achieve a reduction of at least 16% in salt intake in the following four years (European Commission, 2018a).

To achieve the WHO's national recommendations of promoting salt reduction, on the 1st of July 2008 the EU framework for salt reduction was developed (WHO, 2016a). This framework allows for the preservation of the flexibility Member States need to develop specific strategies regarding the reduction of salt consumption, while supporting national plans. In addition, this framework not only assumes food groups that represent the main source of salt intake, namely bread, as a priority but also supports measurable actions. Based on this principle, the Portuguese Ministry of Health requested permission from the EC to broaden the national law and incorporate imported bread.

To protect public health in their territories, Member States are allowed to adopt the rules considered necessary. However, these rules must be in line with the general principles of EU law as a whole and with EU internal market law (C-174/82 *Sandoz*). However, the EC did not endorse the proposal, regardless of the support and evidence provided by the WHO. It was concluded that access to bread produced and sold legally in the remaining Member States would be restricted in Portugal if the new bill came

into force. The EC highlight case law on the directive regarding salt content in bread, which determined that setting restrictions on salt content represented a measure with similar effect to a quantitative restriction, which clashes with Article 34 TFEU (C-17/93 *Van der Veldt*; C-123/00, *Bellamy*).

Nevertheless, if it pursues a legitimate objective of protecting public health (Article 36 TFEU; C-120/78 *Cassis*) and is proportionate to that objective, it is possible to justify and even allow the permanence of a national rule conflicting with Article 34 TFEU. A rule is considered proportional if it is required and suitable for attaining that objective. On the other hand, a measure is considered unnecessary 'if human life and health can be as effectively protected by measures that are less restrictive of trade within the European Union' (C-333/14 *Scotch Whisky Association*, para 41).

Using existing scientific data, Member States are accountable for demonstrating that their measures are crucial for the protection of public health (C-333/08 *Commission v France*). A reliable line of case law has recognized that 'specific evidence' must be offered to validate trade-restrictive public health rules. Therefore, the Member State is required to prove that science objectively endorses the proposition that the rule will be expected to contribute to the protection of public health (C-148/15 *Deutsche Parkinson Vereinigung*; C-456/10 *ANETT*; C-254/05 *Commission v Belgium*; C-319/05 *Commission v Germany*).

Therefore, it is not impossible to justify the rules regarding the salt content for bread. In addition, contrary to what was suggested by the EC, it is not possible to match the population health effects resulting from a mandatory reformulation of the salt levels in all bread products sold in a country, through the implementation of other measures. One of the alternative strategies to achieve salt reduction at the population level is

related to labelling which, according to the CJEU, would be less trade-restrictive (C-17/93 *Van der Veldt*). However, according to the recent review by Hyseni et al. (2017), while labelling achieves a salt reduction of 0.4g/day, the mandatory reformulation allows the reduction of 1.45g of salt per day, which is about 3.6 times higher, and so it is the most effective measure for reducing salt at the population level (Hyseni et al., 2017). Hence, although labelling allows a reduction in salt intake at the population level, there are specific data to support that the same public health objective can be achieved more effectively through mandatory reformulation of the salt levels in all bread products sold in a country. Also, the fact that the gradual reduction in the salt content of bread is less noticeable, as it would not be detected by consumers, constitutes another advantage to the implementation of reformulation measures.

Furthermore, although the pattern of evidence is specific, according to recent case law, Member States only have to show 'objectively whether it may reasonably be concluded from the evidence submitted' that their measures are essential for protecting public health, rather than 'prove, positively, that no other conceivable measure could enable the legitimate objective pursued to be attained' (C-333/14 *Scotch Whisky*, paras 55 and 59). Therefore, instead of being treated as alternatives, the existence of other means to reach a salt reduction in the Portuguese population should be considered as parallel means of reaching the objective and does not overturn the need for legal regulation regarding salt content of the products sold in the country. Moreover, not only is there proven effectiveness of the regulated reformulation strategy, but the scale of the problem associated with excessive salt intake is also alarming. According to the WHO estimates, reformulation measures help reduce mortality in the population. Therefore, it was imperative to make changes in the legislation.

This study illustrates how economic gains related to free trade may conflict with public health interest. The growing increase in consumption of foods rich in fat, sugar, and salt as well as processed foods, is associated with both free trade and globalization (WHO, 2003). If implemented effectively, the HiAP approach (WHO, 2014a) could be a response to this trend, helping policymakers to take steps to strike a better balance between trade policy and health protection and to recognize where trade policy can compromise health protection. The imperatives of HiAP may be contradicted by some, who suggest that EU free movement rules prevent the adoption of evidence-based public health policies and favour the promotion of trade. However, to accommodate the conflict between the objectives of trade and health, EU internal market law has always been continuously developed and framed. The possibility of the Member States to prioritize the protection of public health objectives to the detriment of commercial objectives is covered by internal market law.

By examining the evidence, it is possible to strike a balance between commercial and public health objectives. According to this examination, if there is evidence showing that a public health measure that restricts free trade guarantees real benefits to public health and that it is more effective in guaranteeing those benefits compared to other less restrictive measures to trade, then it can be considered acceptable as a matter of EU law.

When considering the matter of "traditional" bread with protected names, it becomes even more crucial to reconcile the protection of both public health with the protection of free trade in EU law. For countries where traditional bakery products are very popular and belong to the cultural heritage, and where bread is a large part of the daily diet of the population – as is the case in Portugal – this issue is particularly

relevant. Of all existing bread products, around 45% are exempt from the legislation as many regions of Portugal have their own traditional type of bread. Consequently, there is a strong contribution to the total salt intake by the population, as well as the resulting mortality from NCDs, due to the circulation of large amounts of unregulated salt. One of the most important factors of high salt consumption in Portugal will be almost impossible to control if the salt content in bread originating in Portugal cannot be regulated.

Limitations

In the present study, one of the limitations is that several sources were used to collect data, which refer to different years. Some of the input data, such as the percentage of salt intake from bread (Lopes et al., 2017a; Lopes et al., 2018b) and the fraction of bread classified by AIPAN as traditional (AIPAN, 2019), are already estimates. For this reason, instead of being treated as literal values, the values calculated in this study should be considered as estimates. Most of the pre-packaged bread is sold in retail stores, and the figures provided by NIELSEN for pre-packaged bread prices include all data from existing retail stores in Portugal. However, there may be an underestimation of the sales value of this type of product, as the information provided by NIELSEN does not include a small portion of pre-packaged bread that is sold through other channels.

To calculate the percentage of bakeries that comply with the maximum limits established by the legislation of 1.0g of salt per 100g of bread, the Administration of the Central Region (ARSC) sample that was used in the present study refers only to the central region of Portugal, where several projects, worked proactively to reduce the amount of salt present in bread. For this reason, it is predicted that at the national level the proportion of bakeries that comply with the legislation on the limit of salt

content in bread may be lower. Therefore, compared to the value estimated in this study, the real value of the impact of the new legislation may be substantially higher. Another limitation of the present study is related to the impossibility of estimating the contribution of traditional and imported bread to salt intake by the Portuguese population since it was not possible to collect information regarding the salt content present in these bread products.

It should be noted that the National Dietary Survey IAN-AF was used as a source for both the daily intake of salt and the daily amount of bread intake by the Portuguese population, to reduce the number of data sources used in carrying out this study. Nonetheless, it is important to emphasize that, in Dietary Surveys, it is common to underreport salt intake levels. Therefore, as shown by sensitivity analysis 2, the impact of health policies discussed in the present study may be underestimated due to the baseline value considered for salt intake. Likewise, there may also be an overestimation of the impact of health policies, due to the inherent limitations of the PRIME NCD modelling tool, as described in the literature provided. Nevertheless, considering both the possible underestimation and the possible overestimation of the impact of health policies, it is expected that the influence of the bias associated with them is residual.

While the data in this study do not allow to consider the effects of substituting the salt content in bread, if consumers like bread with less salt content, this change could shift their preferences concerning other products with high salt content. Although this possibility may exist – which could not be ruled out in this study – a recent meta-analysis showed that there is no change in consumer acceptability of this type of products, regardless of the salt reduction in bread of up to 40%. This leads to believe that the effects inherent to consumer acceptability are unlikely to affect the findings of

the present study since the legislation only contributes to a variation between 9.9% and 25.7% in the reduction of salt intake from bread (Rachael et al., 2017). Another research study that also refers to a similar strategy is Goiana-da-Silva's (2019d) study on the impact of the Portuguese Food Reformulation Agreement on premature mortality. To model the impact of Public Health Nutrition interventions on the Portuguese population, both the article and the present study use the PRIME modelling tool. However, in the case of the article, the co-regulation intervention of the food industry has a greater impact on deaths prevented, given that it has a broader scope compared to the salt reduction legislation of the present study. For this reason, it seems that the findings of the present study are coherent and aligned with existing literature (Goiana-da-Silva, 2019d).

Policy implications at the national level

Various pieces of evidence show that if Portuguese citizens continue to ingest salt according to the current standard, this will result in a significant impact on the prevalence and incidence of NCDs. Therefore, it not only jeopardizes the sustainability of the National Health Service but also constitutes a serious risk to public health. If this trend continues, Portugal will not be able to accomplish SDG target 3.4, according to which – considering 2010 as the reference year – the number of premature deaths should be reduced by 25% before 2025, and premature mortality should be reduced by one third before 2030.

To ensure that neither economic gain nor cultural heritage jeopardizes health policies that aim to improve people's lives, health and well-being, it is imperative to have a stronger commitment at the EU level for coordinated actions between sectors and Member States to promote HiAP.

Two options may arise for the Portuguese Government if the EC does not find any additional clarifications by the Portuguese Authorities significant enough to justify the full implementation of the proposed legislation. One of these options implies that the Portuguese government accepts the limitations imposed by the EC regarding the measures proposed by Portugal with the aim of protecting its citizens from NCDs that may result from excessive salt consumption. By doing so, alternative non mandatory tools to persuade bread producers to decrease the amount of salt added to bread should be considered. For example, fiscal policies such as taxation of bread with excessive salt levels should be considered in this context.

On the other hand, the Portuguese Government may choose to go against these limitations imposed by the EC, facing the consequent legal actions, but also managing to put the proposed measures into practice, getting closer to achieving its commitment of reducing premature mortality resulting from NCDs by one third by 2030.

According to estimates obtained by the WHO, each year, it would be possible to avoid 286 deaths attributable to NCDs caused by excessive salt consumption by the Portuguese population if the maximum volume of added salt to bread was decreased.

Policy Implications at the global level

Although mandatory reformulation has proven to be effective in reducing salt consumption by the Portuguese population, current legislation does not cover imported or traditional bread, which means that around 50% of bread sold in Portugal is exempt. In order to address this issue, and aligned with the fulfilment of the implementation of EIPAS, a bill was proposed to reduce the maximum levels of salt content in bread to 1.0g of salt per 100g of final product (European Commission,

2018b). However, Portuguese legislation must always comply with the European Union Law. Regardless of the efforts made by the Portuguese government to promote the health of the population through a HiAP approach, a definitive rejection by the EC threatens them. In addition, considering that the EC has made recommendations to Member States to reduce salt intake among citizens, should the implementation of public health policies be reversed, questions may arise as to whether this action goes against these recommendations (European Commission, 2018a).

Health policy issues that may impact citizens lives must no longer be treated like "business as usual legislation" neither at the national level, nor at the regional or global level. Thus, Member States must be the ones drawing that new line of action for their regional and global representatives. That said, and assuming excessive salt consumption over the European Countries citizens is a major public health threat, public health should assume a heavier stake in all the political decisions that may impact salt consumption (even if they are not under the EC Department for health and Food safety jurisdiction). On the other hand, it is time for the Ministries of Health to invest more in acquiring high quality international law competencies, so that the health sector will be able to "speak" the same language used by economic bureaucrats that manage central institutions. At the regional level, there are already good examples of Member States which have managed to overcome such legal limitations posed by European Central Institutions based on public health mandatory interests. After years of legal fights against the EC, Scotland was allowed to apply its Minimum Unit Pricing Ban to Alcoholic Beverages. This created a precedent that other Member States, like Portugal, may want to learn from and eventually follow.

Chapter 7

Nudges: looking for a single front of pack labelling system

Introduction

According to data obtained by GBD, one of the main risk factors to the reduction of healthy life years among the Portuguese population are unhealthy diets, contributing with a risk of more than 15% (Goiana-da-Silva, 2018b; IHME, 2015). In Portugal, chronic diseases represent 86% of the total burden of disease (DGS, 2017b; Goiana-da-Silva, 2018b) and are strongly associated with behavioural risk factors, of which one of the most important determinants is the population's eating habits (Goiana-da-Silva, 2018b). Moreover, as mentioned in previous chapters, other diseases associated with these risk factors are obesity and overweight, which in the Portuguese population have a prevalence above 50% (Lopes et al., 2017a). Given this context, it is imperative to adopt a multi-stakeholder approach, including the private sector together with the entire government, in order to develop a new philosophy for Public Health, with a greater investment in health promotion in Portugal.

In general, several studies previously carried out demonstrated the existence of a great inability of the consumer to fully interpret or understand the information present on food labels (Gomes et al., 2017), which is also supported by data available for the Portuguese population. In addition, a study carried out with the support of the WHO, showed that the nutritional information present on food labels is not understood by 40% of all people surveyed in Portugal (Gomes et al., 2017). It is important to note that this rate increases from 40% to 60% for individuals with a lower socioeconomic level. Also, regarding label comprehension, that same study showed that the use of colours on the front-of-pack labels (FoPLs) was very promising.

The libertarian-paternalist approach to policy known as nudge was initially developed by Thaler and Sunstein (2008). The Nudge theory proposes positive reinforcement and indirect suggestions as ways to influence the behaviour and decision making of groups or individuals. It focuses on designing spaces (including the space of the food labels) to shape the behaviour of individuals while not restricting consumer choice or imposing restrictions or penalties on producers. In the context of concerns over diet-related chronic diseases and obesity, new Nudges, such as FoPLs, have been proposed or implemented in an attempt to shift consumer dietary choices (Scrinis & Parker, 2016).

Several companies have already adopted FoPLs, which were first introduced in the 1980/1990s. In addition, numerous countries have already implemented them, assuming them as part of national nutritional prevention programs, and thus showing public support for FoPLs (Egnell et al., 2019; Goiana-da -Silva, 2019b).
Of all FoPLs, those considered most popular include the following: (i) Keyhole Healthy Choice, which are endorsement logos; (ii) Traffic Light System, which are nutrient specific interpretative models; (iii) Guideline Daily Amount System, which are numeric informative models; and finally (iv) Nutri-Score, which are summary interpretative models.

Several studies show evidence that FoPLs can be a promising strategy not only to encourage food industry manufacturers to enhance the nutritional profile of existing products and to offer healthier products but also to enhance the nutritional quality of the food choices available for consumers (Kleef & Dagevos, 2015; Ni Mhurchu, Eyles & Choi, 2017; OECD, 2008; Vyth et al., 2010; WHO, 2004). Since evidence suggests that implementing FoPLs is an effective nudging strategy (Scrinis & Parker, 2016), the

WHO advises its implementation as a 'best buy' to avoid the development of NCDs among the population (WHO, 2017e).

According to European regulations on FoPLs, in addition to being voluntary, different models can coexist in the same market (European Union, 2012). However, consumers may feel confused due to the existence of multiple models (Draper et al., 2013). For this reason, in order to change the existing regulation to a harmonized regulatory context, since 2018 discussions have been held by the EU commission (DGS, 2017b). With the inclusion of political discussions regarding FoPLs within an electronic Codex Alimentarius working group, the government's interest in this area has been particularly demonstrated (Thow et al., 2019).

In providing nutritional information, evidence suggests that the most efficient method is using colours in the Front-of-pack interpretative models. This type of interpretive models allows consumers to make healthier food choices because they can better understand the information provided on labels, and has already been adopted in France, England and other European countries (Cecchini & Warin, 2016; Emrich et al., 2017). The Traffic Light System was the chosen FoPL model implemented in the United Kingdom, while France opted for a more complex model that allows a global analysis of the product's nutritional profile, choosing the Nutri-Score for this purpose (Deschamps et al., 2015; Julia & Hercberg, 2017).

Although several proposals regarding this matter have been submitted to the Portuguese Parliament, to date none of them have been politically approved. Regardless, following the submission of numerous proposals by various political aisles, the Portuguese Parliament recommended that the Portuguese Government find an

alternative to the current Traffic Light System, considering a simplified model of FoPL as an alternative.

There is more and more evidence that Nutri-Score works well for consumers. This interpretative model, in addition to using letters, also applies a colourful graphic representation. This system considers five mutually exclusive categories that are used to classify the nutritional profile of a given food. As shown in Figure 18, this algorithm, which has already been scientifically validated, allows the innovative classification of products between green (associated with the letter A) and red (associated with the letter E), based on nutritional criteria inherent to the food in question.

Several studies have recently been carried out for the development of the French FoPLs. When comparing other FoPLs with Nutri-Score, they determined that the latter is the easiest to understand. Regardless of the demographic and socioeconomic level, when compared with other systems - particularly with the Traffic Light System - Nutri-Score is not only easily recognized but also easily interpreted. The previously mentioned findings are illustrated in Figure 18, as well as various FoPLs applied to different biscuits, as an example. Compared to other FoPL scoring systems, the Nutri-Score was the one that had the most positive evaluation by all population subgroups, especially in overweight and obese individuals (Julia & Hercberg, 2017; Julia et al., 2017).

Products that have a more adequate nutritional profile can be identified by consumers through different interpretive systems available. However, especially in consumers who adopt unhealthy eating behaviours, evidence shows that Nutri-Score is the system that most successfully promotes healthier choices by the consumer (Ducrot et al., 2015a). Even for consumers who do not have technical knowledge of nutrition,

Nutri-Score can help consumers to successfully classify food products depending on their nutritional characteristics. Moreover, it is possible to promote appropriate nutritional choices by consumers, through marketing and communication initiatives related to Nutri-Score. This is especially clear when it comes to the product category that includes sweets, cookies, and biscuits (Ducrot et al., 2015a).

In 2016, a study was carried out to compare the Nutri-Score with other FoPLs, evaluating about 1298 food products over 10 weeks, in more than 60 supermarkets. Through this study, it was possible to conclude that Nutri-Score never results in poorer preferences from a nutritional point of view – unlike what happens when other labelling systems are used – in addition to demonstrating an obvious superiority when compared to all other FoPLs. Moreover, it is important to note that, evaluating the food products chosen by consumers and present in their shopping baskets, the nutritional quality of these products had an average increase of 4% due to the Nutri-Score labelling system (Fonds français pour l'alimentation, 2017).

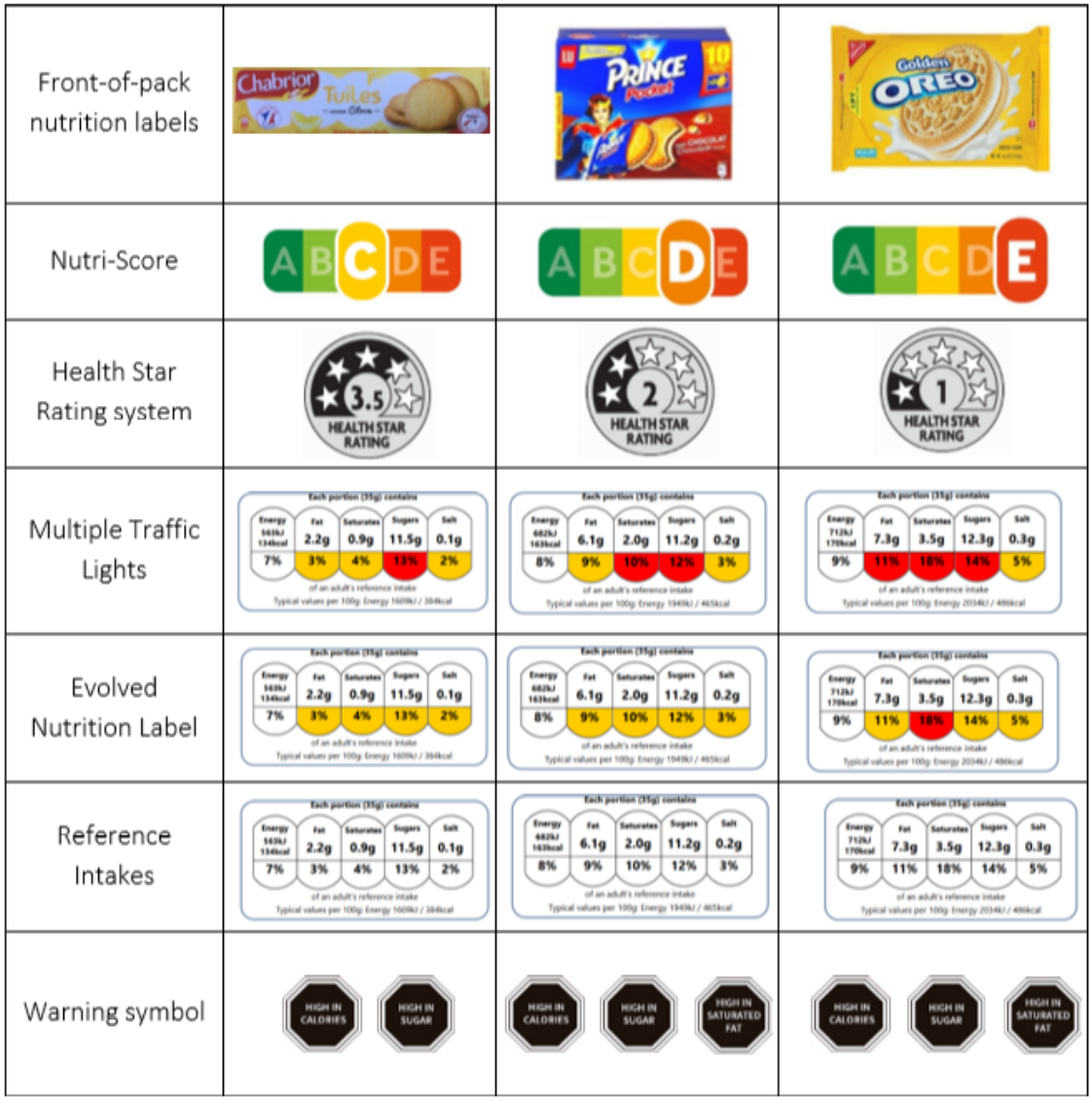


Figure 18 - Different FoPLs applied to different biscuits.

Source: Goiana-da-Silva et al., 2019c: p176

A qualitative study, carried out in more than 20 stores, supported the results that the Nutri-Score and other summary FoPLs were more effective in promoting more appropriate food choices, through guiding consumer shopping and leading to the prioritization of better global nutritional profiles (Centre de recherche pour l'étude et l'observation des conditions de vie, 2017). In addition, regarding the previously mentioned benefits associated with the Nutri-Score concerning public health, these were supported by a recent study, in which 809 individuals participated in real-life

shopping environments, that showed similar results using experimental economy analyses and methodologies (Crosetto, Muller & Ruffieux, 2016).

It was the French Ministry of Health that developed the Nutri-Score and defined it as the national reference. The Nutri-Score was implemented on all products of more than 90 retailers and food manufacturers, who decided to follow the example and implement (or at least committed to implementing) this labelling system. In addition to having the robust support of the European consumer's associations, Nutri-Score was also adopted at the national level by both the Ministries of Health of Spain and Belgium.

On the contrary, little progress has been made in Portugal in this regard. This lack of progress was largely associated with strong opposition from various companies in the retail and food manufacturing sectors, as well as with limited collaboration between different government areas, and regulatory and policy levers lying outside the health sector. Consequently, in Portugal, there is an absence of any type of standardization of FoPLs, with several different systems being used at the national level. Rather than improving consumers' ability to make decisions regarding the most suitable food products, the excess of different FoPLs available on the Portuguese market may have the opposite effect, contributing to greater confusion by consumers. For this reason, it is imperative to implement a harmonized national FoPL system (Goiana-da-Silva, 2019a).

Under these circumstances, guidance was requested by the Regional Office for Europe of the WHO through the hands of the Portuguese Minister of Health. Subsequently, the WHO wrote a report on FoPLs, in which several considerations were identified regarding the review or adoption of national and/or regional food labelling policies. To

guarantee that policies accomplish the expected health outcomes concerning FoPLs, it is essential that certain considerations are taken into account, including:

- conducting formative research along with stakeholder commitment to guarantee the selection of the most suitable policy;
- choosing a government-led policy development as it is more credible to the consumer compared to a commercial system;
- ensuring a clear understanding and use of the FoPLs by the consumer, through the application of a system that is unique and consistent.

There are several similarities regarding food and the structure and organization of meals, between the French and Portuguese population (Gerber, 2016). In October 2018, the Portuguese Government guidance request received an official response from the Regional Director of the WHO, based on these facts. All the criteria that make a FoPL effective seem to be met by the Nutri-Score, according to different evidence provided by several studies. For this reason, it could be assumed that in Portugal, of all FoPLs, Nutri-Score would be appropriate to be both considered and endorsed. Still, for this to happen it is necessary to have evidence in the Portuguese population on the effectiveness of this FoPLs produced in France.

• **Hypothesis** – Nutri-Score is the labelling scheme with greater potential of improving the quality of food choices among Portuguese consumers.

Objectives

This chapter aims to evaluate, in a Portuguese sample, the responses of consumers to to the Nutri-Score FoPL system, in order to be able to help fill this evidence gap.

Methods

The methodology used was based on the one applied in an international comparative experimental study in which, at an initial phase, consumers' understanding and perception regarding five FoPLs currently used worldwide were evaluated, as well as the effect of these labelling systems on food choices by consumers of 12 countries (Egnell et al., 2018a). While assessing 5 different models of FoPL, three parameters were evaluated: (i) food choices; (ii) perception; (iii) and objective understanding. The 5 FoPLs included in the study were the following: (i) the Multiple Traffic Lights (MTL, implemented in the United Kingdom since 2005); (ii) the Health Star Rating system (HSR, implemented in Australia and New Zealand since 2014); (iii) the Chilean Warning symbol (implemented since 2016) ; (iv) the Reference Intakes (RIs, implemented worldwide following a voluntary initiative by the food industry); (v) and the Nutri-Score (implemented in France since 2017, and then in Belgium and Spain).

Population Sample

Once the study design was completed, using word-of-mouth referrals and advertising, 1,059 participants were recruited through an ISO accredited international web panel provider (Pureprofile). Quotas were applied regarding the sex (50% women), age (a third in each category: 18–30 years, 31–50 years, over 51 years), and also household revenue (a third in each category: low, medium and high) of the participants. Considering the latter, the levels were defined according to the annual revenue in euros per person following social and taxes contributions. Thus, the low-income level was considered when the revenue was under €5567; medium income level when the revenue spanned between €5567 and €11219; and high-income level was considered when the revenue was greater than €11219. To guarantee equal coverage for the main population groups, if the group to which certain individuals belonged to had already reached their quota, then these participants were not eligible for the study.

All participants were asked to provide nutrition-related, lifestyle and socio-demographic information such as self-estimated level of knowledge in nutrition, self-estimated diet quality, educational level, monthly household income, involvement in grocery shopping, sex, and age. The answers were collected through an online questionnaire made available after the participants provided their electronic consent. In this questionnaire, the answer hypotheses were "always", "often", "sometimes" and "never". If participants reported that they rarely or never buy at least two of the three food categories studied (breakfast cereals, cakes, and pizzas), then they would be excluded from the study.

In this study, the protocol used is based on the methodology applied in the FOP-ICE study (Egnell et al., 2018a) and has been approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n_17-404 and 17-404 bis) and the Curtin University Human Research Ethics Committee (approval reference: HRE2017-0760).

Intervention

In this study, participants were confronted with fictitious food products belonging to three food categories: (i) breakfast cereals; (ii) cakes; (iii) and pizzas. The choice of these three categories was related to two main reasons, the first being the fact that these products have elevated variability in nutritional quality within the food category. Another reason was related to the fact that these products are consumed in Portugal as well as in all other countries where the FOP-ICE study was carried out.

Based on real food products, both the products themselves and the brand presented to the study participants were created to resemble those products that actually exist. Moreover, factors that could interfere in the interviewees' judgment, namely

consumer buying habits or familiarity and/or loyalty to the brand and product, were taken into consideration by the creation and design of the product. It should be noted that all participants had the option to zoom in on the image, enabling them to enlarge any area of the presented package.

Each participant was presented with 3 products, for each of the 3 categories. All products presented to the participants had a specific nutritional quality profile that could be high, intermediate, or low. For all FoPLs, the same size and location were used, and in the questionnaire, there were no other labels – for example, organic label, or gluten-free label – besides the provided FoPLs.

Procedure

In the first phase, sets of 3 food products were presented to the participants, none of which had any label (No Label Condition). Afterwards, all participants were asked to perform a ranking task and a food choice task, for each food category that was presented to them.

In the second phase, using the five FoPLs selected for the present study (Nutri-Score, HSR system, MTL, RI and Warning symbol), food products were presented with randomly assigned labels (FoPL Condition) and participants were asked to repeat the ranking task and the food choice task.

Finally, 9 statements regarding different aspects of perception were presented to participants and they were asked to respond to each one of those statements.

No Label Condition

For each category participants were asked to choose one product that they would be willing to buy, among the 3 products presented. The option "I would not buy any of these products" was also available,

After completing the first task, participants were asked to assess the nutritional quality of the products presented to them, using a rating from 1 to 3, with being "1 - Highest nutritional quality", "2 - Average nutritional quality" and "3 - Lower nutritional quality" or, if applicable, selecting the option "I don't know".

FoPL condition

In this second phase, participants were asked to repeat the same tasks, this time with products which had a label presenting one of the five selected FoPLs, designated by randomization.

During this phase, regardless of the label used, the products had the same underlying nutritional classification, and to avoid unwanted effects, the order in which the products were presented to the participants was randomized. In addition, none of the participants were aware that each product was going to be presented to them twice, nor that a FoPL would be present on the second presentation.

In addition, participants were also asked whether they could remember which FoPLs had been shown to them.

Perception

Using a 9-point Likert scale, from 1 (strongly disagree) to 9 (strongly agree), participants were asked to answer 9 statements related to perception. These statements regarding perception referred to aspects such as label visibility (e.g. "This

label does not stand out"), ease of understanding (e.g. "this label is too long to understand", "this label is easy to understand") and trust (e.g. "I trust this label").

Statistical analysis

Food choice and objective understanding

Regarding food choice, each product was given a score between 1 and 3 points, being "1 - product with the lowest nutritional quality", "2 - intermediate product," and "3 - product with the best nutritional quality".

By calculating the difference between the ranking tasks related to products with FoPLs and products without a label, the objective understanding of the participants was assessed, that is to what extent consumers were able to understand the information provided by the labels according to what was expected by the designers of those labels.

For each food category presented, the participants were scored according to their objective understanding analyses. Thus, they received -1 point if they rated at least one product out of order, 0 if the participant's answer was "I don't know", and 1 point if the participants classified all products presented in the order expected by the label designer, i.e. according to the nutritional quality of the products.

Subsequently, building on the responses from participants' who selected products both in the FoPL and in the no label conditions, a score was calculated. It was calculated for each of the 3 food categories in the study by subtracting the choice/ranking score in the no label condition from the score in the FoPL condition.

For each task and each of the different food categories presented to the participants, a discreet score between -2 and +2 points was calculated, the first corresponding to a greater deterioration and the second to a greater improvement in the choice of food. Then, a final overall discrete score was obtained varying between -6 and +6, according to the sum of the participants' scores in the three food categories of the study.

Based on the methodology that was used in the FOP-ICE study (Egnell et al., 2018a), participants who answered "I don't know" to the classification task were excluded, in order to be able to perform the sensitivity analysis for objective understanding. Similarly, for the sensitivity analysis regarding a specific food category of the 3 selected for the study, responses from participants who claimed to never buy products belonging to that particular category were excluded.

In order to assess the association between FoPLs and the capacity to correctly rank products and the ability to make better food choices, ordinal logistic regression models were used.

For this study, of all selected FoPLs, IRs were used as a reference category since they are considered the least efficient by previous literature (Egnell et al., 2018b).
For the ordinal logistic regression models used in this study, several covariables were included, namely answers to the question "Do you remember having seen this label during the survey?", involvement in supermarket purchases, quality of the diet, self-estimated nutritional knowledge, family income, sex and age of the participants. In addition to testing interactions between these covariates and FoPLs, analyses were performed for all food categories in the study, by food category.

Perception

Regarding the perception analyses, if all perception questions received the same score by the participants, then those participants would be excluded from the study, except for the ones who gave a neutral score (5 points) on all items. Afterwards, in addition to calculating the mean and respective SD by FoPL for each perception question, to be able to investigate the contribution of the different questions to the general perception of the label, a principal component analysis (PCA) was also performed. For the PCA, the following were considered active variables: "This label takes too long to understand", "This label is easy to understand", "I trust this label", "This label provides me the information I need", "This label does not stand out", "I like this label", "This label is confusing". Additionally, the FoPL itself was considered as a qualitative supplementary variable. The label was mapped on the axes as an illustrative variable, according to the coordinates and the contribution of each variable in each dimension calculated. The significance of the deviation from the origin of the qualitative variable can be tested by analysing a test value. If the test value has an absolute value equal to or greater than 2, this difference can be considered significant at the 95% level (Alevizos & Morineau, 1992).

Analyses on perception were carried out using R software (version 3.4.4). Moreover, statistical analyses were carried out for each individual food category and for all food categories combined, using SAS Software (version 9.3, SAS Institute Inc., Cary, NC, USA). Each result was considered statistically significant if a p-value of less than or equal to 0.05 was observed.

Results

Regarding the Portuguese population sample, Table 18 shows its individual characteristics. Of all participants included in the Portuguese sample, 60% were

responsible for grocery shopping, 40% had an undergraduate degree, 34% had a primary or secondary educational level, 33% had a low level of income, 50% of them were women and 34% of participants were between 18 and 30 years old. Moreover, 14% of the participants admitted having a very or mostly unhealthy diet, and while 64% of the participants felt they were slightly familiar with nutrition, 10% did not have any knowledge about nutrition or were not very familiar with that issue.
In addition, 62% of the participants claimed to have seen FoPLs during the survey, and of all FoPLs used in the study, those with the lowest recall rate were the HSR and the Warning symbol (52.36% and 46.7%, respectively).

The referred socio-demographic data was collected in order to asure the good dsitribution of the selected quotas. Interactions between FoPLs and individual characteristics (sex, age, educational level, level of household income, responsibility for grocery shopping, self-estimated diet quality or nutrition knowledge) on the participants' ability to correctly rank products were tested, and no stastistically significant interaction was found.

Table 18 - Description of the population sample from Portugal (N=1.059).

	N(%)
Sex	
Men	526 (49.67)
Women	533 (50.33)
Age, years	
18-30	364 (34.37)
31-50	363 (34.28)
>50	332 (31.35)
Educational level	
Primary education	11 (1.04)
Secondary education	354 (33.43)

Trade certificate	139 (13.13)
University undergraduate degree	427 (40.32)
University postgraduate degree	128 (12.09)
Level on income	
High	355 (33.52)
Medium	355 (33.52)
Low	349 (32.96)
Responsible for grocery shopping	
Yes	640 (60.43)
No	75 (7.08)
Share job equally	344 (32.48)
Self-estimated diet quality	
I eat a very unhealthy diet	5 (0.47)
I eat a mostly unhealthy diet	147 (13.88)
I eat a mostly healthy diet	855 (80.74)
I eat a very healthy diet	52 (4.91)
Nutrition knowledge	
I do not know anything about nutrition	6 (0.57)
I am not very knowledgeable about nutrition	104 (9.82)
I am not somewhat knowledgeable about nutrition	675 (63.74)
I am very knowledgeable about nutrition	274 (25.87)
Did you see the FoLP label during the survey?	
No	271 (25.59)
Unsure	132 (12.46)
Yes	656 (61.95)
Participants who recalled seeing the FoPL they were exposed to	
HSR	111 (52.36)
MTL	152 (71.70)
Nutri-Score	145 (68.40)
RIs label	149 (70.62)
Warning symbol	99 (46.70)

Food Choice

Depending on the specific food category and the label associated with the products presented to the participants, there was an improvement in their choice of food between 3.8% and 15.1% of the participants, as illustrated in Figures 19, 20 and 21. Moreover, depending on the food category and the label present in the products, it was found that the deterioration was always less than the improvement, both by category and by FoPLs, with a variance ranging from 1.9% to 5.2%.

Among all food categories, the FoPLs with the highest percentages of improvement regarding food choice were MTL and Nutri-Score.

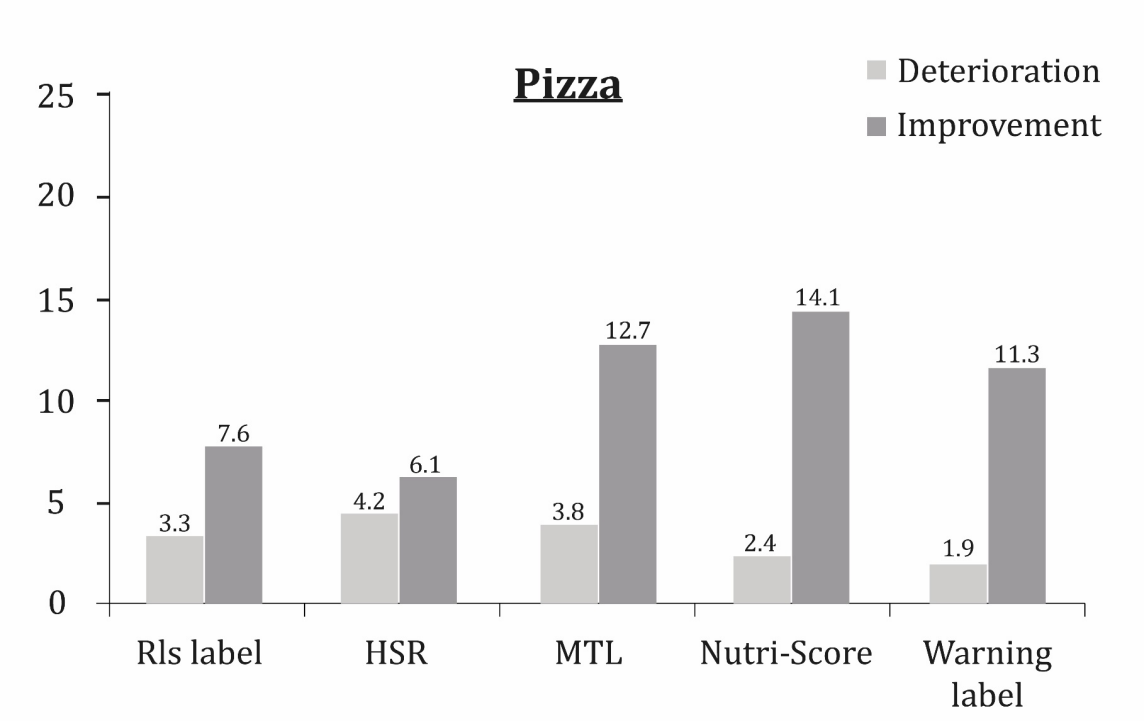


Figure 19 - Percentage of participants having deteriorated or improved their food choices within the pizza food category.

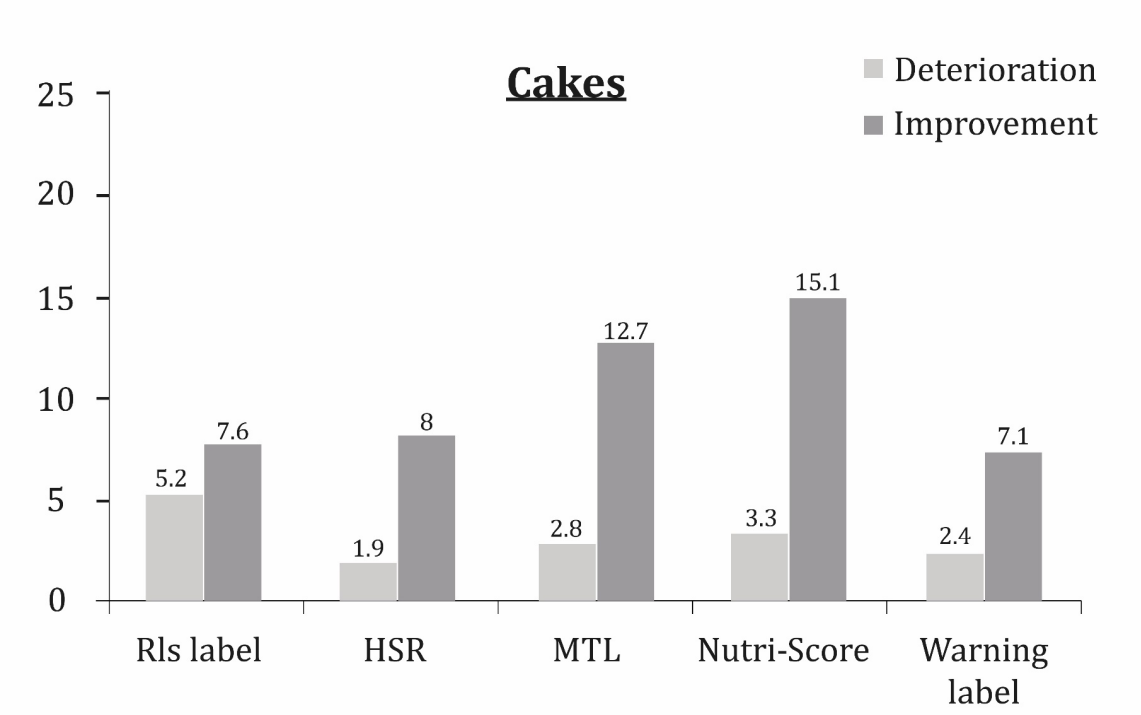


Figure 20 - Percentage of participants having deteriorated or improved their food choices within the cakes food category.

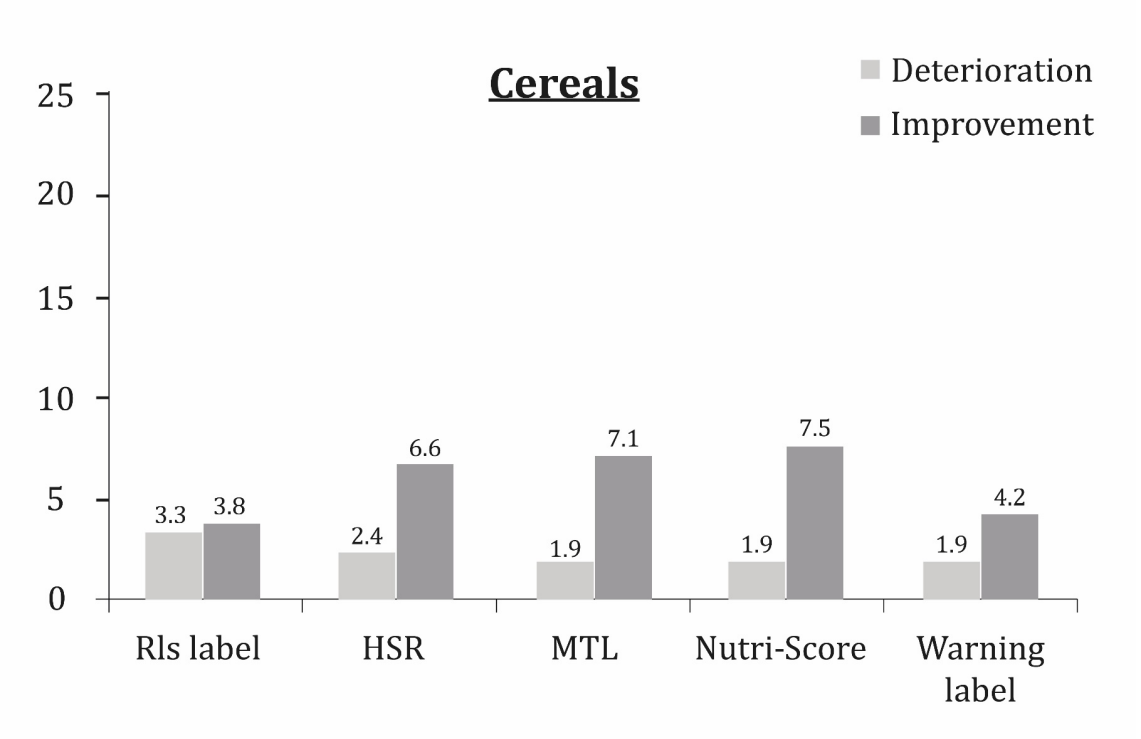


Figure 21 - Percentage of participants having deteriorated or improved their food choices within the cereals food category.

The results of ordinal logistic regression are shown in Table 19. In general, of all of the FoPLs used, those that contributed to the improvement of food choices by consumers, in the most successful way, were Nutri-Score, MTL and Warning label. Among these three, the Nutri-Score was the one that proved to be the most efficient in improving consumers' food choices (Odds Ratio, OR=1.98 [1.26 – 3.12], p-value=0.003).

Finally, regarding individual characteristics and labels, no quantitative interaction was found.

Table 19 - Association between FoPLs and change in the nutritional quality of food choices, by FoPL and food category.

Food Category		**HSR**		**MTL**		**Nutri-Score**		**Warning label**	
	n	Or (95% CI)	**p**	Or (95% CI)	**p**	Or (95% CI)	**p**	Or (95% CI)	**p**
All categories	1007	1.46 [0.92 – 2.23]	0.1000	1.95 [1.24 – 3.07]	0.0040	1.98 [1.26 - 3.12]	0.0030	1.94 [1.22 – 3.08]	0.0050
Pizza	864	1.00 [0.54 – 1.86]	1.0000	1.56 [0.87 – 2.81]	0.1000	1.92 [1.07 – 3.43]	0.0300	1.99 [1.10 – 3.60]	0.0200
Cakes	759	1.64 [0.87 – 3.06]	0.1000	1.89 [1.02 – 3.49]	0.0400	2.20 [1.2 – 4.03]	0.0100	1.41 [0.75 – 2.68]	0.3000
Cereals	890	1.81 [0.87 – 3.77]	0.1000	1.82 [0.87 – 3.80]	0.1000	2.00 [0.96 – 4.13]	0.0600	1.46 [0.72 – 3.34]	0.3000

Notes: The references of the multivariate ordinal logistic regression for the categorical variable "label" were reference intakes. The multivariate model was adjusted on sex, age, educational level, level of household income, responsibility for grocery shopping, self-estimated diet quality and self-estimated nutrition knowledge.

Objective understanding

For each of the participants, the change in the number of correct answers regarding the three categories of food presented was calculated, comparing answers from products with no label to products with FoPLs.

Regarding the FoPLs used in the study, Nutri-Score showed the highest increase in the number of correct answers compared to products with no label. Of the three categories, the one that showed the greatest positive impact from the Nutri-Score was that of cakes, with an increase of 319%, going from 26 correct answers in no labelling to 109 in the FoPL condition. Next up was the cereals category, in which the Nutri-Score contributed to the number of correct answers going from 66 in no labelling to 133 in the FoPL condition, corresponding to an increase of 102%. Finally, the category of pizzas was the one in which the impact of the Nutri-Score, although positive, was smaller, with a 99% increase in the number of correct answers, which went from 69 in no labelling to 137 in the FoPL condition.

Although with a substantially smaller effect compared to the Nutri-Score, of the other FoPLs, MTL showed the second-best performance for the three food categories under study. Of the three categories, the one that showed the greatest positive impact by the MTL was that of cakes, with an increase of 141%, going from 32 correct answers in no labelling to 77 in the FoPL condition. Next up was the cereals category, in which the MTL contributed to the number of correct answers going from 52 in no labelling to 85 in the FoPL condition, corresponding to an increase of 63%. Finally, the category of pizzas was the one in which the impact of the MTL, although positive, was smaller, with a 26% increase in the number of correct answers, which went from 81 in no labelling to 102 in the FoPL condition.

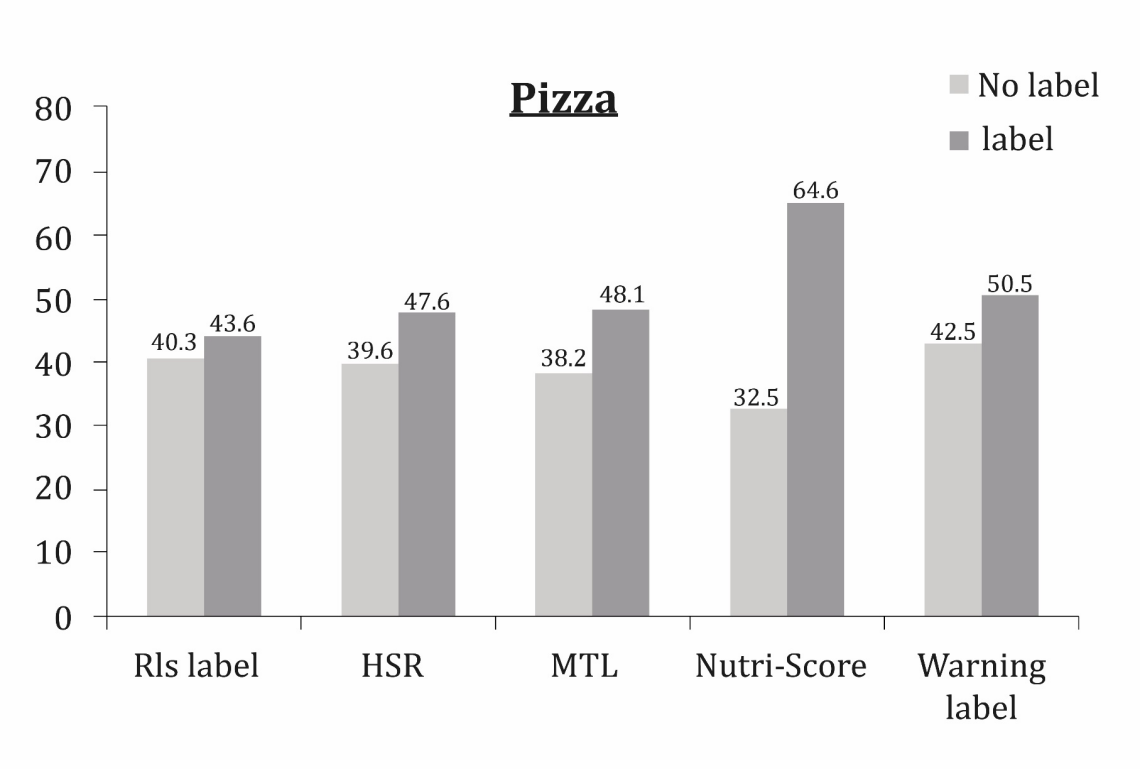


Figure 22 - Percentage of correct answers for the ranking tasks within the pizza category.

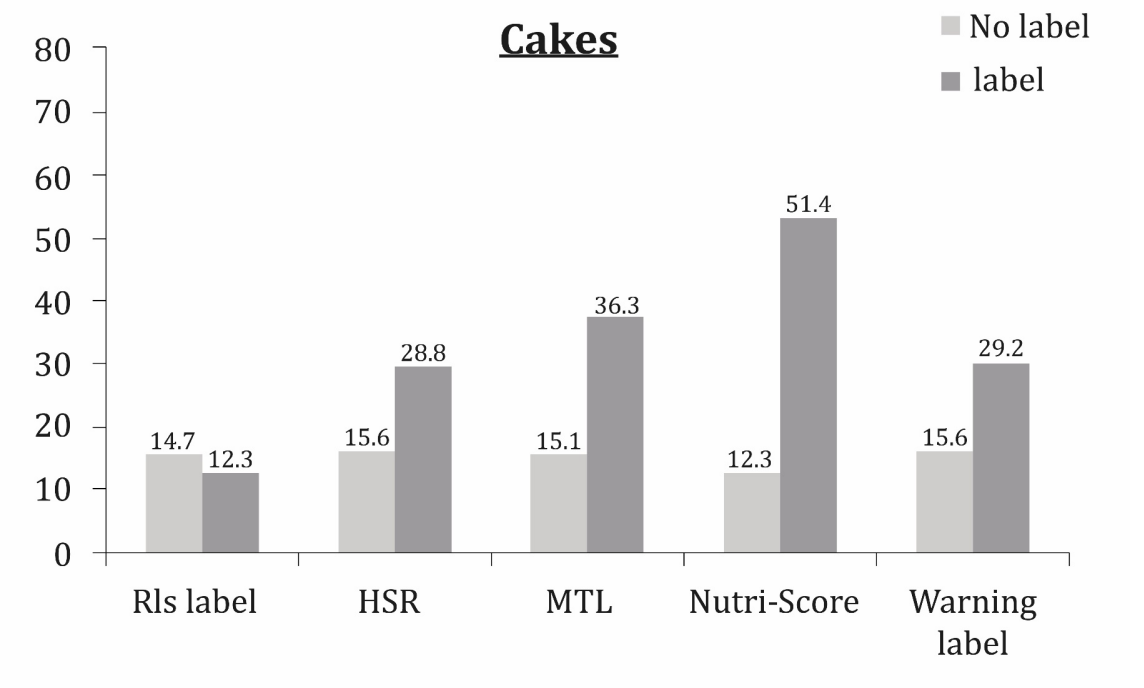


Figure 23 - Percentage of correct answers for the ranking tasks within the cakes category.

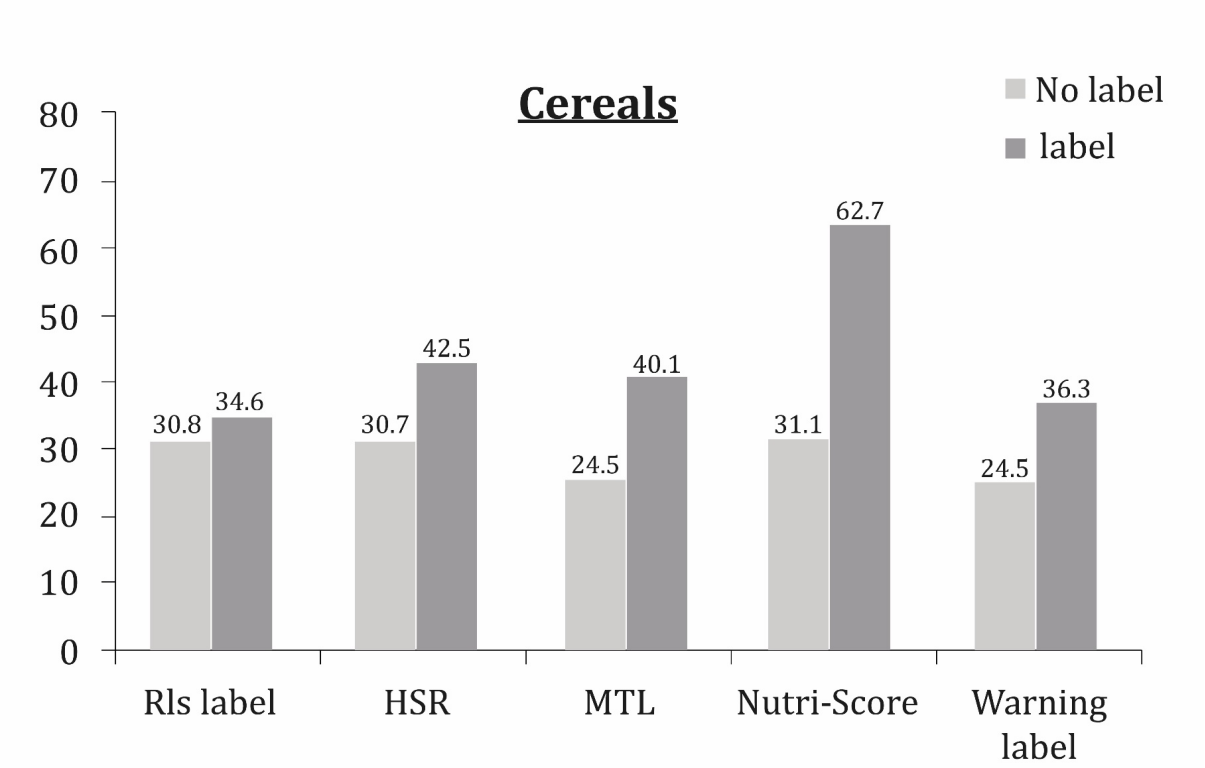


Figure 24 - Percentage of correct answers for the ranking tasks within the cereals category.

Regarding the two conditions analysed in the study – no label condition and FoPLs – it was found that the percentage of correct answers by the participants was higher in the food products that presented FoPLs, as shown in Figures 22, 23 and 24. As for the ability to correctly classify food products according to their nutritional quality, of all FoPLs used, the one that showed the best results, with a percentage of improvement between 32.1% and 38.7%, was Nutri-Score.

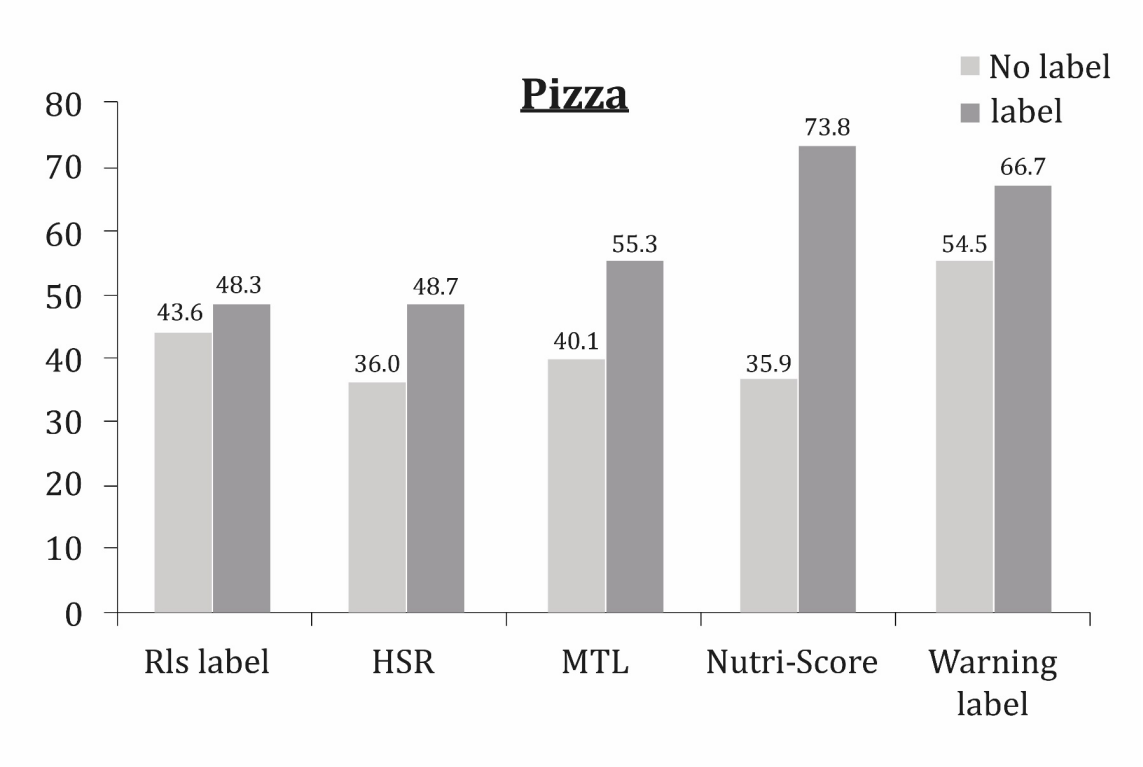


Figure 25 - Percentage of correct answers for the ranking tasks for pizza, among participants who only recalled seeing the FoPL during the survey.

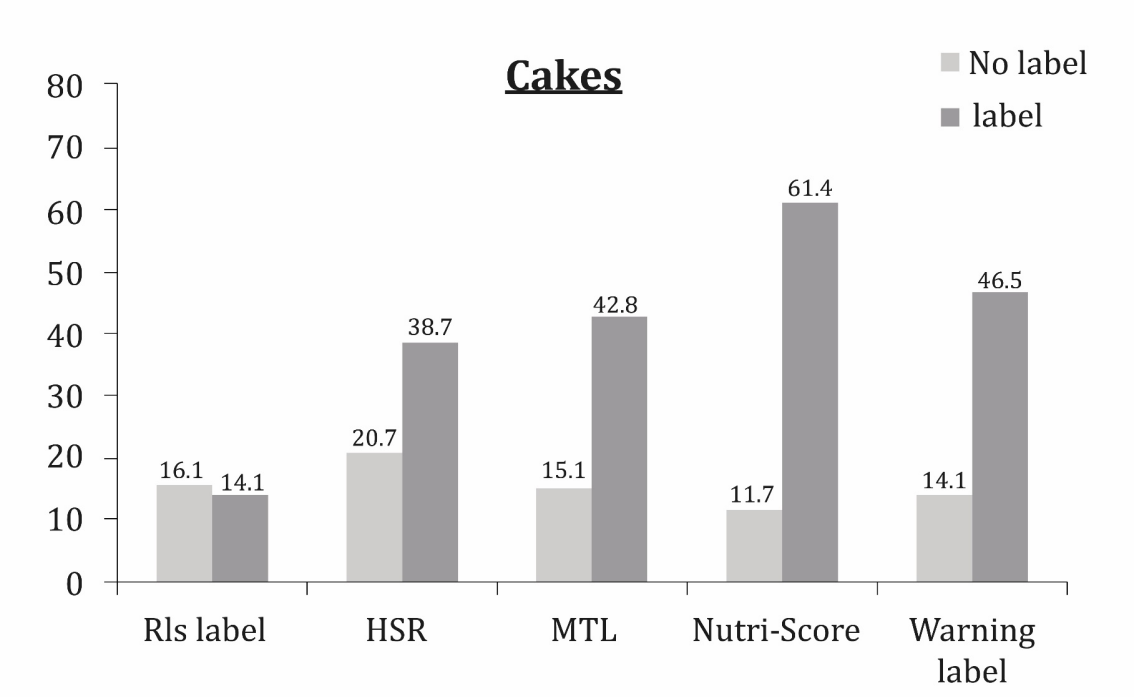


Figure 26 - Percentage of correct answers for the ranking tasks for cakes, among participants who only recalled seeing the FoPL during the survey.

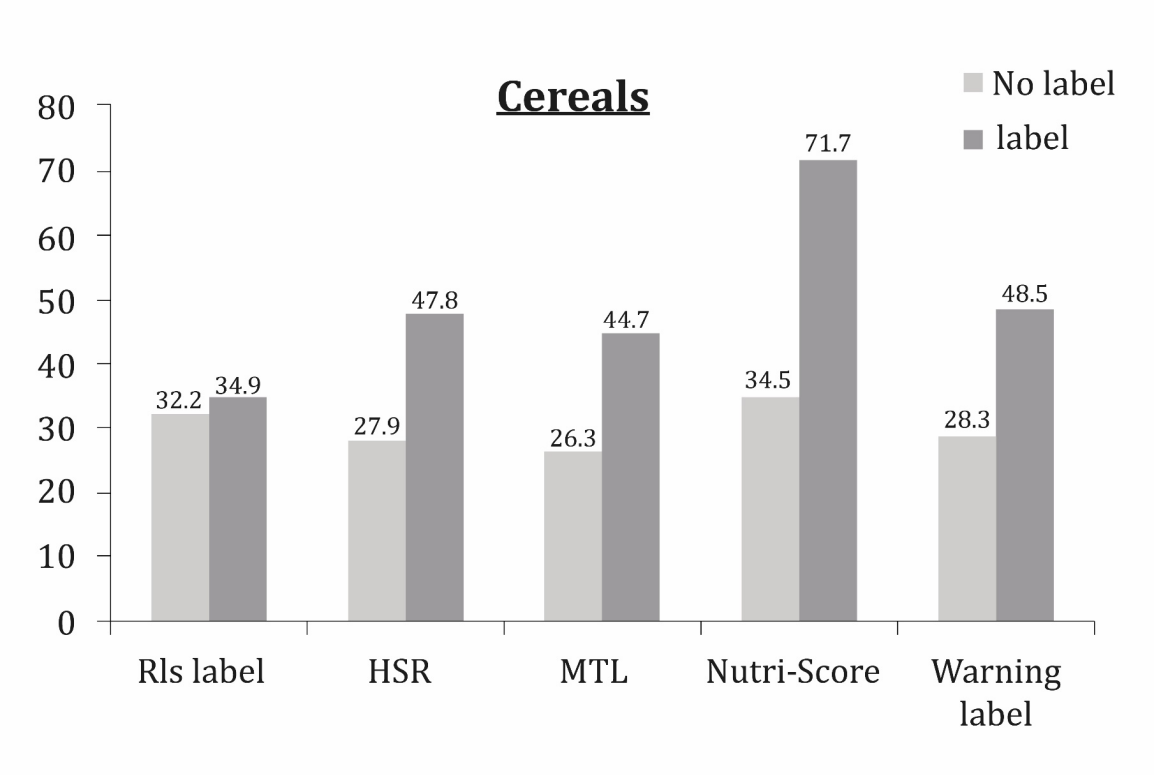


Figure 27 - Percentage of correct answers for the ranking tasks for cereals, among participants who only recalled seeing the FoPL during the survey.

During the study, some of the participants recalled having seen the FoPL only during the survey. Thus, Figures 25, 26 and 27 show the results of the same type of analysis that were previously presented, applied to this group of participants. Of all FoPLs used, the Nutri-Score was again the one that showed the most efficient performance in the 3 food categories presented to the participants. However, this time, the FoPL with the second best performance, was the Warning symbol, instead of MTL.

Table 20 - Association between FoPLs and the ability to correctly rank products according to nutritional quality, by FoPL and food category.

Food Category		HSR		MTL		Nutri-Score		Warning label	
	n	Or (95% CI)	p	Or (95% CI)	p	Or (95% CI)	p	Or (95% CI)	p
All categories	1059	2.02 [1.39 – 2.94]	0.0002	2.11 [1.46 – 3.05]	<0.0001	6.45 [4.43 – 9.39]	<0.0001	2.00 [1.37 – 2.91]	0.0003
Pizza	1031	1.42 [0.91 – 2.22]	0.1222	1.3 [0.84 – 2.01]	0.2470	3.67 [2.39 – 5.64]	<0.0001	1.33 [0.85 – 2.08]	0.2073
Cakes	1038	2.56 [1.65 – 3.97]	<0.001	3.19 [2.07 – 4.93]	<0.0001	7.14 [4.61 – 11.07]	<0.0001	2.88 [1.85 – 4.48]	<0.0001
Cereals	1027	1.58 [0.98 – 2.56]	0.0614	1.77 [1.11 – 2.83]	0.0170	3.68 [2.33 – 5.80]	<0.0001	1.56 [0.96 – 2.53]	0.0727

Notes: The references of the multivariate ordinal logistic regression for the categorical variable "label" were the reference intakes. The multivariate model was adjusted on sex, age, educational level, level of household income, responsibility for grocery shopping, self-estimated diet quality and self-estimated nutrition knowledge level.

The association between the ability to correctly rank food products according to their nutritional quality and FoPLs is presented in Table 20.

In general, comparing with the RIs – the reference category – among all FoPLs, the one that showed greater efficiency in improving the ability to correctly rank products according to their nutritional quality was again Nutri-Score (OR=6,45 [4,43 - 9,39], p-value<0.0001), followed by the MTL, the HSR and then the Warning symbol. Nevertheless, it is important to note that while MTL, HSR and the Warning symbol performed differently depending on the food category, Nutri-Score showed high performance in all 3 categories evaluated in this study.

Table 21 - Associations between FoPLs and the ability to rank products according to nutritional quality.

Food Category		HSR		MTL		Nutri-Score		Warning label	
	n	Or (95% CI)	p	Or (95% CI)	p	Or (95% CI)	p	Or (95% CI)	p
All categories	656	2.27 [1.37 – 3.42]	0.0010	2.70 [1.76 – 4.15]	<0.0001	8.11 [5.18 – 12.70]	<0.0001	2.81 [1.74 – 2.39]	<0.0001
Pizza	640	1,35 [0,79 - 2,30]	0.3000	1.49 [0.91 – 2.44]	0.1000	3.78 [2.31 – 6.19]	<0.0001	1.38 [0.80 – 2.39]	0.3000
Cakes	644	2.15 [1.28 – 3.62]	0.0040	3.47 [2.13 – 5.66]	<0.0001	7.57 [4.57 – 12.53]	<0.0001	4.16 [2.42 – 7.16]	<0.0001
Cereals	635	2.11 [1.18 – 3.79]	0.0100	2.24 [1.31 – 3.85]	0.0030	4.53 [2.65 – 7.76]	<0.0001	2.21 [1.21 – 4.04]	0.0100

Notes: The references of the multivariate ordinal logistic regression for the categorical variable "label" were the reference intakes. The multivariate model was adjusted on sex, age, educational level, level of household income, responsibility for grocery shopping, self-estimated diet quality and self-estimated nutrition knowledge level.

Table 21 shows the results of the sensitivity analysis. Regarding objective understanding, similar findings were observed in the efficiency of the various FoPLs under study, resulting from the exclusion of participants who answered with "I don't know". Importantly, although similar, according to the results obtained, these effects of FoPLs were even greater. However, among the participants recalling having seen the label during the survey, contrary to what was seen in previous analysis, the FoPL that showed the best performance, just after Nutri-Score, was the Warning symbol. Moreover, no interaction was found between individual characteristics and FoPLs.

Perception

The results of the comparison of the SD and the average score of each statement by FoPL are presented in Table 22. Except for the statement "This label does not stand out" where the average score for the Warning symbol was equal to 5.2 while for the Nutri-Score was equal to 3.7, for each of the statements presented to the participants, it was found that the results between the different FoPLs were globally homogeneous, with differences of less than 1 point between different labels.

Table 22 - Associations between FoPLs and the ability to rank products according to nutritional quality.

Questions	Contributions		MTL		Label	v-test	
	Dimension 1	Dimension 2	Dimension 1	Dimension 2		Dimension 1	Dimension 2
This label is confusing	20.76	9.86	-1.75	0.77	HSR	-0.52	1.3
I like this label	12.49	12.29	1.36	0.86	MTL	-0.35	1.76
This label does not stand out	13.13	14.28	-1.39	0.93	Nutri-Score	3.18	-3.44
This label is easy to understand	17.47	1.66	1.61	0.32			
This label takes too long to understand	18.51	16.97	-1.66	1.02	RIs label	-2.26	2.17
This label provides me the information I need	8.46	26.94	1.12	1.28			
I trust this label	9.17	17.99	1.17	1.05	Warning symbol	-0.06	-1.79

Two dimensions were retained, explaining 45.49 % and 18.66% of the variance respectively. After evaluating contributions of active variables, it is possible to state that the first dimension (horizontal axis) represents the statements “this label is confusing”, “This label is easy to understand” and “This label takes too long to understand” whereas the second dimension (vertical axis) represents “This label

provides me the information I need", "I trust this label" and "This label takes too long to understand" (Fig. 28).

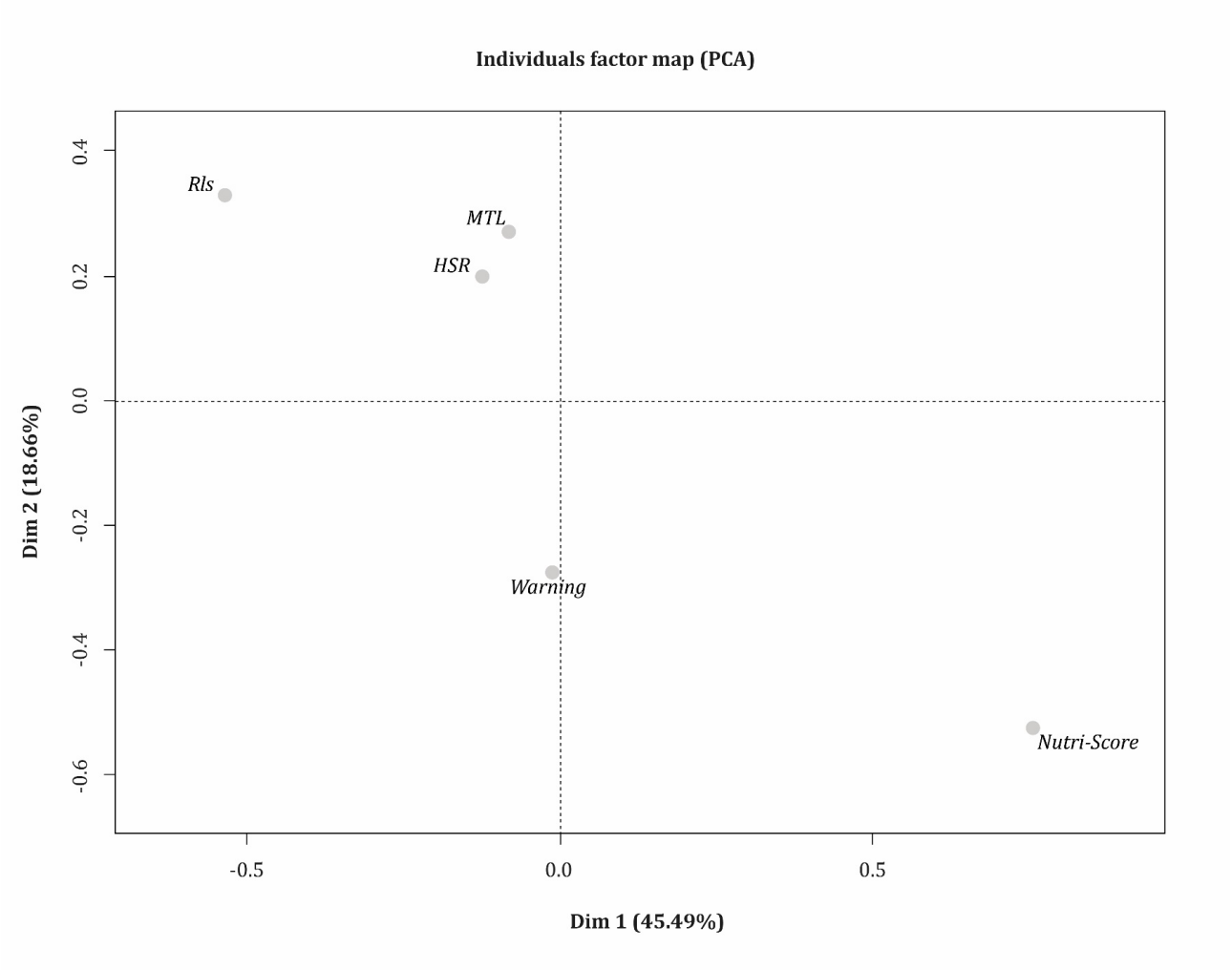


Figure 28 - Principal component analysis map on the contribution of different questions to the perception of FoPLs, where dimensions are a linear combination of the different variables: Dim 1 represents the statements "this label is confusing", "This label is easy to understand" and "This label takes too long to understand" and Dim 2 represents "This label provides me the information I need", "I trust this label" and "This label takes too long to understand". The labelled questions are those with the highest contribution to perception.

After analyzing the PCA and v-test, Nutri-Score and the RIs are opposed on the two dimensions. According to the first dimension, the RIs were more confusing and took

too long to understand. According to the second dimension, the RIs provided more information and were more trusted by consumers compared to the Nutri-Score.

Discussion

In Portugal, consumers are sensitive to the labels present on the products, and evidence shows that when making purchasing decisions, Portuguese consumers take into consideration the information available on the labels provided (Nielsen, 2012). However, there is also evidence showing that labelling information provided on the back of food packaging is not understood by around 40% of the Portuguese consumers surveyed (Gomes et al., 2017).

The labelling information on the back of food packaging seems to be really dificult to read and to interpret by the citizens. Note that the nutritional declatation is presented in the form of a complicated table with many columns and lines and using scientifc terms. This may explain why it is not understood by such an important number of consumers as many studies in Portugal and in other European countries have demonstrstrated. As suggested by WHO and many experts committees, this reality evidenced the need for an interpretative front-of pack labeling system, consumer-friendly and comprehensible by all. Additionally, it would have to take into account the nutritional values of the hardly comprehensible existing nutritional declarations. The French created Nutri-Score in order to address these challenges. After years of development and validation, this new FOPL system was able to translate hardly comprehensible existing nutritional declaration tables in a simple tool understandable by consumers with low need of time to read and to interpret. The usage of an overall synthetic indicator, such as Nutri-Score, provides an advantage due to the reduced cognitive workload that it requires for its interpretation. On the other hand, the use of

single and syntethic indicator rather than the multiple indicators'organized by different nutrients can also reduce confusion related to the interpretation of nutritional terms (e.g. saturated fatty acids, sugars, sodium) and facilitate the comparison of the nutritional quality of food products.

As in previous research (Van Kleef, 2008), our study shows that Portuguese consumers make food choices with higher nutritional quality, under conditions where FoPLs are present. Of all the FoPLs used in this study, the one that appears to be most efficient in helping Portuguese consumers to improve their diets is the Nutri-Score, as it led to a greater increase in the quality of consumers' food choices. Regarding objective understanding, while consumer understanding is increased in general by all FoPLs, Nutri-Score stands out for being efficient in improving the consumer's ability to understand the nutritional quality of food products. Furthermore, even though consumers understand all FoPLs, compared to Nutri-Score, RIs appear to be too long to understand and also more confusing.

According to the results obtained in this study, the colour-coded, graded and summary format of Nutri-Score, make it the most efficient label, among all of the FoPLs, to help Portuguese consumers identifying the healthiest products in purchase situations, as well as informing consumers about the nutritional quality of food products.

The data shown in this study is of particular relevance when taking into account the context in Portugal. The retail market leader in Portugal has been implementing an adapted MTL model for, roughly, ten years. This has led to the Portuguese population having been particularly exposed to an MTL-like model. In fact, within the sample of Portuguese consumers, Nutri-Score and the MTL were the FoPLs with the higher

percentages of improvement across all food categories. Furthermore, when assessing the full sample, Nutri-Score shows the highest improvement on the ability to correctly rank products according to nutritional quality, closely followed by MTL. However, and of note, once we excluded participants who recalled seeing FoPLs prior to the survey, Nutri-Score continues to show better but this time, followed by the Warning symbol. Excluding participants who had already been exposed to FoPLs in Portugal, led to a significant reduction in the results for MTL. These findings highlight the need to account for exposure to existing FoPLs within a particular context when assessing its impact on the nutritional quality of food choices and objective understanding.

Given the similarities between the French and Portuguese population, namely the behaviour and food environment (Gerber, 2016) and considering the effectiveness of the Nutri-Score demonstrated in France (Crosetto, Muller & Ruffieux, 2016; Ducrot et al., 2015b; Fonds français pour l'alimentation, 2017), the results obtained by the present study were expected. They are coherent with previous studies, particularly with regards to objective understanding (Egnell et al., 2018a; 2018b). A study performed on more than 12,000 subjects in 6 european countries (Bulgaria, Denmmark, France, Germany, Spain, UK) and 6 countries in North America (USA, Canada), Latin America (Argentina, Mexico), Asia (Singapore) and Oceania (Australia)(Egnell et al., 2018a) has shown that in all the 12 countries, Nutri-Score was the most effective label when comparing to other labels (UK Multiple Traffic Light, Chilean Health Warnings, Australian Health Star Ratings, GDA/Ris supported by food companies) to improve the ability of consumers to correctly classify foods according to their nutritional quality whatever the socio-demographic category.
Other studies performed on virtual supermarkets, in experimental stores and in real conditions in France have shown that the presence of Nutri-Score improves the overall nutritional quality of shopping baskets and the performance of Nutri-Score is superior

to all other tested labels. More precisely, a randomized trial with an experimental online supermarket comparatively assessed the impact of four types of labels showed that Nutri-Score significantly led to the highest nutritional quality of the selected items in the shopping cart followed by MTL and Tick compared with the control(Ducrot el al., 2016). A study carried out on 691 subjects compared Nutri-Score to the Health Star Rating system, MTL, SENS (a format proposed by retailers) and a modified version of the Reference Intakes (mRIs) also showed best performance by Nutri-Score: the nutritional quality of the shopping cart was improved by 9.3% for Nutri-Score, 6.6% for the Health Star Rating System and 4.8% for MTL. Moreover, Nutri-Score performed best in households with the lowest income (Crosetto at al., 2020). In addition, especially regarding objective understanding, there is consistency between the results of previous studies and the results obtained in the present study (Egnell et al., 2018a; Egnell et al., 2018b).

A study shows that Nutri-Score, unlike the other FoPLs, does not lead consumers to make worse food choices and select products with poor nutritional quality, and is also clearly superior to other FoPLs, as demonstrated after evaluating more than 1200 products in more than 60 supermarkets (Fonds français pour l'alimentation, 2017). In addition, another study that assessed the impact of FoPLs on improving decision-making and consumer shopping in more than 20 stores, concluded that the summary models, which include the Nutri-Score, are the ones that are most effective (Centre de recherche pour l'étude et l'observation des conditions de vie, 2017). Similar results were demonstrated by another real-life environmental study with a sample of 809 individuals (Crosetto, Muller & Ruffieux, 2016).

Policy implications at the national level

There is increasing evidence that the Nutri-Score is a FoPL that not only promotes healthier choices by consumers but also has high efficiency in significantly improving

the understanding by the consumer of the nutritional quality inherent to food products. All of this evidence has led Nutri-Score to stand out among retailers and food manufacturers, who consequently followed suit and implemented this model of label in their products, or at least committed themselves to doing so. This strategy for implementing the Nutri-Score was also publicly announced by some players in the food industry, in Portugal. In addition to several European consumers' associations giving support to Nutri-Score, this FoPL model has also been endorsed by other Ministries of Health in Europe (i.e. the Netherlands, Switzerland, Belgium, Spain, Germany and France), or at least national recommendations have been published to adopt that labelling model.

Regarding the progress that has been made in this area so far, unlike other European countries, in Portugal it is still very weak. This is largely due to the fact that any decisive actions to be taken are deeply hampered by vested interests within and outside of the health sector, limited collaboration among different governmental areas, and policy and regulatory levers lying outside the health sector.

So far, a single FoPL has not been endorsed by the Portuguese Government, as the lack of evidence on the real impact of the use of foreign FoPL labelling systems among the Portuguese population has been pointed out as an obstacle.

Therefore, in order to end the confusion generated in the consumers' minds – resulting from their exposure to several different FoPLs – and to improve consumers' decision-making when buying food products, the research presented in this chapter was able to find evidence that fill the previously identified gap, reinforcing the need for standardization of FoPLs used in Portugal.

Policy implications at the global level

The usage of FoPL is among the list of 88 recommended policies by the WHO to address NCDs. However, it is not yet considered a Best-Buy, due to the lack of evidence on cost-effectiveness at the time of the last update made to the Appendix 3, which was approved in May 2017 by the Seventieth World Health Assembly. Since 2017, important scientific developments have been published. Among these, the positive impacts of the use of NutriScore have been gaining strength. This was why, even without a clear endorsement given by the WHO to this FoPL system, several countries have already endorsed it and implemented it. It is now time to push for an update of the list of Best-Buys, that should take all the new evidence regarding FoPL into account.

Furthermore, the food industry interests that oppose the implementation of a FoPL tend to use the challenge of selecting a single one system by national authorities to cause confusion and delay this policy implementation. Therefore, the WHO should be more supportive and objective in providing clear guidance regarding one single FoPL to be implemented at the global level, or, at least, at the regional level. This sort of guidance would save Member States time and important resources involved in the development of redundant local research.

Chapter 8

Education: school-based programs

Introduction

In both the national and international political agendas, one of the main topics addressed is the need to reduce salt intake by the population, given that evidence shows that excessive sodium consumption (1g of sodium per 100g is equivalent to 2.5g of salt per 100g) is strongly associated with an increased risk of developing NCDs (WHO, 2014b). Apart from being the most cost-effective and feasible strategy to implement to diminish the increasing burden of NCDs, reducing salt consumption also allows for a decrease in health-related costs for both individuals and the government, and is described as a practical action that can prevent several related diseases (WHO, 2013b).

In order to deal with the global crisis of NCDs, one of the 'best buys' or cost-effective actions recommended by the WHO that should be prioritised is to reduce salt consumption by the population (Beaglehole et al., 2011; WHO, 2017c), which should be targeted at less than 2g for children, and less than 5g for adults (WHO, 2012). Furthermore, WHO Member States agreed to work in the best possible way so that, by 2025, the global target of a 30% relative decrease in the average salt intake, compared to 2010 levels, is attained. In fact, to achieve the overall goal, which implies reducing the premature mortality resulting from NCDs by 25%, it is crucial that this target of reducing salt consumption in the population is met, given the risk of developing NCDs due to excessive salt intake (WHO, 2013b).

Between 2010 and 2015 there was more than a doubling in the number of countries that decided to implement national strategies that involve reducing the consumption of salt by the population. However, according to data collected from 2013 (European

Commission, 2013; WHO, 2013e), in most countries salt consumption by the population varied between 7g/day (Latvia, Germany, Cyprus and Bulgaria) and 13g/day (Czech Republic), which shows that despite all the remarkable efforts and actions carried out so far in an attempt to reduce salt intake, there is still a long way to go that will require further action.

Among all eating habits, the most adverse results are associated with excessive salt intake, which in the Portuguese population is found to be twice the average daily level recommended by the WHO (<5g) (Polonia et al., 2014), reaching the 10.7g. (Lopes et al., 2017a; Correia-Costa et al., 2016). As mentioned in Chapter 5, in Portugal there is excessive salt consumption in both men and women, corresponding to the highest value of salt intake identified among all European countries (Sardinha et al., 2012). Moreover, it is important to note that these poor eating habits are not only a problem for the adult Portuguese population, but also for both adolescents and children, since most of them also have an excessive daily salt consumption (Correia-Costa et al., 2016; Polonia et al., 2014).

In addition, one in three children in Portugal is overweight, which has been consistently identified as one of the countries where child overweight is more prevalent (Rito et al., 2016). Also, considering that both in Portugal and worldwide the main cause of death and disability are CVDs (one of the top NCDs), which are largely associated with excessive salt consumption, it is imperative to create measures to tackle this issue, especially since great population benefits can result from simple actions like reducing salt consumption (DGS, 2015c; Li et al., 2017).

In order to reduce the excessive consumption of salt in the younger sections of the population, several strategies are presented by the "National Program for the

Promotion of Healthy Eating" (DGS, 2012), based on internationally recommended interventions (WHO, 2016b), namely programs of information/education and consumer protection, especially those promoting the reduction of salt content in school meals.

To promote healthier eating habits in the younger strata of the population and improve the nutritional quality of the food served in schools, numerous efforts have been made to access children in schools (Centres for Disease Control and Prevention, 1997; Branca, Nikogosian & Lobstein, 2007; Flodmark, Marcus & Britton, 2006; French & Stables, 2003; Lytle & Kubik, 2003; Sharma, 2006a; Sharma, 2006b). Primary and secondary schools have a decisive role in promoting a healthier diet and in improving the eating behaviours of children and adolescents (Commission of the European Communities, 2005) either through nutritional education classes, or by determining the types of food and beverages available in the school's vending machines or served in the school meals to students, at least once each day.

Regardless of the socioeconomic status of families, school is a privileged environment for health education among children, as it has the capacity to guarantee access to balanced meals from a nutritional point of view, as well as promote social equality and healthy lifestyles (WHO, 2016c). In Portugal, both the responsibility for managing the menus of preschool and primary schools, as well as the delivery of their school meals (lunch) lies with the municipalities. Except for schools that have their own cooking facilities, the supply of school meals during secondary education is endorsed by the Directorate General of Education Institutions (DGEstE, 2015). Moreover, the salt content present in the several components of the meal provided by Portuguese schools (soup, main dish, and bread) is subject to a set of guidelines that have been established (DGEstE, 2015).

Considering the WHO recommendation regarding the maximum value for salt consumption (WHO, 2012), at lunch the amount of salt ingested should not exceed 1.5g, assuming that 30% of the total energy value is represented by that meal (Institute of Medicine, 2010). The quantities of various nutrients present in food samples served in schools are assessed in the laboratory, using a variety of techniques recommended by international organizations, which are already standardized (Association of Official Analytical Chemists, 2000). However, besides the lack of detailed knowledge about the complete nutritional composition of these school meals (soup, main dish, and bread), the need for interventions in this matter is emphasized by the few existing studies in Portugal, which identified average values of school meals' sodium content varying between 2.83 and 3.82g (Paiva et al., 2011; Viegas et al., 2015), which should undoubtedly be reduced.

With the aim of developing an approach that addresses this and other issues regarding children's food, in 2016-2017 Portugal created *Eat Mediterranean* Program for Eliminating Dietary Inequalities in Schools (EM) (Rito et al., 2020). With the implementation of EM, one of the main priorities, at both the community and individual level, was the improvement of the school food environment, namely in vending machines, cafeterias, and canteens, by tackling the quality of the food offered, from a nutrition point of view. The EM program proposed to modify, within the school food environment, the food composition of school meals provided to students, in order to reduce the nutritional deviations identified through the assessment of school meals regarding its nutritional adequacy.

Hypothesis

Educating the staff responsible for cooking the meals in public schools is an effective

way of improving dietary patterns among pupils.

Objectives

This chapter aims to evaluate the salt content and nutritional composition of Portuguese school meals, prior to and following the EM program intervention.

Methods

For these following sections, the methodology used is as described in Rito et al. (2020).

Program and Participants

Within the school community belonging to three Portuguese public school groupings from the Alpiarça and Santarém Municipalities, the EM program was developed during the school years 2015/2016 and 2016/2017. The program was approved by Lisbon & Tagus Valley Regional Health Administration Ethical Committee, and targeted students aged between 3 and 21 years, belonging to 25 schools from preschool to secondary education.

The EM program comprised three phases. The first took place between March and June 2016 and consisted of a Diagnosis Phase, in which laboratory analyses were carried out following the collection of a total of 386 samples from all school meals served during the 2015-2016 school year, among the schools under study. The second phase took place between July and March 2017 and was an Intervention Phase, during which several training and nutritional education sessions were held for school professionals who would have the responsibility of handling the food served at

school. Finally, the third phase took place between April and June 2017, called the Post-Intervention Phase, in which a new quantitative assessment was made considering the implementation of the new changes in the meals served in schools through the development of procedures by the respective municipalities.

Food sample collection and preparation

Food samples were collected from all 10 kitchens that served meals to the 25 schools involved. Both in the diagnosis phase and in the post-intervention phase, samples of the complete meal (soup, main dish, and bread) were collected, regarding food served to children at lunch time in schools.

Latex gloves were used during sample collection. In order to maintain confidentiality, the samples were subsequently stored in sterile polyethylene bags coded in alphabetical order. After being properly refrigerated and transported to the laboratory, to avoid contamination, a GRINDOMIX GM 200 knife mill equipped with high-speed titanium knives was used to grind and homogenize the samples. Until the subsequent processing of the prepared samples, they were stored in vacuum bags at freezing temperature (-20 ºC).

Laboratory analysis and interpretation

Under quality assurance conditions fulfilling the requirements described in Standard EN ISO / IEC 17025: 2005 (International Organization for Standardization, 2005), samples were analysed according to the methodology recommended by the Official Methods of Analysis of AOAC International (Association of Official Analytical Chemists, 2000). For Sodium (Na) determination, its content was measured using ICP-OES Thermo iCAP 6000 series, an inductively coupled plasma optical emission spectrometer, and samples were analysed in triplicate. Afterwards, using the formula

"salt = sodium (Na) × 2.5", (Regulation (EU) No 1169/2011) the salt content in g/100 g of food was calculated.

Importantly, although other sodium salts, such as sodium phosphate, sodium bicarbonate, mono-sodium-glutamate MSG, among others, are common sources of sodium in seasoning, processing and food preparation, the biochemical determination was limited to sodium. However, in the present study, data are reported as "salt intake", assuming that all sodium in food is added as sodium chloride. Bearing in mind that 5g is the WHO reference value for salt intake (WHO, 2012), and assuming that 30% of the daily energy intake comes from lunch (Institute of Medicine, 2010), in the present study 1.5g was used as the reference value given that 0.30 x 5 = 1.5 g.

Statistical Analysis

Using Microsoft Excel® spreadsheets, data sets were produced and using IBM SPSS® statistics for Windows, version 22, data sets were statistically analysed (IBM Corp, 2016). In this study, the mean +/- SD was used to report the obtained results. Moreover, in the case of paired samples, mean comparison tests were performed. The results were considered statistically significant according to the significance level of $\alpha = 0.05$.

Results

As shown in Table 23, when comparing the post-intervention samples with the original samples, there was a 23% reduction in the sodium equivalent per serving portion of a complete meal (g), while for salt reduction was slightly lower (20%). Furthermore, while the main dish revealed an increase of 3% in mean serving portion (corresponding to 7.5 g), soup showed a 3% reduction, equivalent to 6.8 g. In

addition, a reduction for both the sodium equivalent and the salt equivalent per serving (g) was only shown by soup, this reduction being 33%, not occurring in any of the other components of the meal.

Table 23 - Sodium and salt equivalent content of the components of the school meals.

		Serving (g)		Sodium (g/serving portion)			Salt (g/serving portion)[a)]			Sodium (g/100g)			Salt (g/100g) [a)]		
	n	Diagnosis	Post-intervention	Diagnosis	Post-intervention	p value	Diagnosis	Post-intervention	p value	Diagnosis	Post-intervention	p value	Diagnosis	Post-intervention	p value
Soup	10	227.10 ± 30.24	220.30 ± 37.08	0.59 ± 0.12	0.39 ± 0.24	0.017	1.46 ± 0.29	0.97 ± 0.59	0.017	0.26 ± 0.04	0.17 ± 0.09	0.022	0.64 ± 0.08	0.43 ± 0.23	0.022
Main dish	10	262.30 ± 51.71	269.80 ± 61.28	0.68 ± 0.21	0.60 ± 0.25	0.169	1.70 ± 0.54	1.51 ± 0.63	0.169	0.26 ± 0.08	0.23 ± 0.09	0.241	0.57 ± 0.14	0.57 ± 0.22	0.721
Bread	9	46.00 ± 14.80	46.56 ± 16.08	0.19 ± 0.09	0,18 ± 0,11	0.441	0.49 ± 0.21	0.46 ± 0.27	0.514	0.41 ± 0.05	0.37 ± 0.08	0.038	1.03 ± 0.12	0.93 ± 0.21	0.035
Complete meal	10	-	-	1.5±0.30	1.16±0.45	0.028	3.62±0.40	2.91±1.12	0.047	-	-	-	-	-	-

[a)] The salt content was calculated by the formula: salt = sodium (Na) × 2.5 (Regulation (EU) No 1169/2011).

Source: Rito (2020)

Figure 29 shows the changes in the mean salt content (g), both in the diagnosis phase (pre-intervention) and in the post-intervention phase, for each of the schools included in the present study. It was found that, apart from two schools, all the rest showed a decrease in salt content after the intervention of the EM project.

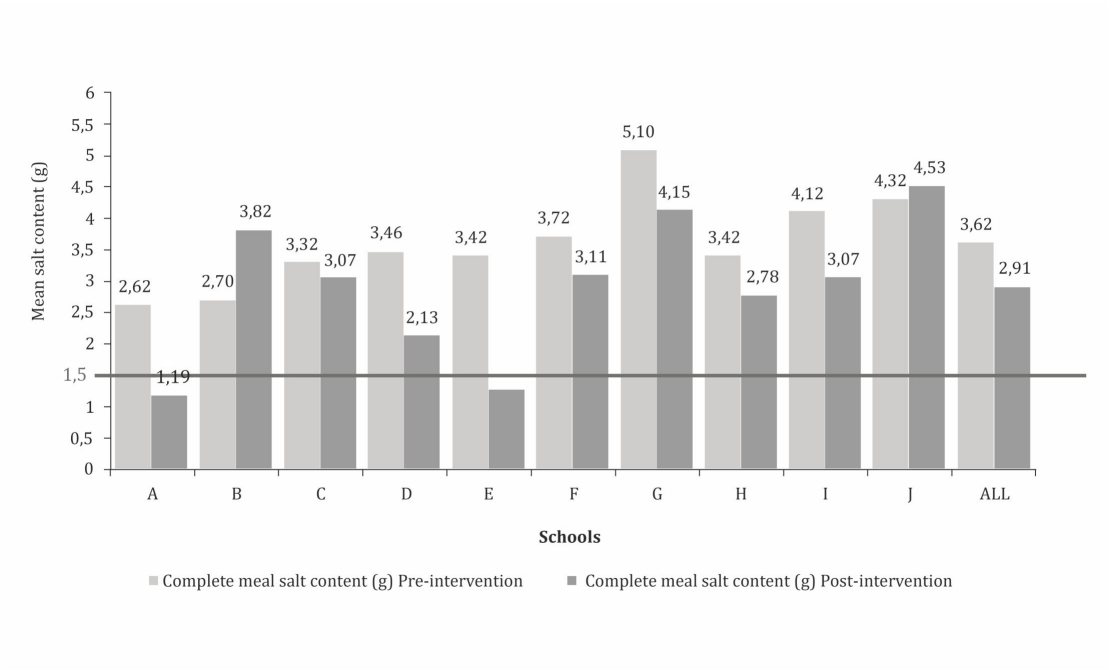


Figure 29 - Mean salt content (g) of the complete school meals analysed at the diagnosis phase and at the post-intervention phase.

Source: Rito (2020)

Discussion

This study aimed to assess the impact of the EM program – which sought to modify the food composition of school meals offered to students,

improving their nutritional quality – by assessing the salt content present in school meals before and after the intervention of this program. Apart from school B (Preschool + Primary school) and J (Elementary school + Secondary school), there was a reduction of approximately 20% in the salt content present in meals served by schools under the intervention of this community program. Therefore, it seems that the salt content of meals served in schools covered by the EM program has undergone a significant improvement.

The results of the present studies were similar to previous studies carried out in several countries (Ahn et al., 2013) and also in Portugal (Paiva et al., 2011; Viegas et al., 2015), which evaluated the salt content present in the meals served in the school canteens, as this study recorded an average salt content of 3.62g per meal, at the beginning of the EM program. Although it is still far from the previously mentioned reference value of lunch salt (1.5 g of salt), there was a reduction in the salt content per meal from 3.62g to 2.91g, which corresponds to a significant drop of 20% ($p < 0.05$), resulting from the intervention of the EM program. If each component of the meal is observed independently, it appears that the major contribution to the salt content present in the total meal comes from the main dish. Similar results were observed in the study carried out in 2018 by Barbosa et al. (2018), with samples from the canteens of the Portuguese University. According to this study, it was suggested that the results could possibly be explained by the amount of salt added to the main dish during cooking, which may be greater than in soups. Moreover, it was also suggested that the intrinsic sodium present in foods, such as

fish and meat is greater than the sodium intrinsically present in vegetables used for soups (Martins, Porto & Oliveira, 2007), which could justify the results obtained. Regarding the salt content present in the soup served by the schools, there was a significant reduction of around 34% resulting from the intervention of the EM program, having decreased from 1.46g (pre-intervention) to 0.97g (post-intervention) of salt per serving.

Importantly, compared to the results reported by other Portuguese studies (Gonçalves et al., 2014; Paiva et al., 2011), the values obtained in the present study, both before and after the intervention of the EM program, are higher. In addition to advising the replacement of salt by either aromatic herbs or glasswort, according to the Portuguese 2018 guidelines regarding school menus and canteens, during the cooking process of soups and main courses, a maximum of 0.2g of iodized salt can be added. In turn, the salt composition of the serving of bread included in school meals cannot exceed 1%, and therefore the 25g serving of bread for preschool and primary school corresponds to 0.25g of salt per serving and the 45g serving for the elementary and secondary school corresponds to 0.45g of salt per serving. Importantly, before and after the intervention of the EM program, the salt content per serving of bread was significantly above the established guidelines, even though the mean serving of bread in the current study is slightly higher than 45g.

During the implementation of the EM program, several challenges arose, including the reduction of the amount of salt added to food during the preparation by cooks of the meals served at school. Currently, several

cooks continue to choose to measure by "hand" the amount of salt added during the preparation of the meals, going against technical guidelines that clearly state that the amount of salt added must be measured accurately. These observations are consistent with the study by Gonçalves et al. (2014), which showed that although many food handlers in a school environment acknowledge that they do not taste the food before adding salt, the amount of salt added to meals during preparation is influenced by the cook's taste. According to this study, food handlers claim that their greatest difficulty in reducing salt content in meals is related to consumers' acceptance and opinion, although they are aware of the recommended values of salt content and also of health problems related to excessive salt consumption (Gonçalves et al., 2014). Thus, considering these limitations, to make programs whose goal is to reduce the salt content of meals served in various locations including schools more efficient, the relevance of educating both food handlers and consumers is emphasized.

In order to decrease and prevent the risk of developing NCDs, it is urgent to implement actions that promote the reduction of salt consumption, especially in the younger sections of the population. As confirmed recently by the National Food, Nutrition and Physical Activity Survey (Lopes et al., 2017a; Correia-Costa et al., 2016), both the development of diseases and the acquisition of poor eating habits may result from the meals with high sodium content offered in school environments, as well as from the increased consumption of processed foods. The need to address and tackle this public health issue becomes even more relevant given that

emerging evidence points to an association between the development of diseases such as obesity and sodium intake, which may be due to increased consumption of high energy drinks resulting from the induction of thirst by salt, but also due to pathophysiological mechanisms associated with excessive salt consumption (Cappuccio & Capewell, 2015; Grimes et al., 2016; Ma, He & MacGregor, 2015; Libuda, Kersting & Alexy, 2012; Yoon & Oh, 2013; Zhu et al., 2014). A previous study carried out in the United Kingdom, using a nationally representative sample of adults and children, showed that regardless of the consumption of sugar-sweetened beverages or energy intake, there is an association between several measures of adiposity and salt intake.

Given that the intervention of the EM program has shown significant nutritional improvements in school menus, the feasibility of mechanisms with the potential to successfully provide school meals with reduced salt content is evident.

It is expected that all parties responsible for meals served in schools, including trained kitchen staff, will strictly comply with the technical sheets so that school meals served to students are nutritionally adequate. It is essential to continue monitoring the serving of meals and all stages of meal preparation by the cooking staff, as well as to keep educating teachers, educators, parents, and students about eating healthily. The EM program was successful largely due to the concerted and integrated work between educational communities, municipalities, research institutions and health departments.

Consumer rejection behaviour due to "lack of flavour" seems to be one of the most frequent challenges that educators encounter when trying to decrease the quantity of salt added to meals. However, it is well described that the neurological system associated with flavours can adapt to small reductions in the amount of salt in meals (Cappuccio & Capewell, 2015). Thus, the school environment may be ideal for educating and shaping flavours so that children are more receptive to less salty foods, in addition to nutritional literacy interventions amongst children.

One of the biggest potential limitations of this work is the short time period for the intervention of this study. A continuous assessment of the adaptation to changes implemented in a school setting could have deeply benefited the process and robustness of results. Given its ability to recognize the importance of consumer acceptance in order to achieve sustainable changes, EM paved the way for further work. It is expected that the training, capacity building and nutritional education activities will increase the potential for long-lasting effects of the program (Rito et al., 2020).

There seems to be an increase in the effectiveness of interventions at school in programs that, in addition to increasing exposure to interventions, are also comprehensive to the point of combining diet, behavioural interventions and physical activity (Bleich et al., 2018; Sobol-Goldberg, Rabinowitz & Gross, 2013; Verrotti et al., 2014). Other aspects that help to promote the effectiveness of these interventions include

monitoring the behaviour of children, changing the environment in which they operate, and also involving parents and teachers, including several community settings such as a secondary home, and targeting children aged less than 12 (Ickes et al., 2014; Bleich et al., 2018; Sobol-Goldberg, Rabinowitz & Gross, 2013; Verrotti et al., 2014). A universal approach towards promoting healthy behaviour can be ensured by the collaboration between several stakeholders which further improves the success of such programs.

Policy implications at the national level

Health promotion activities, when integrated into school environments, constitute common ground for the Ministry of Education and the Ministry of Health. However, programs like EM are not actually developed transversally in all the schools in Portugal. This reality implies inequalities, that go from schools that don't go beyond the national Ministry of Education determined compulsory curricula to schools and teachers that proactively seek additional activities and initiatives in the areas of healthy nutrition in order to make the compulsory curricula more complete and fully realised. In this context, the easiest solution is to engage private sector players from the food sector in order to access free teaching materials and content. However, these rarely show evidence of any health or behavioural impact. Thus, further standardization and mapping of health literacy projects promoted in Portuguese public and private schools is urgent. Promoting accountability for such activities is a way of ensuring they actually deliver the results they are supposed to and helps to avoid

vested interests from external agents that get into the school environment. There is a gap in the existing national literature concerning all health literacy initiatives being implemented in school settings. A detailed review of all initiatives promoting health literacy that are being conducted in schools should be done, in particular a review of those promoted by the private sector, in order to ensure compliance with best practices and the available evidence to date.

Additionally, and as a way of reducing inequalities between schools, the Portuguese Government should consider using the lessons learned from initiatives like EM, in order to build new, compulsory and comprehensive national programs that involve all the school stakeholders. Countries like Japan have done so through the creation of compulsory Eating and Food Education classes for all primary schools.

Teaching and developing healthy eating skills in children requires professional education. Thus, formal education in the areas of nutrition should be delivered to teachers and school staff so that they can facilitate the knowledge acquisition of their pupils. Training delivered by health professionals such as nutritionists may be the way to tackle such challenge. Since these health professionals are the most qualified to manage nutrition related scientific knowledge, the possibility of integrating them permanently in the school staff shall also be considered. However, such qualified health human resources allocation will certainly imply important policy endeavours.

Policy implications at the Global Level

Healthy food and improved nutrition should be a high priority on every school agenda because of the positive effect on child well-being, and subsequent enhanced learning ability and academic performance. A single global school food and nutrition policy cannot be formulated due to wide cross-country variation among schooling systems. It is therefore essential for each country, authority or school to decide which of the suggestions for school nutrition and food policy are most appropriate and applicable to their circumstances.

Learning opportunities for healthy dietary practice inside and outside of the classroom setting are important.

Food and nutrition policy must include aspects of curriculum monitoring and evaluation to allow continuous adjustment and improvement specific to the contextual needs of the pupils. In addition, concepts of healthy living and life-skills education should be extended to include broader health aspects i.e. alcohol consumption, drugs and disease prevention (WHO, 2006).

Creating partnerships and involving local farmers and retailers offer multiple benefits to both children and to the general understanding of food concepts. School trips to local farms enable children to learn first-hand about food production and the food chain. Further, a collaboration between primary and secondary school in close vicinities could provide an avenue for peer-based education and healthy lifestyle promotion (WHO, 2006). In addition, generating media and publicity encourages community

involvement and raises awareness of health promotion campaigns. One way of generating publicity is to encourage the local media to cover the school food and nutrition initiative with a press release sent to newspapers, radio and television. In addition, within the school and community special letters and regular newsletters may offer an important avenue of communication. Pupils should be involved in writing newsletters and be encouraged to contribute articles, recipes, poems or artwork.

It is also important to promote the healthy food and nutrition recommendations and the project's achievements on the school website. A further way of communicating with parents and the local community would be to organize concerts, plays, exhibitions or fairs. Health promotion messages and nutritional education should be positive and consistent throughout the school environment. Advertising and marketing (especially of branded products) should be minimised within the school setting.

Chapter 9

Discussion and Conclusions

The discussion and conclusions of this thesis shall be presented according to two major discussion axes: policy and implementation insights. The first reflects the most important take aways from each of the main chapters of this thesis, which address one major NCD policy area each. The latter discusses the implementation management dimension of each of the main NCD policy areas, addressed over the main chapters. In order to do that, a Health Policy Implementation framework with five different dimensions is presented and used.

Building on this discussion, a list of evidence-based future policy recommendations is presented for a national and international audience of policy makers, international organizations and public health practitioners.

Policy Insights

NCDs have grown to be one of the most prominent health challenges of the 21st century, in addition to becoming the primary cause of mortality and incapacity worldwide. The WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020 (Global NCD Action Plan) was a steppingstone for a global answer to this well-known pandemic. It has been updated more than once since its first approval, more precisely Appendix 3 has been updated. Appendix 3 of the WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020, actually includes a

total of 88 interventions and recommended policies. However, even though all the Member States committed to implementing such WHO recommended policies, implementation asymmetries worldwide were to be expected. Therefore, it would be essential to analyse and benchmark implementation performances among the WHO Member States and, to actually see how Portugal performed.

In Chapter 2, the objective answers attained made it possible to confirm the first research hypothesis: **"**In the global context, Portugal performs well regarding the overall implementation of NCD policies." In this chapter, the fact that the implementation of WHO-recommended NCD policies has increased over time was highlighted. On average, countries implemented just under half of the NCD policies recommended by the WHO in 2017. Nutrition-related policies saw gains. Aggregate implementation scores tended to be highest in high-income countries that invest in health care and education. In the global context, Portugal is among the top 20 NCD policies implementers and climbed up several positions in terms of implementation score (from 34th to 11th).

Almost 40 years after the creation of the National Health Service, Portugal has made great advances in public health. However, the country is also witnessing profound demographic and epidemiological changes (Ministério da Saúde, 2018). Living longer is one of the most remarkable achievements. The average life expectancy in Portugal is above average compared to the European Union (EU) and now stands close to 81 years (PORDATA, 2020). However, along with longer life expectancy comes an

aged population. More than 20% of the Portuguese population is over 65 years old (Eurostat, 2018a). This presents challenges associated with the increasing prevalence of NCDs as well as with a shrinking pool of taxpayers and spiralling costs to health services (Panagopouos & Barreira, 2013).

At the same time, lifestyle patterns are changing with serious implications for health and economic well-being (Cecchini et al., 2010; Brown et al., 2015). For example, according to the WHO European Childhood Obesity Surveillance Initiative (COSI) (Rito et al., 2016), it is estimated that 30.7% of all Portuguese children aged 6-9 years are overweight and that 11.7% are obese; international comparisons reveal that the prevalence of child overweight in Portugal is above the average of all Member States of the Organisation for Economic Co-Operation and Development (OECD, 2017). In addition, more than 50% of the adult Portuguese population is overweight (Lopes et al., 2017). Underpinning these figures is a worrying trend away from the protective Mediterranean diet towards unhealthy eating. Indeed, it has been estimated that unhealthy diets are responsible for the loss of 15.8% of healthy years of life among the Portuguese population (Direção-Geral da Saúde, 2016).

It is clear that several factors actively threaten the health of the population as well as the universality and viability of the Portuguese NHS. As such, controlling the prevalence of NCDs and tackling important risk factors, such as unhealthy diets, has become an urgent priority for Portugal in recent years. Building on a reality where disease treatment

was the unquestionable focus of the National Health System, there was, therefore, a clear need for a cultural change that would give a growing relevance to the health promotion and disease treatment areas. Some may argue that such cultural change already started. As referred in the introductory chapter of this thesis, Portugal has gained international attention due to the health policy endeavours developed in the Healthy Nutrition Promotion field. That fact was one of the motivations for looking into the Portuguese case in more depth. Thus, this thesis developed as an analysis and characterization of the Portuguese experience of bringing the WHO's 'Best Buys' and recommended policies from global concept to local action.

In order to do so, Portugal developed and implemented the so-called Integrated Strategy for the Promotion of Healthy Eating. Chapter 3 offered a detailed analysis of the process that led to the development of that strategy. The HiAP core was evident throughout the journey and, therefore a hypothesis was formed about the effectiveness of using HiAP approaches (such as Integrated Strategy for the Promotion of Healthy Eating) in order to convert the WHO's recommended policies into implementation-oriented national policies. The pathway followed by political leaders and policy makers, from the WHO's 'best buys' and policy recommendations to local actionable measures, was described and critically analyzed. This process evidenced high level political commitment, leadership, strategic planning as well as engagement from all relevant stakeholders both inside and outside the health sector. This was an exceptional example of adopting a HiAP approach. Therefore, the research

hypothesis that motivated the development of chapter 3 was confirmed. However, raising the budgets available to health promotion and disease prevention initiatives, and more precisely to HiAP initiatives, as well as developing a multiannual funding commitment for the Portuguese NHS are key success factors. Despite the commitment to the implementation of EIPAS demonstrated by the Portuguese Government at early stages, it may be a challenge to maintain the existing efficacy of EIPAS' implementation, as well as its speed and effectiveness. Given that long-term considerations can be replaced by short-term political goals, regarding a country's health care system, the greater its politicization the lesser its likelihood of effectiveness.

From all the policy measures included in EIPAS, back in 2017, the Portuguese Ministry of Health's leadership identified five that deserved special attention and commitment to implementation due to their innovative profile at the national level. Chapter 4 focus on one of those: the Sugar-Sweetened Beverages Tax.

In that chapter, evidence from Portugal regarding the impact of the levy applied on SSBs, both in reducing the consumption of these drinks, as well as in decreasing their average sugar and energy content was delivered. Tax policies should prevent obesity mainly in younger individuals since they are the ones who consume SSBs the most. Both the reduction in sugar consumption and the decrease in sales of SSBs was significantly accelerated after the implementation of the tax. These phenomena are expected to have an important impact on the health of

Portuguese citizens, namely in the prevalence of obesity in future years. Therefore, the research hypothesis that mandatory regulations such as the Sugar-Sweetened Beverages Tax were effective in tackling NCDs was confirmed. However, it is important to stress that despite being effective, such policies have a very limited impact by themselves. This is of particular note considering the challenge Portugal will have to face if it is to achieve the WHO's 2025 targets.

It was then timely to look for another policy recommendation included in EIPAS: the Food Sector Reformulation Agreement. Chapter 5 looked to find evidence regarding the effectiveness of such voluntary self-regulation policies in tackling NCDs. Modelling the impact of such measures was the way forward. The modelling exercise developed in chapter 5 suggests that fully meeting the targets initially suggested by the Ministry of Health (before negotiations with the food industry) would prevent 798 premature deaths from NCDs per year. However, the targets initially used in the modelling study were not those agreed upon by all parties. The final agreement targets were actually much less ambitious than the preliminary ones. Chapter 5 highlights that voluntary industry agreements like the one described will prevent premature deaths, however in a relatively small volume. Therefore, the research hypothesis that motivated the development of chapter 5 and that looked for the evidence of the effectiveness of policies like the Food Sector Reformulation Agreement was confirmed. However, once again, such policy actions seem to be insufficient on their own and must be complemented with other public health interventions in order to significantly improve population health

outcomes. In fact, evidence suggests that health gains from mandatory measures could be 20 times higher than voluntary interventions.
Since this thesis looks into the health reality of Portugal, it is important to address the challenge of excessive salt consumption this country faces. Therefore, chapter 6 focused on looking for evidence to support or deny the effectiveness of regulating the maximum amount of added salt to highly consumed products in tackling NCDs. In this chapter, the potential impact of regulating the maximum amounts of added salt to highly consumed products, such as bread, was assessed. According to the estimation and calculations presented in the chapter, every year of delay in updating the regulation in place results in 286 avoidable deaths attributable to excessive salt intake. Building on this information, it is fair to assume that the research hypothesis that motivated the development of chapter 6 was confirmed. However, despite having Member States' buy-in, such regulatory policies may see their implementation blocked by bureaucrats leading regional regulatory institutions, for example, the European Commission.

If on one hand, such obstacles may prevent countries from implementing effective policy measures that may impact the actual trading agreements, the fact is that there are also good examples of health policy measures that may be enforced at the national level building on the international evidence. The implementation of a single front of pack labelling systems is one of them. However, in Portugal, unlike other European countries, little progress has been made in this area. Policy and regulatory levers lying outside the health sector, limited collaboration between different

governmental areas, and vested interests within and outside of the health sector have deeply hampered any decisive action from being taken. Until now, the lack of evidence on the real impact of the use of foreign FoPL systems on the Portuguese population had been highlighted as an obstacle to the Portuguese Government endorsing a single FoPL. The research developed in chapter 8 aimed to fill this evidence gap and its results achieved that. Not only was it possible to elect the NutriScore system as the best option for Portugal but also it became clear that the standardisation of the FoPL used at the national level is required in order to put a stop to the confusion generated by the coexistence of several different FoPLs at food retailers.

Finally, the area of education was examined as an opportunity for the implementation of health policy measures. Chapter 8 attempted to validate the research hypothesis that educating the staff responsible for cooking the meals in public schools is an effective way of improving dietary patterns among pupils. In this chapter, the impact of an educational intervention among the cooking staff of public schools on the quality of the meals delivered to pupils is analyzed and assessed through a controlled trial. The sodium content of school meals was assessed before and after the educational intervention. The intervention was a comprehensive community-based program to identify nutritional deviations and correct them by modifying the food composition of school meals, through training of the schools' food handlers and through the development and implementation of new menus.

Overall, the studied intervention allowed a significant decrease in the mean sodium content of the meals served to school students, mainly achieved by the reduction of sodium content per serving portion of soup. Results show that community-based programs may have positive impacts on the nutritional quality and balance of school meals. Moreover, school settings may be ideal for nutrition literacy interventions among children and for flavour shaping and educating towards the acceptance of less salty food. The initial research hypothesis was confirmed by the presented findings.

Implementation Insights

The health impact of innovative health policies, such as the ones described and assessed in the 8 chapters of this thesis, tend to also be conditioned by factors that go beyond public health science.

In the field of public health, "implementation science" studies offer the best practices in improving population health. This body of knowledge leverages multidisciplinary methods to scale up evidence-based interventions in a systematic and sustained way (Campos & Reich, 2019; Lobb & Colditz, 2013). Deliverology, which is another approach to studying implementation, provides a set of methods to promote progress and the delivery of results in the area of public policy (Barber, Moffit & Kihn, 2011). These methods have been developed for public policy in health, agriculture and education, among other areas and are outcome-driven.

Regardless of how you approach it, this is arguably an aspect of policies that is often neglected. In order to produce health gains, innovative NCD policies require more than just to be evidence-based and backed by large amounts of documentation (Gilson, 2016; Roberts et al., 2004). They need to be implementation driven. This requires ´the aggregation of the separate actions of many individuals, and an understanding of how and why the actions in question are consistently reproduced by the behaviour of individuals´ (Lipsky, 1980: p.12).

According to the literature, an often-referred challenge is the fact that the responsibility of policy implementation lies with different governmental players to those who initially designed the policy itself (Oliver, 2006). As such, policy makers are often ill-prepared to fully understand policy implementation. Given this, effective innovative health policy implementation demands collaboration across actors and organizations (e.g. to communicate objectives of a certain policy, the availability of key resources, etc.) (Campos & Reich, 2019). This context often leads to delays due to adjustments required to ensure the viability of said policy (Oliver, 2006). Policies require consideration in the national context for successful implementation (Roberts et al., 2004). Similarly, the complexities of the administrative side of policy implementation deeply impact implementation (Barber, Moffit & Kihn, 2011; Hill & Hupe, 2003).
Political sciences recognize that policies are often implemented in ways that rarely achieve the originally intended outcomes (Campos & Reich, 2019). The term "implementation deficit" came to life in order to explain the disconnect between levels of government and local level

organizations. According to Pressman and Wildavsky (1973: p.24), "the longer the chain of causality, the more numerous the reciprocal relationships among the links and the more complex implementation becomes". With this in mind, policy implementation-oriented studies coined the term "implementation gap"; used to explain the gap between the expectations behind policy design and the results of its implementation. The literature also contrasts analyses of policy implementation using a "top-down" or a "bottom-up" approach (Hill & Hupe, 2003). Similarly, the so-called "multi-layer problem" is also referred to as a key implementation challenge given the different policy layers at a governmental level (Dunsire, 1978).

Watching a slow-motion disaster, such as the growing trends of the NCD pandemic, unfold is a vexing public-health challenge. It is particularly frustrating when policymakers, aware of the problem, fail to respond. The histories of climate change, HIV, and famine are prominent examples of such malignant neglect—that is, "doing harm by doing nothing" (Stuckler & Basu, 2013). When confronted with this passive behaviour, political leaders would tend to find justifications in the lack of scientific evidence to back more aggressive policies. Fortunately, science has evolved in the area of NCD prevention, thus invalidating the argument of a lack of evidence to base policies on.

On the other hand, several political leaders would argue that the lack of guidance provided by international organizations would leave Member States in an uncertain situation and lacking the confidence to implement

innovative policies. Most countries prefer not to take risks associated with being the first mover. In this context, the 88 WHO 'Best Buys' and other recommended policies are instrumental. Most political leaders have no other option than to honour their commitment to meet the WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020 targets. Implementation failures and setbacks seem to play an important role in the current fight against NCDs. Apart from validation of each chapter's research hypothesis, the Portuguese experience in implementing the diet-related WHO 'Best Buys' and other policy recommendations is a valuable opportunity to analyse the implementation challenges faced. Based on the aforementioned literature, and inspired by several health policy implementation frameworks available, this thesis suggests the usage of a framework based on 6 core elements that complete the gap between health policy recommendations, such as the WHO's 'Best Buys', and local level implementation. These core elements – Leadership, Strategy, Governance, Management, Accountability and Sustainability – and their interactions are presented in Figure 30.

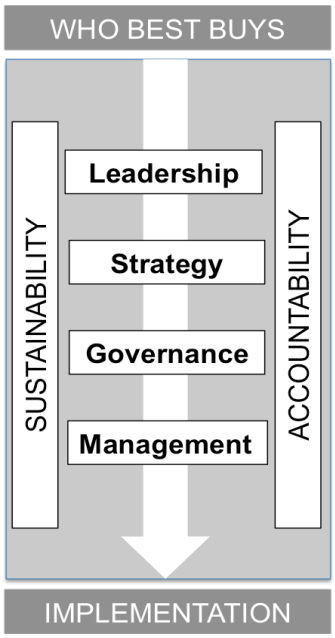


Figure 30 – Health Policy Implementation Framework

The WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020 was officially made public by the WHO during the World Health Assembly of 2013. Being a set of voluntary NCD-related premature mortality reduction targets, it aimed to be broad enough to adapt to all the WHO Member States. Thus, this document, that aimed to push for a strong response at the global and national level, actually left all the implementation work to be done by member states. Even though more detailed guidance is provided in Appendix 3 regarding what policies to implement, the fact is that the "How to" seems to be mostly absent.

As argued in Chapter 1, countries with strong health systems like Portugal seem to have been doing well regarding the implementation of the WHO's list of 'Best Buys'. However, can we really attribute the reason for such achievements to the WHO's 'Best Buys'? The answer is, at least partially, no. In fact, even before the WHO's 'Best Buys' list was published (2013) most of its policies were already in place in Portugal. However, from the

WHO-recommended policies with little implementation progress over the last 10 years are the nutrition-related ones.

Chapter 1 presents the evolution of the WHO's 'Best Buys' implementation scores over time, by country, mostly based on self-reported data. It is important to stress that, unfortunately, this scoring model is too broad to actually be able to distinguish the difference between implementing a policy and implementing a policy compatible with the health challenges faced by one country. In other words, looking at the very high consumption of salt levels by the Portuguese, presented and discussed in chapters 6 and 8, one may question whether Portugal actually should be reporting a full implementation score for salt policies since 2013. Assuming that Portugal has implemented them, two scenarios may explain the actual salt intake levels by the Portuguese: either the policies implemented don't work, or they were not implemented in adequate number, scope and/or ambition.

In December 2015, the XXI Constitutional Government of the Portuguese Republic was elected. The newly elected government represented a switch in the governing political party and therefore in the political actors in charge. Professor Adalberto Campos Fernandes and Professor Fernando Araújo (both physicians) were nominated Minister and Vice-Minister of Health, respectively. In the Portuguese Ministry of Health, it is normal for the Minister and his Vice-Ministers to assume leadership of different ruling areas. As such, the Minister, Professor Adalberto Campos Fernandes, set the overall vision for the Ministry of Health and mandated Vice-Minister

Fernando Araújo to assume the Public Health dossier and coordinate the implementation of these programs. This implied managing the National Public Health Authorities and promoting the much-needed development of innovative policies to address the ongoing NCD pandemic.

With the national epidemic in mind, Minister Campos Fernandes, together with the Vice-Minister Araújo, realised that the existing Health Promotion and Disease Prevention policies, as well as the institution responsible for their implementation, the Directorate General of Health, were not delivering the results the country needed. Not being a Public Health specialist and faced with several teams of old-fashioned Public Health Specialists that were adamant on maintaining the status quo, Vice-Minister Araújo had to look for answers elsewhere, in order to be able to fulfil the vision established by Minister Campos Fernandes. The WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020 presented itself as an important tool that allowed political leaders to understand the areas they should be focusing on if they were to reverse the growing trends of NCDs' prevalence and incidence. The implementation of the Portuguese measures makes for a formidable test case to put the six-elements implementation analysis framework outlined at the beginning of this thesis to test.

Leadership

Leadership is the art of motivating a group of people to act toward achieving a common goal (Prentice, 2004). Strategic vision, technical knowledge, political skills and ethical orientation are all essential

components for health systems' leaders to master in order to lead policy design and implementation (Frenk, 2010). Advanced leadership and management skills are required to overcome the resistance to change that often comes as a response to new and innovative policy proposal. Very few leaders of health systems have experience as executives of large organizations and, as such, deeply lack management skills (Roberts et al., 2004).

Generally speaking, leaders must "promote, enable, and support decision-making and execution by actors at all levels". The same is applicable in health systems' leadership (Campos & Reich, 2019). It is often stated that policy implementation is hindered at the frontlines of healthcare delivery; but obstacles might come from all levels of the health system (Gilson, 2016). Policy implementation teams (or task forces) frequently need to call upon higher political leaderships to aid in the implementation of innovative health policies (Campos & Reich, 2019). Therefore, one important vector of analysis necessarily pertains to leadership, which is crucial to attaining the next elements, by overseeing the implementation of strategy, the enforcement of governance, the empowerment of management and the push for accountability and sustainability.

The first goal of the XXI Constitutional Government of the Portuguese Republic, as referred to in its Government Plan, was to improve public health. To do so it was essential to tackle the ongoing NCD pandemic. Concerned about the public health institutions status quo, as per the mandate of Minister Campos Fernandes, and inspired by the WHO's Global

Action Plan for the Prevention and Control of NCDs 2013–2020, Vice-Minister Fernando Araújo decided to personally engage in the process of converting the WHO's high level recommendations, into actionable policies. Only a few months after his nomination, speeches of the two Government Members were totally aligned with the mission of creating a sense of urgency among the population around the NCD pandemic. It became a habit to hear very concerning numbers regarding NCD high prevalence and avoidable risk factors at the beginning of each public intervention made by the Minister of Health and his Secretaries of State. Often, political leaders are not always an example of putting into action their own words. Fortunately for Portugal, that was not the case of Minister Campos Fernandes and Vice-Minister Fernando Araújo, who also started to dedicate most of their time to follow up and support the Directorate General of Health on the development and implementation of innovative policies for tackling NCDs.

It didn't take long for these Members of Government to realize that most health policies developed solely by public health teams would be blocked by other stakeholders, namely other ministries inside the Portuguese Government.

This was why the Portuguese Ministry of Health decided to ask for the Prime Minister's endorsement for the implementation of a pack of innovative health policies addressing the food sector. This process is described in detail in chapter 3.

Political leadership is always temporary. Therefore, if a government aims to be successful in tackling challenging problems such as the one described here in a very short period of time, informally taking over the management of institutions such as the Directorate General of Health, instead of replacing their leaders, may be efficient and create less instability in the short term. However, it is certainly not the best way of making sure the cultural change will survive into the next political cycle.

The Portuguese Vice-Minister of Health, supported and mandated by the Minister of Health, took the mission of managing the change from a disease intervention focused health system to a prevention focused health system in his own hands. However, no forced leadership replacements happened among the underperforming leaders responsible for the NCD policy development, management and implementation. These individuals were, in fact, partially responsible for the concerning situation the system was in.

Strategy

The process of strategy development, in the scope of policy making, consists of operationalizing a policy into actionable activities and identifying key resources. The buy-in of parties responsible for mobilizing resources (human and financial) in policy design, significantly increases the potential for successful implementation. Broad stakeholder involvement is therefore key, at both a local and functional level. Additionally, stakeholders must have the required authority and capability to carry out intended activities (Campos & Reich, 2019). In this context, strategy development requires a wide set of skills and institutional

capabilities. As such, all parties involved in policy implementation must be involved in health strategy development and strategic planning. Parties involved must understand, on the one hand, the health sector and, on the other hand, the needs of the population. Furthermore, the stakeholders involved have to be able to secure the resources required for policy implementation (Campos & Reich, 2019).

The WHO's 'Best Buys' for NCDs and other recommended policies communicate key priorities and provide broad guidance on how to achieve goals. However, for a policy to realize its intended impact, it must be operationalized into concrete, actionable steps and the resources (human and financial) required to implement them must be identified and mobilized.

Only a few weeks after nomination, the Portuguese Vice-Minister of Health started working with the Directorate General of Health on converting the WHO's recommended policy avenues into concrete and actionable policies addressing unhealthy eating habits. However, to be successfully implemented, these would need the buy-in of other government sectors with overlapping competencies. Thus, the Healthy Eating Strategy ended up morphing into an inter-ministerial and integrated strategy of the Portuguese government. Led by Vice-Minister Araújo, EIPAS took almost one year to be developed using a HiAP approach.

This publication was the first-ever in the food sector for over 20 years, and, as such, some concessions had to be made by health authorities. In

fact, many of the 50 measures recommended by EIPAS are not objective or specific enough. Furthermore, no deadlines were defined nor were specific entities identified as being responsible for each policy implementation. During the negotiations, the Ministry of Health, who assumed leadership, had to decide between risking consensus to push for more objective, accountable and actionable measures and ensuring consensus with less concrete, less operationable and less accountable measures. By taking the second path, EIPAS became more dependent on the political leadership and commitment of future Ministries of Health. Without strong supervision by the Ministry of Health, backed by firm political support, most of the proposed measures may not reach the light of day since there was no specific timeline or accountability. Moreover, EIPAS was developed with the participation and buy-in of those responsible for mobilizing human and financial resources. Therefore, it involved stakeholders from different government sectors as well as from local and functional levels with authority to carry out the plans. However, no funding was directly allocated to the implementation of EIPAS. Once again, the lack of resources posed an additional limitation to its full implementation.

Governance

Good governance is warranted whenever a group of stakeholders need to pull together towards a common goal. Having a set of rules in place to govern how these stakeholders interact is the foundation of such an enterprise. Given the autonomy of entities responsible for policy implementation, organizational culture is an important factor (Barrett,

2004). Furthermore, despite having different priorities and values, these entities are expected to collaborate and work in partnership for policy implementation (Wright, 2017). As such, reviewing, identifying and correcting shortcomings within the organizational structures may be one of the most important implementation steps. This review should aim at ensuring health policies are prioritized and legitimate (McPherson et al., 2016). In line with this, extensive literature advocates that cross-organizational networking, which is perceived as an important factor for policy implementation, is promoted by destroying organizational silos and should be encouraged during policy design (Forbes, Evans & Scott, 2010). Misalignments between entities, due to a lack of coordination, different risk profiles and different decision-making processes, among other factors, are often barriers to implementation (Cooksey & Krieg, 1996).

For decades the Governance of the Portuguese Health System solely promoted disease treatment. The governance structure of the Portuguese Health System is complex. At the central level, both the Directorate General of Health and the National Institute of Health have overlapping responsibilities regarding Public Health policy development, implementation and evaluation. On the other hand, Regional Health Administrations control all the implementation processes at the local level. In a country with only 10 million inhabitants like Portugal, it seems hard to understand such an intricate governance structure. Many argue the need for a radical simplification of the system; however, no one has been bold enough to push for such a revolution when in power.

Considering the implementation of EIPAS, the lack of clear responsibilities for each stakeholder was a challenge and factor hindering its deployment. That was why, since the beginning, the Portuguese Vice-Minister of Health, in implementing the vision established by the Minister of Health, pushed for the engagement of all stakeholders from the local and central level. However, in a system traditionally organized in silos, communication problems between institutions were common. Furthermore, the commitment of some of the most important institutional leaders was not total and, sometimes, non-existent. Some leaders of health authorities, namely those with particular influence due to their long tenure argue that "several Ministers of Health have passed by me, and I am the one that always stays. So, why would I bother to change too much? Anyway, this government will change soon." Despite this lack of commitment and collaboration, the Portuguese Minister and Vice-Minister of Health considered that the time required to replace them would consume precious time that could be otherwise used for EIPAS implementation. EIPAS implementation was clearly affected by the governance of the Portuguese Health System because no single institution had the resources or the authority to push for implementation alone. While in office, Vice-Minister Araújo was able to push for effective collaboration between out-dated health institutions and their old-fashioned leaders. However, this system was too dependent on the political leadership of an extremely motivated and effective team composed by the Minister of Health and his Vice-Minister.

The system designed to follow-up EIPAS implementation was, in layman terms, a monitoring and supervision system of the health sector. As described in Chapter 3, the same government sectors representatives that collaborated in the development of EIPAS were nominated as part of the monitoring task force. This had implications in terms of conflicts of interest and accountability that shall be discussed later.

Management

Policy implementation demands the identification of responsible individuals and the communication and close articulation between them. Clear guidance on expectations and responsibilities is also of particular importance in promoting policy implementation (Frattaroli & Teret, 2006; MacGregor et al., 2013; McPherson et al., 2016). Finding ways to balance the flexibility afforded to the implementing leaders and the compliance with policy recommendations is also of particular concern (Wright, 2017). This is of especially true when policy implementation requires the understanding, interpretations and/or dissemination of complex and nuanced concepts across different levels of management (Caldwell & Mays, 2012).

As previously discussed, the Governance Structure of the Portuguese Health System is not simple at all. Thus, the management practices of its senior leaders are impacted by it. At the time of EIPAS' publication, most senior leaders of the Portuguese public health institutions were in office for a long time. Furthermore, their management experience is often solely in the public sector. It is well known that the Portuguese public health

system pays relatively low salaries to senior managers. Therefore, the quality of management is inevitably impacted. The best managers tend to prefer the private sector. Building on this, the fact that EIPAS' implementation relied on the Directorate General of Health raised concern. With low human resources available and no plan for organizational restructuring that would allow for the acquisition of additional competencies, the management of EIPAS relied, once again, on the close supervision of the Portuguese Ministry of Health. Often, staff from the Ministry of Health, particularly of Vice-Minister Araújo's office, would be participating and even leading EIPAS follow up meetings. During the mandate of Minister Campos Fernandes and Vice-Minister Araújo, the implementation of EIPAS was ensured through very effective management. It is important to note that this was, to some extent, and as unexpectedly as it may sound, a result of serendipity, as the Ministry of Health's team had staff with extensive experience and track record in management, acquired in both the private sector and internationally.

Accountability

The quality and effectiveness of policy implementation have been shown to owe a lot to accountability (Budd, Schwarz & Haire-Joshu, 2012; Frattaroli & Teret, 2006). The distribution of responsibilities between policy makers and those responsible for its implementation is of particular importance. This is amplified when policy implementation requires the intervention of local partnerships (Wright, 2017). Enforcement mechanisms and overall accountability measures can clarify the responsibilities of each party, as long as these are accounted for in policy

development and formally agreed upon (McPherson et al., 2016). Nonetheless, a certain amount of flexibility must be ensured in order to allow for learning and adaptation to local needs (McPherson et al., 2016). Also, and according to the literature, accountability agreements are likely to be more effective if, within them, explicit links are drawn between government goals/mandates and actions planned for local implementation (Wright, 2017).

Another recommended measure is the establishment of incentives and/or sanctions to promote policy implementation and avoid a setting in which policies can be of voluntary deployment (Hooper, Giles-Corti & Knuiman, 2014; Maycraft Kall, 2014). An additional factor hindering policy implementation might be the development of policies conflicting with existing policies, regulations or previously agreed upon responsibilities (O'Toole et al., 2011). Moreover, when discussing accountability, in the sphere of policy design and implementation, an often-overlooked factor is the need to provide stakeholders who are held accountable with adequate support at both a technical and political level (Kelly, Garvey & Palcic, 2016).

Side by side with the Portuguese word "saudade", the English word "accountability" is among the only words that don't have a direct translation from one language to another. This fact speaks to a historic difference between southern European and northern European political systems. However, nowadays, and as the implementation framework discussed herein shows, it would hardly be possible to succeed in health

policy implementation without integrating the concept of accountability. However, when analysing the modus operandi of Public Health Institutions in Portugal, the historic absence of real accountability is obvious. This is particularly evident if one analyses the governance system of the Directorate General of Health. Being the institution responsible for the development and implementation of health policies tackling NCDs, it is particularly hard to justify that its leader, the Director General of Health, does not have to commit to any key performance indicators when nominated by the government. In other words, the Public Health Technical Leader of this country cannot be made accountable for any of his actions as a leader. This reality may explain the fact that, despite the growing trends of NCDs in the country throughout his mandate, the previous director general of health was maintained his position for over 15 years. In this context, it is pertinent to quote António Horta Osório, a Portuguese banker: "People shall not perpetuate themselves in the same leadership jobs because it is not beneficial for institutions nor for them" (Osório, 2020).

If one looks in more detail to the way the National Health Programs inside the Directorate General of Health, such as the National Program for the Promotion of Healthy Eating, have historically been made accountable among the civil society, an interesting reality reveals itself. Technical officers responsible for managing and developing the activities of each National Public Health Program are also the ones who write their own program performance report every year. With such conflicts of interest, it is hard to imagine how accountable public health players may actually be

made in Portugal. Furthermore, most of the actual Directors of the Directorate General of Health National Programs (i.e. the National Program for the Promotion of Healthy Eating, the National Program for Physical Activity, the National Program for Cardiovascular Diseases, the National Program for Mental Health) don't perform their leadership roles full time. More than that, their source of income is not even the Directorate General of Health, since they are paid by their 'home' institutions (Universities, Hospitals, etc). That said, building on the fact they are not actually paid by the Directorate General of Health, it would be hard to make them accountable for their "pro bono" leadership work.

The implementation of EIPAS was a trigger for a wider cultural change in the Portuguese Health System. Vice-Minister Araújo determined accountability among civil society as being mandatory since the first day EIPAS started being discussed. By committing to the set of 50 measures recommended by EIPAS, all parties involved would have to be made accountable for their actions twice a year. Given that EIPAS measures were made broad enough, it ended up being considered a success, even though the depth and disruption brought by the implemented policies were not enough to address the ongoing pandemic of NCDs. Furthermore, similarly to what happens at the Directorate General of Health in Portugal, the same government sector representatives that were involved in EIPAS development (as described in chapter 2) were nominated as part of EIPAS follow-up task force. In this context, one question arises: What would be their interest in saying that the strategy they planned on behalf of their

Ministries was not properly implemented by their own Ministries (from where they get their salaries)?

While Minister Campos Fernandes and Vice-Minister Araújo were in office, and thanks to their personal commitment to this endeavour, the EIPAS follow up task force fulfilled its obligation of producing public implementation status reports twice a year. As expected, most policies reported status was "implemented" or "ongoing". As an example, the aim of promoting a single FoPL system in Portugal as soon as possible only resulted in the development of studies and more studies that delayed any concrete position from the Portuguese Government. Which, in fact, was in line with the Ministry of Agriculture and Economy self sided interests. Therefore, from the 5 policies, which were studied in chapters 4, 5, 6, 7 and 8, only two have been implemented at the time of writing. After this team left the Ministry of Health, the aforementioned task force never published another public document. Nowadays, if not already cancelled, the status of EIPAS remains a mystery.

Sustainability

Knowledge of the sustainability of health promotion programs is scant and highly fragmented. Despite there being abundant knowledge on program planning, as well as on their implementation and evaluation, little is known about the sustainability (i.e. long-term continuity) of these programs. A sustainable health promotion program is comprised of a collection of activities, with well-defined duration, and resources aimed to

achieve the goals of the said program. This definition implies that health promotion programs must have been clearly defined and measurable objectives. The sustainability of health promotion programs is of particular relevance for it to be effectively beneficial for a population. First of all, sustainable health promotion programs sustain effect over long periods, implicitly allowing the assessment of the resultant long-term impacts. Second, health promotion programs do not generate immediate effects after their implementation. Often, there is a period of time between the start of its implementation and any effects on public health. As such, sustainable programs survive throughout this hiatus and realize the intended effect. Finally, health promotion programs perceived to be beneficial but failing to show sustainability, result in investment loss for the population itself but also for the promotors of those programs. This is of particular relevance in Portugal, considering that the national healthcare system is publicly funded. Furthermore, discontinuing health promotion programs which are perceived as being beneficial may pose additional barriers for the implementation of subsequent programs, as a result of the disillusion of the participants and targeted populations (WHO, 2011b).

When analysed under the 6 main criteria of the health policy implementation framework hereby used, EIPAS presents itself as an exceptional example of how challenging the task of converting the WHO's policy recommendations into actionable policies at the national level may be for Member States. By analysing EIPAS' implementation details, there remains no doubt about how essential political leadership and

commitment is for policy implementation. The vision of Minister Campos Fernandes and the role played by Vice-Minister Araújo are perfect illustrations of that. However, as happens so often in these contexts, EIPAS also tells a story made of limitations, mistakes and miscalculations. The strategy ended up being made of a set of 50 measures that were neither objective enough nor time-bounded. No leadership changes were introduced at the technical level, despite the discouraging performance of current senior managers. Furthermore, no budget for implementation or dedicated human resources were integrated into the EIPAS package. Finally, accountability was to be assured by a team of individuals with clear conflicts of interest regarding EIPAS' success. All of these details made EIPAS' implementation depend even more on political leadership. Political leaders are susceptible to political cycles and, unexpectedly, all the Ministry of Health team was replaced on 15th October 2019 (only one year after EIPAS was officially published as a public strategy). The fact that the incoming political team of the Portuguese Ministry of Health had other priorities rather than health promotion and disease prevention left EIPAS to be managed at the technical level by the same Directorate General of Health as before, which had proved to be relatively inconsequential.

Recommendations at the national level

Building on the policy and implementation insights gathered in the chapters of this thesis and summarized over the previous paragraphs, several opportunities for change and improvement in Portugal became

obvious. Therefore, policy recommendations were developed based on this research.

Policy Recommendations

HiAP

The HiAP approach should also be used by Portugal to address other NCDs' risk factors such as alcohol consumption, physical inactivity or tobacco usage, in order to gather broader commitment among other government sectors apart from health, as well as from relevant civil society and industry stakeholders. Multisectoral initiatives should seek the highest level of political endorsement, such as the Prime Minister or President themselves, in order to ensure a continuing and simultaneous level of commitment. Regardless of endorsements, however, sometimes consensus is not possible among conflicting sectors. In these cases, health interests should be afforded greater weight in the balance in order to prevail.

Fiscal Policies

Fiscal policies are more effective and quicker in generating health gains for the population than self-regulation policies, thus, given the ongoing pandemic of NCDs, the first shall be prioritized over the second. All the income generated for the states through health-related taxation policies shall preferentially be applied to grow the budget dedicated by the government to health promotion and disease prevention programs, that is actually under 1% of the total (which is below the 3% average investment made by the European Countries). It may also be used to support funding

other healthcare areas directly impacted by the negative externalities of the taxed food products consumption.

In this context, the taxes applied to food products with excessive amounts of added salt, sugar and fat, and therefore their final prices, should be increased in order to support the real costs of their short, medium and long term negative health externalities that impact the Portuguese health system's economic sustainability. However, fiscal policies shall not be implemented in isolation: in order to maximize health impact, they should always be integrated into broader NCD health policies packages. Fiscal policies tend to lose their impact on consumption and reformulation behaviours as time passes. Thus, they must be continuously monitored and updated, improving taxation values and punishing the lowest nutritional value products.

Fiscal policies have proven to be effective in promoting SSBs reformulation. However, Portugal must carefully follow the addition of other chemical substances, such as artificial sweeteners, that aim to replace sugar. There is a lack of evidence on the long-term impact of such substances on health, thus Portugal should assume measures of precaution regarding this topic.

Even though the Industry lobby against fiscal policies may be high, governments should not step back regarding these public health policies and must be able to defend such policies with data and persuasive reasoning-based evidence.

Self-Regulation Policies

The last decades' experience shows that self-regulation policies in the Portuguese food sector have had low or unknown impact. Self-regulation policies are less effective and slower than fiscal policies or mandatory policies in generating health impacts through consumption behaviours. The self regulation agreement signed by the Portuguese Ministry of Health has already failed its first public accountability checkpoint (March 2020). Public accountability of such relevant initiatives must not be overlooked. If the private players of the food sector don't achieve the agreed reformulation targets on time, such agreement should be immediately replaced by fiscal or mandatory policies in order to achieve, at least, the same results in a shorter period of time. Given the low predicted impact of the agreement signed with the food sector, the Portuguese Government should consider the urgent implementation of other EIPAS mandatory policies, including those that cover food served in cafeterias, canteens, restaurants and hotels as one of the leading sources of sugar, salt and trans fats in Portugal.

Mandatory Policies

Updating the actual regulation on the maximum amount of salt added to bread in Portugal is urgent. All the preparatory work (described in Chapter 6) was developed almost 3 years ago, under Vice-Minister Fernando Araújo's mandate. There is no reason for the new legislation freeze since then. The Portuguese Government should consider following the precedent

created by Scotland, who after years of legal disputes, was allowed by the EC to apply its Minimum Unit Pricing Ban to all the Alcoholic Beverages entering the country. In order to be able to do that, the Ministry of Health should invest in acquiring competencies that better allow its proposed legislation to be implemented by using the EC law exceptions instead of attempting to do so directly. Furthermore, when mandatory policies face international legal obstacles so complex that they may delay their health impact for years, the Portuguese Government should automatically consider the usage of fiscal tolls to persuade producers to reformulate their food products faster.

Nudges

The evidence available is enough to support an informed endorsement of a single national FoPL in Portugal: NutriScore. Even though not being a perfect FoPL system, it is the best performing one. Therefore, it should be officially endorsed by the Portuguese government. The instability caused by the Portuguese Ministry of Health's lack of decision and specific action regarding FoPLs is actually pushing back most of the food sector players from taking any action on this matter. Food labelling legislation should no longer be an exclusive competence of the Ministry of Agriculture. The Ministry of Health should be responsible for regulating, at least, the FoPL systems use across the country since their first aim is to promote healthier dietary patterns. In order to guarantee an alignment among all the food sectors, the usage of a single Government Endorsed FoPL system should not be voluntary. It should be compulsory. The usage of FoPL systems like NutriScore has been shown to promote reformulation

initiatives among the food sector players. Therefore, it should be seen not only as a way of better informing the citizens but also as a way of nudging the food industry to improve their products nutritional profiles faster. In parallel with the endorsement of a single FoPL system, the Portuguese Government should invest in mass media education campaigns to empower citizens to make the proper use of this new nutritional information source.

Education and Health Literacy

The Portuguese Government should consider using the lessons learned from initiatives like EM, in order to build new, compulsory and comprehensive national programs that include school curricula. A detailed review and regulation of all initiatives being done in schools to promote health literacy are needed, in particular those promoted by the private sector, in order to ensure compliance with best practices and the available evidence to date. Only health literacy initiatives showing scientific evidence of an effective impact on pupil's behaviours should be allowed to enter school environments. Nutritional education delivered in school settings is more effective when delivered by health professionals such as nutritionists. These are the most qualified and appropriate agents to deliver such activities in school settings. Availability of, at least, one nutritionist working in every school setting is essential in order to support the development and delivery of innovative health literacy programs.

Implementation Recommendations

Leadership

Present and future governments must stay committed to long-term national policies with a clear vision, to avoid the prioritizing of disease treatment over prevention.

Political will is key. The political players chosen to lead the health sector must clearly assume disease prevention and health promotion as their number one priority.

Political buy in is essential. Since political cycles tend to be short and unpredictable, political leaders chosen to lead the health sector must have a clear plan of action to address NCDs that is ready to implement, even before being nominated. There is no time to waste and creating a sense of urgency regarding the NCD pandemic among the health workforce and general population must be a clear mission of any political player in the health sector immediately after nomination.

Top-level health politicians must have a proven track record on implementation of substantive restructuring projects: this is central for the successful completion of these policies. Having proven high-level management education/skills (ideally not exclusively developed in the public sector) may be an asset for political leaders aiming to modernize the traditional public health system. Ministers of Health should prioritize the nomination of strategic planning, management and implementation experts for their inner circles as well as for the leadership of public institutions. Ideally, such advisers and leaders must not have conflicts of

interest that may limit their disruptive transformation aim regarding the public health sector. Being temporary, Ministerial teams of advisers should dedicate their time to supporting and fast-tracking the implementation and change management led by newly committed technical leaders at the public institutions.

Strategy

Strategies must always be objective in the measures they present, leaving almost no space for different interpretations. Furthermore, all the measures suggested in any implementation strategy must be timeline bound, leaving no opportunity for stakeholders to change their minds during the implementation process. Strategies must be as inclusive as possible in what concerns accepting external stakeholders' feedback and suggestions. Consensus does not necessarily mean conceding. Thus, shorter, more disruptive and impactful policies should sometimes be preferred over bigger, broader subjective and more consensual ones.

Financing shall be in line with the priorities set in the strategy. A budget for implementation is a mandatory element in any strategy pack: it will raise commitment, accountability and stakeholder's willingness to commit. Leaders should avoid making the implementation of their strategy dependent on the stakeholders' ability to absorb it into their own budgets (that are typically already short).

Governance

The Portuguese Health System's organizational structure is in need of dramatic simplification. Competence overlaps, such as the ones of the Directorate General of Health and the National Institute of Health, increase inefficiency and waste precious resources. The system would benefit tremendously from having fewer but more capable institutions. Furthermore, defining key performance indicators that may guide public health leaders' actions as a way of driving the adoption of certain behaviours will prove beneficial. The creation of incentives for public health leaders to achieve key performance indicators will further engage the leadership and align them with the strategy. It is important to create specific mechanisms that allow for public health leaders replacement when they show they are not able to tackle public health threats such as the NCDs' incidence trends. The eligibility criteria for public health institutions leadership positions should not be limited to public health physicians. Health management merit and capability is limited neither to the medical profession nor to the public health speciality.

Management

Health policy implementation requires specialized and fully dedicated human resources. Recruitment must take into consideration the particular skills of the individual as well keep in mind the beneficial effects of a diverse workforce. Intermediate management should be empowered and supported by careful upskilling plans and clear career paths.

Accountability

Accountability processes must be part of any strategy itself. For that reason, performance indicators, deliverables and deadlines should be made public. Ensuring total independence between strategy developers, implementers, and teams responsible is another excellent tool to promote accountability. A plan for data collection regarding all the policies implemented should be put in place for use in scientifically-based impact evaluation development, that can later be shared with the scientific community and international organizations.

Sustainability

The mandate of the strategy implementation team, as well as the resources available for its work, should not depend on specific political leaders' sponsorship or mandates. This will ensure that the strategy can be implemented irrespective of the leadership cycles. Political leadership and support should be seen as a change igniter and not as an essential part of the implementation. The less a strategy relies on political support the more sustainable it will be in the medium and long term.

Recommendations at the Global level

This thesis acknowledges the importance of taking actionable lessons from academic enterprises and, as such, will synthesize practical recommendations based on this research. Such recommendations are not case-specific, but rather take benefit from the experience in Portugal and

how it could apply globally. It encompasses both a policy dimension, and an implementation dimension, both indispensable, and are as follows:

Policy Recommendations

HiAP

Intersectoral strategies such as EIPAS are good examples of how to operationalize the HiAP concept. HiAP-based strategies are useful tactics for Ministries of Health to overcome traditional obstacles posed by other government sectors in what concerns the implementation of health policies in areas that are not traditionally ruled by the health sector. In order to be more effectively applied, any HiAP strategy development must have the highest political authority's sponsorship and buy in. This is the only way other government sectors will accommodate the health sector's policy demands. The WHO should lead the development of a guide for Member States detailing the steps to be taken in order to use the HiAP concept as a way to fast track innovative health policies. Ultimately, HiAP strategies themselves should be considered as an eventual WHO "best buy" measure to address NCDs.

Fiscal Policies

The WHO should consider broadening the concept of food taxation as a recommended policy in order for it to include not only SSBs but also any other processed foods with excessive amounts of added sugar, salt or trans-fats. This would incentivize countries to increase the use of these effective tools in other important food groups. Building on the growing evidence that supports the effectiveness of SSBs taxation policies over the

world, it is time for the WHO to update Appendix 3 of the WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020, attributing these policies the condition of 'Best Buys', and not only recommended policies. Food taxation should not only be seen as a way of reducing consumption among citizens but rather it should also be seen as a way of nudging the industry to speed up their food reformulation processes. Fiscal policies alone have very limited impact on health. In order to reach their full impact potential, they should be included as a part of broader NCDs prevention strategies.

Further evidence on the long-term impact of artificial sweeteners ingestion is urgent as well as guidance for what precautionary measures to adopt for countries already implementing SSBs taxes.

Self Regulation Policies

Self-regulation policies must always be a second option for governments aiming to effectively impact consumption patterns among citizens and push for fast reformulation processes among the food sector industry. The priority should be to implement taxes or other mandatory policies. When no other options other than self regulation policies are possible, governments should promote co-regulation solutions, where public health institutions are the ones making the food industry accountable for the ambition of their voluntary actions. Self-regulation policies must have as many checkpoints as possible, so that governments may switch their approaches to more ambitious targets or mandatory policies in case self-regulation agreements do not show effective results. Self-regulation

policies alone have very limited impact on health. In order to reach their full impact potential, they should be included as a part of broader NCD prevention strategies.

Mandatory Policies

Mandatory policies are more effective at improving consumption patterns as well as food reformulation initiatives. Thus, governments must prioritize such kinds of legislation over self-regulation approaches regarding the improvement of eating habits. When designed, mandatory policies must be as "implementation oriented" as possible, therefore avoiding space for different interpretations. Any product exclusions from a mandatory policy must be carefully analyzed and considered since they may impact the overall policy, such as it happened in Portugal regarding the actual legislation that regulates the maximum amount of salt added to bread. Traditional manufacturing doesn't mean nutritional value. Thus, cultural heritage shall not be prioritized over the health interests of the citizens.

Furthermore, mandatory legislation must always be accompanied by regular inspective initiatives led by regulatory bodies among the producers and retailers. Mandatory policies must always be evidence-based. Finally, mandatory policies alone may have limited impact on health. In order to reach their full impact potential, they should be included as a part of broader NCD prevention strategies.

Nudges

The food sector retailers and producers have effectively used nudges in recent decades. However, they have been used as tools to pursue commercial and economic objectives. It is time for governments to master such knowledge in order to use it for public and social purposes and to properly regulate it. Nudges such as FoPL systems are effective and, therefore, should be transversally implemented in order to impact people's eating habits. Moreover, health literacy promotion should be a priority for governments in order to empower citizens not to be so vulnerable to industry-led nudges.

The sectors that tend to oppose the implementation of FoPL systems are normally prioritizing their economic interests and not the citizens' ones. These sectors are not limited to the private sector. As the Portuguese example clearly displays, they may include the Ministry of Agriculture and Economy. Ministries of Health must not let this kind of interests surpass the community's health interests.

Nudges alone may have limited impact on health. In order to reach their full impact potential, they should be included as a part of broader NCD prevention strategies.

Education

The best environments and opportunities for governments to intervene in order to promote health literacy may vary from country to country. There are no "one fits all" approaches in this context. However, health literacy

may have a synergic impact on other kinds of health promotion legislation initiatives, such as the ones referred to and discussed above. Therefore, education must always be integrated as an essential part of any of these. Formal platforms of discussion and collaboration between Ministries of Health and Ministries of Education are essential in order to give health literacy promotion the priority it deserves in school curricula. Moreover, health education initiatives have a multiplying effect that works in different pathways. Adults may impact the young by teaching them but the young may also impact their families' behaviours by implementing at home what they are told at school. Governments must tackle all of these learning dissemination opportunities properly.

Implementation Recommendations

Leadership

International institutions such as the WHO must be more effective in obtaining from each country's political leaders the commitment and ability to deliver NCD policies implementation. Leadership capability regarding NCD policies implementation among different Member States should be objectively assessed and communicated by the WHO. The WHO should consider creating a ranking of the more effective and more committed political leaders regarding NCD policies worldwide, on a regular basis.

Strategy

Several of the WHO's documents tend to be very broad because they aim to be applicable to different settings and realities. This makes them harder

to turn into actionable national strategies. National strategies should make the bridge between global recommendations and effective implementation. However, they require expertise and experience. Thus, the WHO should develop more tailor-made guidelines to be used by different countries when developing their implementation strategies, to bridge the expertise and experience gap that often exists at a national level.

Governance

High levels of organizational complexity may pose additional obstacles to HiaP strategies' implementation. Governments should consider radically simplifying their health systems, in order to better respond to the actual challenges of public health. Health systems' structures should be patient-centred and patient-oriented and not organized in order to maintain the power of the traditional system players.

Management

The development of management skills in health professionals must be a priority for governments. Having management education and competencies should be considered as essential criteria when choosing individuals to lead change through implementation. Hiring professionals with different backgrounds and experiences, not limited to the public and health sector, may be an asset for governments in order to be more effective regarding implementation.

Accountability

International institutions, such as the WHO, must make countries and political leaders accountable for their level of commitment regarding NCD policy implementation. Analysis such as the one made in Chapter 2 should be made regularly by the WHO itself. In order to make Member States accountable, further performance indicators and batter data collection systems (that don't simply rely on self reported data) must be developed and made public by the WHO. NCDs constitute a pandemic with higher mortality and health impact than any infectious diseases nowadays. Thus, they must be treated accordingly. Therefore, sanctions and other international pressure tools may be used to persuade member states to implement recommended policies the same way they are used to promote and defend other sorts of human rights among low implementers.

Sustainability

NCDs and their consequent comorbidities and premature mortality rates constitute the biggest challenge for health systems' sustainability. Therefore, if countries are really committed to tackling them, as shown in the 2011 United Nations General Assembly Declaration that led to the creation of the WHO's Global Action Plan for the Prevention and Control of NCDs 2013–2020, they must put 'their money where their mouth is'. In other words, further and consistent investment in health promotion and disease prevention is urgent in order to ensure that this a long-lasting effort. Even though they may have different speeds of generating impacts, NCD policies normally do not have impressive short-term results. If countries are committed to collect considerable impacts on health from

such policies, they must provide medium/long stability for full implementation. Therefore, both financing and resources allocation to such strategies must be pluriannual and not dependent on political cycles.

References

Ahn, S., Park, S., Kim, J.N., Han, S.N., Jeong, S.B. & Kim, H.K. (2013) Salt content of school meals and comparison of perception related to sodium intake in elementary, middle, and high schools. *Nutrition research and practice.* 7(1), 59-65. Available from: doi:10.4162/nrp.2013.7.1.59.

Alevizos D. & Morineau, A. (1992) Tests et valeurs-tests: application à l'étude de mastics utilisés dans la fabrication des vitraux. *Revue de Statistique Appliquée*. 40, 27-43. Available from: http://www.numdam.org/item/RSA_1992__40_4_27_0/ [Accessed 30 june 2019].

Allais, S. (2012) Economics imperialism, education policy and educational theory. *Journal of Education Policy*. 27(2), 253-74. Available from: doi:10.1080/02680939.2011.602428.

Allen, L., Nicholson, B., Yeung, B. & Goiana-da-Silva, F. (2020) Implementation of non-communicable disease policies: a geopolitical analysis of 151 countries. *The Lancet Global Health*. 8, e50-e58. Available from: doi:10.1016/S2214-109X(19)30446-2.

Allen, L., Williams, J., Townsend, N., Mikkelsen, B., Roberts, N., Foster, C. & Wickramasinghe, K. (2017) Socioeconomic status and non-communicable disease behavioural risk factors in low-income and lower-middle-income countries: a systematic review. *The Lancet Global Health*. 5(3), e277-89. Available from: doi:10.1016/S2214-109X(17)30058-X.

Alvarado, M., Unwin, N., Sharp, S.J., Hambleton, I., Murphy, M.M., Samuels, T.A., Suhcke, M. & Adams, J. (2019) Assessing the impact of the

Barbados sugar-sweetened beverage tax on beverage sales: an observational study. *Int J Behav Nutr Phys Act*. 16(1),13. Available from: doi:10.1186/s12966-019-0776-7.

Associação dos Industriais de Panificação, Pastelaria e similares do Norte (AIPAN). (2019) *Homepage*. Available from: http://www.aipan.pt/index.html [Accessed 15th june 2020].

Association of Official Analytical Chemists (AOAC) (2000) *International Official Methods of Analysis of AOAC International*. Rockville, MD, AOAC International.

Autoridade de Segurança Alimentar e Económica (ASAE) (2019) *O pão*. Available from: https://www.asae.gov.pt/seguranca-alimentar/informacoes-sobre-actividades-economicas-na-area-alimentar/pao.aspx [Accessed 15th june 2020].

Barber, M., Moffit, A. & Kihn, P. (2011) *Deliverology 101: a field guide for educational leaders*. Thousand Oaks (CA), Corwin Press.

Barbosa, M., Fernandes, A., Gonçalves, C., Pena, M., Padrão, P., Pinho, O. & Moreira, P. (2018) Sodium and Potassium Content of Meals Served in University Canteens. *Portuguese Journal of Public Health*. 35(3), 27-33. Available from: doi.org/10.1159/000488074.

Barreto, M., Gaio, V., Kislaya, I., Antunes, L., Rodrigues, A.P., Silva, A.C. et al. (2016) *1º Inquérito Nacional de Saúde com Exame Físico (INSEF 2015): estado de saúde*. Lisboa, National Institute of Health.

Barrett, S. (2004) Implementation studies: Time for a revival? Personal reflections on 20 years of implementation studies. *Public Administration*. 82(2), 249-262. Available from: doi: 10.1111/j.0033-3298.2004.00393.x.

Barrientos-Gutierrez, T., Zepeda-Tello, R., Rodrigues, E.R., Colchero-Aragonés, A., Rojas-Martinez, R., Lazcano-Ponce, E., Hernández-Ávila, M., Rivera-Dommarco, J. & Meza, R. (2017) Expected population weight and diabetes impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. *PLoS ONE*. 12(5), e0176336. Available from: doi:10.1371/journal.pone.0176336 PMID: 28520716.

Beaglehole, R., Bonita, R., Horton, R., et al. (2011) Priority actions for the non-communicable disease crisis. *The Lancet Global Health*, 6736(11), 1-10. Available from: doi:10.1016/S0140-6736(11)60393-0.

Bennett, J.E., Stevens, G.A., Mathers, C.D., Bonita, R., Rehm, J., Kruk, M.E., Riley, L.M., Dain, K., Kengne, A.P., Chalkidou, K. & Beagley, J. (2018) NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4. *The Lancet*. 22, 1072-88. Available from: doi:10.1016/S0140-6736(18)31992-5.

Bleich, S.N., Vercammen, K.A., Zatz, L.Y., Frelier, J.M., Ebbeling, C.B. & Peeters, A. (2018) Interventions to prevent global childhood overweight and obesity: a systematic review. *The Lancet Diabetes & Endocrinology*. 6(4), 332–346. Available from:10.1016/S2213-8587(17)30358-3.

Boyland, E., Garde, A., Jewell, J., & Tatlow-Golden, M. (2018) *Evaluating implementation of the WHO set of recommendations on the marketing of foods and non-alcoholic beverages to children: progress, challenges and guidance for next steps in the WHO European Region*. Copenhagen: WHO Regional Office for Europe. Available from:

http://www.euro.who.int/__data/assets/pdf_file/0003/384015/food-marketing-kids-eng.pdf [Accessed 18th June 2020].

Branca, F., Nikogosian, H. & Lobstein, T. (2007) *The challenge of obesity in the WHO European Region and the Strategies for Response*. Copenhagen: World Health Organization. Available from: http://www.euro.who.int/en/publications/abstracts/challenge-of-obesity-in-the-who-european-region-and-the-strategies-for-response-the [Accessed 18th June 2020].

Breda, J., Darzi, A., Araújo, F. & Lopes, C. (2020a) Projected impact of the Portuguese sugar-sweetened beverage tax on obesity incidence across different age groups: a modelling study. *PLOS Medicine*. 17(3), e1003036. Available from: doi:10.1371/journal.pmed.1003036.

Briggs, A.D., Mytton, O.T., Kehlbacher, A., Tiffin, R., Rayner, M. & Scarborough, P. (2013a) Overall and income specific effect on prevalence of overweight and obesity of 20% sugar sweetened drink tax in UK: econometric and comparative risk assessment modelling study. *BMJ*. 347, f6189. Available from: doi:10.1136/bmjf6189.

Briggs, A.D., Mytton, O.T., Madden, D., O'Shea, D., Rayner, M. & Scarborough, P. (2013b) The potential impact on obesity of a 10% tax on sugar-sweetened beverages in Ireland, an effect assessment modelling study. *BMC Public Health*. 13, 860. Available from: doi:10.1186/1471-2458-13-860.

Brown, C., Halvorson, E., Cohen, G., Lazorick, S. & Skelton, J. (2015) Addressing Childhood Obesity: opportunities for prevention. *PediatrClin*

North Am. 62(5), 1241–1261. Available from: doi:10.1016/j.pcl.2015.05.013.

Budd, E., Schwarz, C. & Haire-Joshu, D. (2012) Factors influencing the implementation of school wellness policies in the United States, 2009. *Preventing Chronic Disease,* 9. Available from: doi: 10.588/pcd9.110296

Cabrera-Escobar, M.A., Veerman, J.L., Tollman, S.M., Bertram, M.Y. & Hofman, K.J. (2013) Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis. *BMC Public Health*. 13(1), 1072. Available from: doi:10.1186/1471-2458-13-1072 PMID: 24225016

Caldwell, S. & Mays, N. (2012) Studying policy implementation using a macro, meso and micro frame analysis: the case of the Collaboration for Leadership in Applied Health Research & Care (CLAHRC) programme nationally and in North West London. *Health Research Policy and Systems*. 10(32), 1-9. Available from: doi:10.1186/1478-4505-10-32.

Camões, M., Lopes, C., Oliveira, A., Santos, A.C. & Barros, H. (2010) Overall and central obesity incidence in an urban Portuguese population. *Prev Med*. 50(1–2), 50-55. Available from: doi:10.1016/j.ypmed.2009.11.

Campbell, N., Browne, S., Claudy, M., Mialon, M., Serge, H., Goiana-da-Silva, F. & Finucane, F. (2021) The Gift of Data: Industry-Led Food Reformulation and the Obesity Crisis in Europe. *Journal of Public Policy & Marketing*. Available from: doi: 10.1177/0743915620983842.

Campos, P.A. & Reich, M.R. (2019) Political Analysis for Health Policy Implementation. *Health Systems & Reform*. 5(3), 224-235. Available from: doi: 10.1080/23288604.2019.1625251.

Capacci, S., Allais, O., Bonnet, C. & Mazzocchi, M. (2019) The impact of the French soda tax on prices, purchases: an ex post evaluation. *PLoS ONE*. 14(10), e0223196. Available from: doi:10.1371/journal.pone.0223196.

Cappuccio, F.P. & Capewell, S. (2015) Facts, issues and controversies in salt reduction for the prevention of cardiovascular disease. *Functional Food Reviews.* 7(1), 41–61. Available from: doi:10.2310/6180.2015.00005.

Caro, J.C., Corvalan, C., Reyes, M., Silva, A., Popkin, B. & Taillie, LS. (2018) Chile's 2014 sugar-sweetened beverage tax and changes in prices and purchases of sugar-sweetened beverages: an observational study in an urban environment. *PLoS Med*. 15(7), e1002597. Available from: doi:10.1371/journal.pmed.1002597.

Casa, S., Cruz, R., Costa, N., Graça, P. & Breda, J. (2016) *Trans-fatty acids in Portuguese food products*. Available from: https://www.euro.who.int/en/countries/portugal/publications/trans-fatty-acids-in-portuguese-food-products-2016 [Accessed 18th June 2020].

Cecchini, M., Sassi, F., Lauer, J.A., Lee, Y.Y., Guajardo-Barron, V. & Chisholm D. (2010) Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. *The Lancet*. 376(9754), 1775-84. Available from: doi:10.1016/S0140- 6736(10)61514-0.

Cecchini, M. & Warin L. (2016) Impact of food labelling systems on food choices and eating behaviours: a sytematic review and meta-analysis of randomized studies. *Obesity reviews*. 17, 201-210. Available from: doi:10.1111/obr.12364.

Centers for Disease Control and Prevention (1997) Guidelines for school health programs to promote lifelong healthy eating. *J Sch Health.* 67(1), 9–26. Available from: doi:10.1111/j.1746-1561.1997.tb06289.x.

Centre de recherche pour l'étude et l'observation des conditions de vie. (2017) *Les enquetes complementaires (étude quantitative). Evaluation ex ante de systemes d'etiquetage nutritionnel graphique simplfie. Rapport final.* Paris, Centre de recherche pour l'étude et l'observation des conditions de vie.

Chan, M. (2017) Ten years in public health, 2007–2017. Available from: http://www.who.int/%0Apublications/10-year-review/en/ [Accessed: May 12th 2012].

Chauliac, M. & Hercberg, S. (2012) Changing the food environment: the French experience. *Adv Nutr*. 3(4), 605S–10S. Available from: doi:10.3945/an.112.001941.

CHRODIS (2020). *Implement good practices for chronic disease*. Available from: http://chrodis.eu/about-us/ [Accessed 15th october 2020].

Cobiac, L.J., Vos, T. & Veerman, J.L. (2010) Cost-effectiveness of interventions to reduce dietary salt intake. *Heart*. 96(23), 1920–5. Available from: doi:10.1136/hrt.2010.199240 PMID: 21041840.

Commission of the European Communities (2005) *Green paper: Promoting Healthy Diets and Physical Activity: A European Dimension for The Prevention of Overweight, Obesity and Chronic Diseases*. Brussels, Commission of the European Communities; Available from: https://eur-lex.europa.eu/legal-

content/EN/TXT/PDF/?uri=CELEX:52005DC0637&from=EN [Accessed 30 june 2019].

Cooksey, J. & Krieg, R. (1996) Metropolitan Health Policy Development: Barriers to Implementation. *Journal of Public Health Policy*. 17(3), 261-274. Available from: https://pubmed.ncbi.nlm.nih.gov/8918019/ [Accessed 30 june 2019].

Correia-Costa, L., Cosme, D., Nogueira-Silva, L., Morato, M., Sousa, T., Moura, C., et al. (2016) Gender and obesity modify the impact of salt intake on blood pressure in children. *Pediatric nephrology*. 31(2), 279-88. Available from: doi:10.1007/s00467-015-3210-7.

Crosetto, P., Muller, L. & Ruffieux, B. (2016) Réponses des consommateurs à trois systèmes d'étiquetage nutritionnel face avant. *Cah Nutr Diététique*. 51, 124–31. Available from: doi:10.1016/j.cnd.2016.04.002.

Crosetto, P., Lacroix, A., Muller, L. & Ruffieux, B. (2020). Nutritional and economic impact of five alternative front-of-pack nutritional labels: experimental evidence. *European Review of Agricultural Economics*. 47, 2, 785–818.

Dalal, S., Beunza, J.J., Volmink, J., Adebamowo, C., Bajunirwe, F., Njelekela, M., Mozaffarian, D., Fawzi, W., Willett, W., Adami, H.O. & Holmes, M.D. (2011) Non-communicable diseases in sub-Saharan Africa: what we know now. *International journal of epidemiology*. 40(4), 885-901. Available from: doi:10.1093/ije/dyr050.

Dekkers, A.L., Verkaik-Kloosterman, J., Van Rossum, C.T. & Ocké, M.C. (2014) SPADE, a new statistical program to estimate habitual dietary

intake from multiple food sources and dietary supplements. *J Nutr*. 144(12), 2083–91. Available from: doi:10.3945/jn.114.191288.

Deschamps, V., Julia, C., Salanave, B., Verdot, C., Hercberg, S. & Castetbon, K. (2015) Score de qualité nutritionnelle des aliments de la Food Standards Agency appliqué aux consommations alimentaires individuelles des adultes en France. *Bull Epidémiologique Hebd*. 24/25, 466–75. Available from: https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/documents/article/score-de-qualite-nutritionnelle-des-aliments-de-la-food-standards-agency-applique-aux-consommations-alimentaires-individuelles-des-adultes-en-france [Accessed 30 june 2019].

Direção-Geral da Educação (DGEstE) (2018) *Orientações sobre ementas e refeitórios escolares* [Circular n.º 3097/DFE/2018]. Available from: http://www.dge.mec.pt/sites/default/files/Esaude/oere.pdf [Accessed 30 june 2019].

Direção-Geral da Saúde (DGS) (2012) *Programa nacional da promoção da alimentação saudável - orientações programáticas.* Lisboa, Direção-Geral da Saúde.

Direção-Geral da Saúde (DGS) (2015a) *Plano Nacional de Saúde em números*. Lisboa, Direção-Geral da Saúde.

Direção-Geral da Saúde (DGS) (2015b) *Proposta de Estratégia para a redução do consumo de sal na população portuguesa através da modificação da disponibilidade da oferta.* Available from: https://www.dgs.pt/em-destaque/estrategias-para-a-reducao-de-sal-

nosprodutosalimentares-a-venda-em-portugal-pdf.aspx [Accessed 30 june 2019].

Direção-Geral da Saúde (DGS) (2015c) *Programa Nacional para a Promoção da Alimentação Saudável. Portugal Alimentação Saudável em Números – 2015-2016*. Available from: http://nutrimento.pt/activeapp/wp-content/uploads/2016/03/Relatório-Portugal-Alimentação-Saudável-em-números-2015.pdf [Accessed 30 june 2019].

Direção-Geral da Saúde (DGS) (2016) *A saúde dos Portugueses*. Lisboa, Direção-Geral da Saúde.

Direção-Geral da Saúde (DGS) (2017a) *Programa Nacional para as Doenças Cardiovasculares*. Available from: https://www.dgs.pt/em-destaque/relatorio-do-programanacional-para-as-doencas-cerebro-cardiovasculares-2017. aspx [Accessed 30 june 2019].

Direção-Geral da Saúde (DGS) (2017b) *A Saúde dos Portugueses 2016*. Lisboa, Direção-Geral da Saúde.

Direção-Geral da Saúde (2017c) *Programa Nacional para a Promoção da Alimentação Saudável 2017*. Lisboa, Direção-Geral da Saúde.

Direção-Geral da Saúde (DGS) (2018a) *Relatório do Programa Nacional para as Doenças Cérebro-Cardiovasculares*. Lisboa, Direção-Geral da Saúde (DGS).

Direção-Geral de Saúde (DGS) (2018b) *The Nation's Health 1990–2016.* Porto; 2018. Available from: https://comum.rcaap.pt/handle/10400.26/22502 [Accessed 30 june 2019].

Djojosoeparto, S.K., Kamphuis, C.B.M., Vandevijvere, S., Harrington, J.M. & Poelman, M.P. (2020) *JPI-HDHL Policy Evaluation Network. The Healthy Food Environment Policy Index (Food-EPI): European Union. An overview of EU-level policies influencing food environments in EU Member States*. Utrecht, Utrecht University.

Dobbs, R., Sawers, C., Thompson, F., Manyika, J., Woetzel, J.R., Child, P. et al. (2014) *Overcoming obesity: an initial economic analysis*. McKinsey Global Institute. Available from: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Economic%20Studies%20TEMP/Our%20Insights/How%20the%20world%20could%20better%20fight%20obesity/MGI_Overcoming_obesity_Full_report.ashx [Accessed 30 june 2019].

Draper, A.K., Adamson, A.J., Clegg, S., Malam, S., Rigg, M. & Duncan, S. (2013) Front-of-pack nutrition labelling: Are multiple formats a problem for consumers? *Eur. J. Public Health*. 23, 517–521. Available from: doi:10.1093/eurpub/ckr144.

Drescher, K. & Becher, H. (1997) Estimating the generalized impact fraction from case-control data. Biometrics. 53(3), 1170–6. Available from: https://pubmed.ncbi.nlm.nih.gov/9290235/ [Accessed 30 june 2019].

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., et al. (2015a) Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. *Nutrients*. 7,7106–25. Available from: doi:10.3390/nu7085325.

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S. & Péneau, S. (2015b) Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. *PLoS ONE*. 28(10), e0140898. Available from: doi: 10.1371/journal.pone.0140898.

Ducrot, P., Julia, C., Mejean, C., Kesse-Guyot, E., Touvier, M., Fezeu. L., et al (2016) Impact of Different Front-of-Pack Nutrition Labels on Consumer Purchasing Intentions: A Randomized Controlled Trial. *Am J Prev Med*. 50, 627 36).

Dunsire, A. (1978) *The execution process: implementation in a bureaucracy*. Oxford, Martin Robertson.

Egnell, M., Talati, Z., Gombaud, M., Galan, P., Hercberg, S., Pettigrew, S. & Julia, C. (2019) Consumers' Responses to Front-of-Pack Nutrition Labelling: Results from a Sample from The Netherlands. *Nutrients*. 11(8), 1817. Available from: doi: 10.3390/nu11081817.

Egnell, M., Talati, Z., Hercberg, S., Pettigrew, S. & Julia, C. (2018a) Objective Understanding of Front-of-Package Nutrition Labels: An International Comparative Experimental Study across 12 Countries. *Nutrients*. 10, 1542. Available from: doi: 10.3390/nu10101542.

Egnell, P., Ducrot, M., Touvier, B., Allès, S., Hercberg, E., Kesse-Guyot, C., & Julia, C. (2018b) Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE*. 23(13), e0202095. Available from: doi: 10.1371/journal.pone.0202095.

Emrich, T.E., Qi, Y., Lou, W.Y. & Abbe, M.R. (2017) Traffic-light labels could reduce population intakes of calories, total fat, saturated fat, and sodium. *PLOS One*. 12(2), e0171188. Available from: doi: 10.1371/journal.pone.0171188.

Encarnação, R., Lloyd-Williams, F., Bromley, H. & Capewell S. (2016) Obesity prevention strategies: could food or soda taxes improve health? *J R Coll Physicians Edinb*. 46(1), 32-38. Available from: doi: 10.4997/ JRCPE.2016.109.

European Commission (2009) *High Level Group on Nutrition and Physical Activity. EU framework for national salt initiatives*. Brussels, European Commission. Available from: http://ec.europa.eu/health/archive/ph_determinants/life_style/ nutrition/documents/national_salt_en.pdf [Accessed 30 june 2019].

European Commission (2011a) *High Level Group on Nutrition and Physical Activity. EU Framework for National Initiatives on selected nutrients*. Brussels, European Commission; 2011. Available from: https://ec.europa.eu/health//sites/health/files/nutrition_physical_activity/ docs/euframework_national_nutrients_en.pdf [Accessed 30 june 2019].

European Commission (2011b) *High Level Group on Nutrition and Physical Activity. EU Framework for National Initiatives on selected nutrients. annex II: added sugars*. Brussels, European Commission. Available from: https://ec.europa.eu/health/sites/health/files/nutrition_physical_activity/d ocs/added_sugars_en.pdf [Accessed 30 june 2019].

European Commission (2013) *Survey on Member Sates' implementation of the EU salt reduction framework*. Brussels, European Commission.

Available from: https://ec.europa.eu/health/sites/health/files/nutrition_physical_activity/docs/salt_report_en.pdf [Accessed 30 june 2019].

European Commission (2018a) *Salt campaign - Public Health*. Brussels, European Commission; Available from: https://ec.europa.eu/health/nutrition_physical_activity/high_level_group/nutrition_salt_en [Accessed 30 june 2019].

European Commission (2018b) Legislation laying down maximum levels for the salt content in bread. Brussels, European Commission. Available from: https://ec.europa.eu/growth/tools-databases/tris/en/index.cfm/search/?trisaction=search.detail&year=2018&num=363&mLang=PT [Accessed 30 june 2019].

European Observatory on Health Systems and Policies (EOHSP) (2017) *Portugal: Country Health Profile.* Brussels: EOHSP.. Available from: http://www.euro.who.int/__data/assets/pdf_file/0007/355993/Health-Profile-Portugal-Eng.pdf?ua=1[Accessed 30 june 2019].

European Union (2012) *Europa Summary of EU legislation. Labeling of Food studs. Regulation (EU) No. 1169/2011*. Brussels, European Union.

European Union. (2015) EU Annex on Added Sugars (Dec 2015), (accessed May 24 2019). Available at: https://ec.europa.eu/health/sites/health/files/nutrition_physical_activity/docs/added_su gars_en.pdf [Accessed 15 january 2021].

Eurostat (2018a) *Population and social conditions*. Available at:. http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tps00010&language=en [Accessed 30 june 2019].

Eutostat (2018b) *Causes of death: deaths by country of residence and occurrence*. Available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=hlth_cd_aro&lang=en [Accessed 30 June 2019].

Falbe, J., Thompson, H.R., Becker, C.M., Rojas, N., McCulloch, C.E. & Madsen, K.A. (2016) Impact of the Berkeley excise tax on sugar-sweetened beverage consumption. *Am J Public Health*. 106(10), 1865–71. Available from: doi:10.2105/AJPH.2016.303362.

Farrell, D. & Goodman, A. (2013) *Government by design: Four principles for a better public sector.* Available from: https:// www.mckinsey.com/industries/public-sector/our-insights/ government-by-design-four-principles-for-a-better-publicsector [Accessed 30 June 2019].

Fletcher, J.M., Frisvold, D.E. & Tefft, N. (2010a) The effects of soft drink taxes on child and adolescent consumption and weight outcomes. *J Public Econ*. 94(11), 967–74. Available from: doi:10.1016/j.jpubeco.2010.09.005.

Fletcher, J.M., Frisvold, D. & Tefft, N. (2010b) Can soft drink taxes reduce population weight? *Contemp Econ Policy*. 28(1), 23–35. Available from: doi:10.1111/j.1465-7287.2009.00182.x.

Flodmark, C.E., Marcus, C. & Britton, M. (2006) Interventions to prevent obesity in children and adolescents: a systematic literature review. *Int J Obes*. 30(4), 579–589. Available from: doi:10.1038/sj.ijo.0803290.

Fonds français pour l'alimentation (2017) *Evaluation ex ante de systèmes d'étiquetage nutritionnel graphique simplifié. Rapport final*. Paris: Comité Scientifique de l'étude d'expérimentation. Available from:

https://alimentation-sante.org/wp-content/uploads/2017/03/Rapport-CS-de%CC%81finitif-14-mars.pdf [Accessed 30 june 2019].

Food and Agriculture Organization of the United Nations (FAO) (2016) *FAOSTAT: new food balances—metadata*. Rome: Food and Agriculture Organization of the United Nations. Available from: http://www.fao.org/faostat/en/#data/FBS/metadata [Accessed 24 feb 2020].

Forbes, T., Evans, D. & Scott, N. (2010) Implementing health and social care policy – England and Scotland compared. *Policy Studie.* 31(6), 591-611.

Frattaroli, S. & Teret, S. (2006) Understanding and informing policy implementation: A case study of the domestic violence provisions of the Maryland Gun Violence Act. *Evaluation Review*, 30(3), 347-360. Available from: doi:10.1177/0193841X06287684.

Freitas, A.I., Moreira, C. & Santos, A.C. (2018) Time trends in prevalence and incidence rates of childhood overweight and obesity in Portugal: Generation XXI birth cohort. *Int J Obes*. 43(2), 424. Available from: doi:10.1038/s41366-018-0286-8.

French, S.A. & Stables, G. (2003) Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Prev Med*. 37(6), 593–610. Available from: doi:10.1016/j.ypmed.2003.09.007.

Frenk, J. (2010) The global health system: strengthening national health systems as the next step for global progress. *PLoS Med*. 7(1), e1000089. Available from: 10.1371/journal.pmed.1000089.

Gillespie, D.O., Allen, K., Guzman-Castillo, M., Bandosz, P., Moreira, P., McGill, R., et al. (2015) The health equity and effectiveness of policy options to reduce dietary salt intake in England: policy forecast. *PLoS One.* 10(7), e0127927. Available from: doi:10.1371/journal.pone.0127927.

Gerber, M. (2016) Implementing the Mediterranean diet: a French perspective and comparisons with other Mediterranean countries. In: Romagnolo, D.F. & Selmin, O.I. (eds.) *Mediterranean diet: dietary guidelines and impact on health and disease*. New York, USA, Springer, pp. 57-67.

Gilson, L. (2016) Everyday politics and the leadership of health policy implementation. *Health Syst Reform*. 2(3),187–93. Available from: doi:10.1080/23288604.2016.1217367.

Global Burden of Disease 2017 Diet Collaborators (2019) Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 393: 1958-1972. Available from: doi.org/10.1016/S0140-6736(19)30041-8.

Global Burden of Disease Alcohol Collaborators (2018) Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 392: 1015–35. Available from: doi.org/10.1016/S0140-6736(18)31310-2.

Global Burden of Disease Study (2019) Health effects of dietary risks in 195 countries, 1990–2017:a systematic analysis forthe Global Burden of Disease Study. *Lancet.* 393: 1958–72. Available from: doi.org/10.1016/S0140-6736(19)30041-8.

Goiana-da-Silva, F., Cruz-e-Silva, D., Gregório, M.J., Nunes, A.M., Graça, P. et al. (2018a) Bringing government sectors together to address noncommunicable diseases: Portugal's interministerial healthy eating strategy. *Public health panorama*. 4(3), 426 - 434. Available from: https://www.euro.who.int/__data/assets/pdf_file/0018/380331/php-4-3-cs2-eng.pdf?ua=1 [Accessed 30 june 2019].

Goiana-da-Silva, F., Nunes, A.M., Miraldo M., Bento, A., Breda, J. & Araújo, F.F. (2018b) Fiscalidade ao serviço da saúde pública: a experiência na tributação das bebidas açucaradas em Portugal. *Acta Med Port*. 31(4),191–5. Available from: doi: 10.20344/amp.10222.

Goiana-da-Silva, F. Cruz-e-Silva, D., Gregório, M.J., Miraldo, M., Darzi, A. & Araújo, F. (2018c) The future of the sweetened beverages tax in Portugal. Lancet Public Health. 3(12), e562. Available from: doi:10.1016/S2468-2667(18)30240-8.

Goiana-da-Silva, F., Cruz-e-Silva, D., Miraldo, M., Calhau, C., Bento, A., Cruz, D., Almeida, F., Darzi, A. & Araújo, F. (2019a) Front-of-pack labelling policies and the need for guidance. *The Lancet.* 4, e15. Available from: doi: 10.1016/S2468-2667(18)30256-1.

Goiana-da-Silva, F. Cruz-e-Silva, D., Gregório, M.J., Nunes, A.M., Calhau, C., Hercberg, S., Rito, A., Bento, A., Cruz, D., Almeida, F., Darzi, A. & Araújo, F. (2019b) Nutri-Score: a public health tool to improve eating habits in Portugal. *Acta Med Port*. 32(3),175-8. Available from: doi:10.20344/amp.11627.

Goiana-da-Silva, F., Cruz-e-Silva, D., Carriço, M., Teixeira, N., Darzi,A. & Araújo, F. (2019c) Changing the channel: television health campaigns in

Portugal. *The Lancet.* 4, e179. Available from: doi: 10.1016/S2468-2667(19)30039-8.

Goiana-da-Silva, F., Cruz-e-Silva, D., Allen, L., Gregório, M.J., Severo, M. Nogueira, P.J., Nunes, A.M., Graça, P., Lopes, C., Miraldo, M., Breda, J., Wickramasinghe, K., Darzi, A., Araújo, F. & Mikkelsen, B. (2019d) Modelling impacts of food industry co-regulation on noncommunicable disease mortality, Portugal. *Bulletin of the World Health Organization*. 97, 450-459. Available from: doi:10.2471/BLT.18.220566.

Goiana-da-Silva, F., Cruz-e-Silva, D., Nunes, A.M., Carriço, M. et al. (2019e) Disrupting the landscape: how the Portuguese National Health Service built an omnichannel communication platform. Public health panorama, 5 (2-3), 314 - 323. Available from: https://apps.who.int/iris/handle/10665/327063 [Accessed 30 june 2019].

Goiana-da-Silva, F., Cruz-E-Silva, D., Allen, L., Nunes, A. M., Calhau, C., Rito, A., Bento, A., Miraldo, M., & Darzi, A. (2019f) Portugal's voluntary food reformulation agreement and the WHO reformulation targets. *Journal of global health*. 9(2), 020315. Available from: doi:10.7189/jogh.09.020315.

Goiana-da-Silva, F., Cruz-e-Silva, D., Oom-Sousa, A., Nunes, A.M.; Gregório,M.J., Cordeiro, T., Calhau, C., Lopes, C., Rito, A., Miraldo, M., Bento, A., Darzi, A., & Araújo, F. (2020a). Portugal: The Portuguese sweetened beverages tax. In: World Health Organization. (Ed). *Improving dietary intake and achieving food product improvement Policy opportunities and challenges for the WHO European Region in reducing*

salt and sugar in the diet. Copenhagen, The Regional Office for Europe of the World Health Organization, pp. 37-46.

Goiana-da-Silva, F., Severo, M., Cruz-e-Silva, D., Gregório, M.J.,,Allen, L., Muc, M., Nunes, A.M., Torres, D., Miraldo, M., Ashrafian, H., Rito, A., Wickramasinghe, K., Breda, J., Darzi, A., Araújo, F. & Lopes, C. (2020b) Projected impact of the Portuguese sugar-sweetened beverage tax on obesity incidence across different age groups: A modelling study. *PLOS Medicine* *17*(3): e1003036. Available from: doi:10.1371/journal.pmed.1003036.

Goiana-da-Silva1, F., Cruz-e-Silva, D., Bartlett, O., Vasconcelos, J., Nunes, AM., Ashrafian, H., Miraldo, M., Machado, MC., Araújo, F. & Darzi, A. (2020c) The Ethics of Taxing Sugar-Sweetened Beverages to Improve Public Health. *Front. Public Health*. Available from: doi.org/10.3389/fpubh.2020.00110.

Goiana-da-Silva, F., Muc, M., Cruz-e-Silva, D., Rito, A., Lopes, C., Miraldo, M., Darzi, A. & Araújo, F. (2020d) Prioritizing health over internal market interests: a policy dilemma between Portugal and the European Commission. *Health Policy journal*. [Aprove to publication].

Gomes, S., Nogueira, M., Ferreira, M. & Gregório, M.J. (2017) *Portuguese consumers´ attitudes towards food labelling*. Copenhagen, Worls Health Organization.

Gonçalves, C., Abreu, S., Padrão, P., Pinho, O., Graça, P., Breda, J. et al. (2016) Sodium and potassium urinary excretion and dietary intake: a cross-sectional analysis in adolescents. *Food & Nutrition Research*. 60. Available from: doi: 10.3402/fnr.v60.29442.

Goncalves, C., Monteiro, S., Padrão, P., Rocha, A., Abreu, S., Pinho, O. et al. (2014) Salt reduction in vegetable soup does not affect saltiness intensity and liking in the elderly and children. *Food Nutr Res*. 58. Available from: doi: 10.3402/fnr.v58.24825.

Gonçalves, J. & Santos, J.P. (2019) *Brown sugar, how come you taste so good? The impact of a soda tax on prices and consumption*. Lisbon, Ministry of Economy Office for Strategy and Studies.

Graça, P. & Gregório, M.J. (2013) A construção do programa nacional para a promoção da alimentação saudável: aspectos conceptuais, linhas estratégicas e desafios iniciais. *Revista Nutrícias*. 18, 6-9. Available from: https://hdl.handle.net/10216/70234 [Accessed 30 june 2019].

Graça, P., Gregório, M.J., Sousa, S.M., Carriço, J., Correia, A. & Salvador, C. (2016) The Portuguese National Programme for the Promotion of Healthy Eating: 2012–2015. *Public Health Panorama*. 2(2): 117-247. Available from: http://www.euro.who.int/ en/publications/public-health-panorama/journal-issues/volume-2,-issue-2,-june-2016/report2 [Accessed 30 june 2019].

Graça, P., Gregório, M.J., de Sousa, S.M. et al. (2018) A new interministerial strategy for the promotion of healthy eating in Portugal: implementation and initial results. *Health Res Policy Sys*. 16, 102. Available from: doi:10.1186/s12961-018-0380-3.

Gravely, S., Giovino, G.A., Craig, L., Commar, A., D'Espaignet, E.T., Schotte, K. & Fong, G.T. (2017) Implementation of key demand-reduction measures of the WHO Framework Convention on Tobacco Control and change in smoking prevalence in 126 countries: an association study. *The*

Lancet Public Health. 2(4), e166-74. Available from: doi: 10.1016/S2468-2667(17)30045-2.

Greszczuk, C. (2019) *Implementing health in all policies: Lessons from around the world.* London, The Health Fundation. Available from: https://www.health.org.uk/sites/default/files/upload/publications/2019/Implementing%20health%20in%20all%20policies.pdf [Accessed 10 february 2021].

Grimes, A., Bolhuis, D., He, F. & Nowson, C. (2016) Dietary sodium intake and overweight and obesity in children and adults: a protocol for a systematic review and meta-analysis. *Systematic Reviews*. 5(1), 7. Available from: doi:10.1186/s13643-015-0175-3.

Habib, S. and Saha, S. (2010). Burden of non-communicable disease: Global overview. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 4(1), pp.41-47. Available from doi:10.1016/j.dsx.2008.04.005

Hawkes, C., Jewell, J., & Allen, K. (2013) A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the nourishing framework. *Obes Rev*. 14(2), 159-68. Available from: doi:10.1111/obr.12098.

Harrington, J.M., Leydon, C.L., Twohig, C.H. & Vandevijvere, S. (2020) *Policies for Tackling Obesity and Creating Healthier Food Environments in Ireland: Food-EPI 2020. Current policies and priority actions*. Cork, School of Public Health, University College Cork 2020.

He, F.J., Brinsden, H.C. & MacGregor, G.A. (2014) Salt reduction in the United Kingdom: a successful experiment in public health. *J Hum*

Hypertens. 28(6), 345–52. Available from: doi: 10.1038/jhh.2013.105 PMID: 24172290.

Healthy Caribbean Coalition (2017) *POS NCD Summit Grid Report NCD Progress Indicator*. Available from: https://www.healthycaribbean.org/tracking-ncd-progress-in-caricom/ [Accessed 30 june 2019].

Hiilamo, H. & Glantz, S. (2018) Limited implementation of the framework convention on tobacco control's tobacco tax provision: global comparison. *BMJ open*. 8(10), e021340.

Hill, M & Hupe, P. (2003) The multi-layer problem in implementation research. *Public Manag Rev*. 5(4), 471–90. Available from: doi: 10.1080/1471903032000178545.

Hooper, P., Giles-Corti, B. & Knuiman, M. (2014) Evaluating the implementation and active living impacts of a state government planning policy designed to create walkable neighbourhoods in Perth, Western Australia. *American Journal of Health Promotion*, 28(3), 5-18. Available from: doi: 10.4278/ajhp.130503-QUAN-226.

Hunter, D.J. & Reddy, K.S. (2013) Noncommunicable diseases. *New England Journal of Medicine*. 369(14), 1336-43. Available from: doi: 10.1056/NEJMra1109345.

Hyseni, L., Bromley, H., Kypridemos, C., O'Flaherty, M., Lloyd-Williams, F., Guzman-Castillo, M. et al. (2017) Systematic review of dietary trans-fat reduction interventions. *Bulletin of the World Health Organization*. 95(12), 821-30. Available from: doi: 10.2471/BLT.16.189795.

IBM Corp. (2016) *IBM SPSS Statistics for Windows, Version 22*. Armonk, NY, IBM Corp.

Ickes, M., McMullen, J., Haider, T. & Sharma, M. (2014) Global School-Based Childhood Obesity Interventions: a review. *International Journal of Environmental Research and Public Health*. 11(9), 8940–8961. Available from: doi: 10.3390/ijerph110908940

Institute for Health Metrics and Evaluation. (2016) GBD compare. Seattle, University of Washington. Available from: https://vizhub.healthdata.org/gbd-compare [Accessed 30 june 2019].

Institute for Health Metrics and Evaluation (IHME) (2017) *Global burden of disease study 2017. Results.* Seattle, Institute for Health Metrics and Evaluation. Available from: http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf [Accessed 30 june 2019].

Institute for Health Metrics and Evaluation (IHME) (2018) *GBD foresight*. Seattle, Institute for Health Metrics and Evaluation, University of Washington; 2018. Available from: https://vizhub.healthdata. org/gbd-foresight/ [Accessed 19 june 2019].

Institute for Health Metrics and Evaluation (IHME) (2020) *Portugal*. Available from: Available from: http://www.healthdata.org/portugal [Accessed 30 june 2019].

Institute of Medicine (2010) *School Meals: Building Blocks for Healthy Children*. 2010. Available from: https://www.nap.edu/catalog/12751/school-meals-building-blocks-for-healthy-children [Accessed 30 june 2019].

International Organization for Standardization (ISO/IEC) (2005) *General Requirements for the Competence of Testing and Calibration Laboratories. 2nd ed.* Geneva. Available from: https://www.iso.org/standard/66912.html [Accessed 30 june 2019].

Jakab, Z. (2018) Reducing the burden of noncommunicable diseases in Europe. *Public Health Panorama.* 4(3):374–5. Available from: https://www.euro.who.int/en/publications/public-health-panorama/journal-issues/volume-4,-issue-3,-september-2018/editorial [Accessed 30 june 2019].

Jamison, D.T., Summers, L.H., Alleyne, G., Arrow, K.J., Berkley, S., Binagwaho, A., Bustreo, F., Evans, D., Feachem, R.G., Frenk, J. & Ghosh, G. (2013) Global health 2035: a world converging within a generation. *The Lancet.* 382(9908),1898-955.

JAPNA (Joint Action on Nutrition and Physical Activity) (2017) *Tackling childhood obesity and overweight in Europe*. Available at: http://www.janpa.eu/outcomes/Deliverables/2_scheda_inform%20POSITION%20PA PER_4p_210x297_JANPA.pdf [Accessed 27 April 2018].

Johnson, R.K., Appel, L.J., Brands, M., Howard, B.V., Lefevre, M., Lustig, R.H. et al. (2009) Dietary sugars intake and cardiovascular health: a scientific statement from the *American Heart Association*. 120(11), 1011–20. Available from: doi: 10.1161/CIRCULATIONAHA.109.192627.

Jones, A., Magnusson, R., Swinburn, B., Webster, J., Wood, A., Sacks, G. et al. (2016) Designing a Healthy Food Partnership: lessons from the Australian Food and Health Dialogue. *BMC Public Health*. 16(1), 651. Available from: doi: 10.1186/s12889-016-3302-8 PMID: 27465746

Jorge, R. (2019) *Childhood Obesity Surveillance Initiative-COSI Portugal*. Lisbon, National Institute of Health.

Julia, C. & Hercberg, S. (2017) Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panorama*. 3(4), 712-25. Available from: https://apps.who.int/iris/handle/10665/325207[Accessed 30 june 2019].

Julia, C., Péneau, S., Buscail, C., Gonzalez, R., Touvier, M., Hercberg, S. et al. (2017) Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: cross-sectional study among the NutriNet-Santé cohort participants. *BMJ*. 7, e016108. Available from: doi: 10.1136/bmjopen-2017-016108.

Juma, P.A., Mohamed, S.F., Matanje Mwagomba, B.L. et al. (2018) Non-communicable disease prevention policy process in five African countries. *BMC Public Health*. 18, 961. Available from: doi: 10.1186/s12889-018-5825-7.

Khalid, MA. (2014) Prevalence of tobacco use and exposure to environmental tobacco smoke among Saudi medical students in Riyadh, Saudi Arabia. *J Community Health*. 39(4):668–73.

Kanter, R., Vanderlee, L. & Vandevijvere, S. (2018) Front-of-package nutrition labelling policy: global progress and future directions. *Public Health Nutr*. 21, 1399-408. Available from: doi: 10.1017/S1368980018000010.

Kelly, B. & Jewell, J. (2018) *What is the evidence on the policy specifications, development processes and effectiveness of existing front-*

of-pack food labelling policies in the WHO European Region? Copenhagen: WHO Regional Office for Europe. Available from: http://www.euro.who.int/__data/assets/pdf_file/0007/384460/Web-WHO-HEN-Report-61-on-FOPL.pdf?ua=1 [Accessed 30 june 2019].

Kelly, N., Garvey, J. & Palcic, D. (2016) Health policy and the policymaking system: A case study of primary care in Ireland. *Health Policy.* 120(8), 913-919. Available from: doi: 10.1016/j.healthpol.2016.06.006.

Kessler, M. (2018) Draft Political Declaration for UN High-Level Meeting on NCD lacks strength and ambition required to avoid a preventable global health crisis. Press release. Available from: https://enoughNCD.com/draft-political-declaration/ [Accessed 30 june 2019].

Kleef, E.V. & Dagevos, H. (2015) The growing role of front-of-pack nutrition profile labeling: A consumer perspective on key issues and controversies. *Crit. Rev. Food Sci. Nutr*. 55, 291–303. Available from: doi: 10.1080/10408398.2011.653018.

Konfino, J., Mekonnen, T.A., Coxson, P.G., Ferrante, D. & Bibbins-Domingo K. (2013) Projected impact of a sodium consumption reduction initiative in Argentina: an analysis from the CVD policy model – Argentina. *PLoS One*. 8(9), e73824. Available from: doi:10.1371/journal.pone.0073824.

Kraak, V.I., Vandevijvere, S., Sacks, G., Brinsden, H., Hawkes, C., Barquera, S. et al. (2016) Progress achieved in restricting the marketing of high-fat, sugary and salty food and beverage products to children. *Bull*

World Health Organ, 94(7),540-8. Available from: doi:10.2471/BLT.15.158667.

Lal, A., Mantilla-Herrera, A.M., Veerman, L., Backholer, K., Sacks, G, Moodie, M. et al. (2017) Modelled health benefits of a sugar-sweetened beverage tax across different socioeconomic groups in Australia: a cost-effectiveness and equity analysis. *PLoS Med*. 14(6), e1002326. Available from: doi:10.1371/journal.pmed.

Larsen, P.S., Kamper-Jorgensen, M., Barros, H., Bonde, J.P., Brescianini, S. et al. (2013) Pregnancy and birth cohort resources in Europe: a large opportunity for aetiological child health research. *Paediatr Perinat Epidemiol*. 27(4), 393–414. Available from: doi:10.1111/ppe.12060 PMID: 23772942.

Laverty, A., Kypridemos, C., Seferidi, P et al. (2019) Quantifying the Impact of the Public Health Responsibility Deal on Salt Intake, Cardiovascular Disease and Gastric Cancer burdens: Interrupted Time Series and Microsimulation Study. *Journal of Epidemiology and Community Health*. 73 (9), 881–887.

Lee, M.M., Falbe, J., Schillinger, D., Basu, S., McCulloch, C.E. & Madsen, K.A. (2019) Sugar-sweetened beverage consumption 3 years after the Berkeley, California, sugar-sweetened beverage tax. *Am J Public Health*. 109(4), 637–9. Available from: doi:10.2105/AJPH.2019.304971.

Li, X., Jan, S., Yan, L.L. et al. (2017) Cost and cost-effectiveness of a school-based education program to reduce salt intake in children and their families in China. *PlosOne*. 12(9), 1–17. Available from: doi: 10.1371/journal.pone.0183033.

Libuda, L., Kersting, M. & Alexy, U. (2012) Consumption of dietary salt measured by urinary sodium excretion and its associated with body weight status in healthy children and adolescents. *Public Health Nutr*. 15(3), 433–41. Available from: doi: 10.1017/S1368980011002138.

Lipsky, M. (1980) *Street-level bureaucracy: dilemmas of the individual in public services*. New York, Russell Sage Foundation.

Lobb, R. & Colditz, G.A. (2013) Implementation science and its application to population health. *Annu Rev Public Health*. 34(1), 235–51. Available from: doi:10.1146/annurev-publhealth-031912-114444.

Lopes, C., Torres, D., Oliveira, A., Severo, M., Alarcão, V., Guiomar, S. et al. (2017a) *National food, nutrition, and physical activity survey of the Portuguese general population. IAN-AF 2015-2016: Summary of results*. Porto, Universidade do Porto. Available from: http://www.ian-af.up.pt [Accessed 18 jul 2018].

Lopes, C., Torres, D., Oliveira, A., Severo, M., Guiomar, S., Alarcão, V. et al. (2017b) *National Food, Nutrition and Physical Activity Survey of the Portuguese general population. EFSA supporting publication 2017:EN1341*. Parma, European Food Safety Authority.

Lopes, C., Torres, D., Oliveira, A., Severo, M., Alarcão, V. & Guiomar, S. et al. (2017c) *Inquérito Alimentar Nacional e de Atividade Física IAN-AF 2015-2016. Relatório Parte II*. Porto, Universidade do Porto.

Lopes, C., Torres, D., Oliveira, A., Severo, M., Alarcão, V. & Guiomar, S. et al. (2018a) *National food, nutrition, and physical activity survey of the Portuguese general population, IAN-AF 2015–2016: summary of results*. Porto, Universidade do Porto.

Lopes, C., Torres, D., Oliveira, A., Severo, M., Guiomar, S., Alarcão, V. et al. (2018b) National food, nutrition, and physical activity survey of the Portuguese general population (2015–2016): protocol for design and development. *JMIR Res Protoc.* 7(2), e42. Available from: doi:10.2196/resprot.8990 PMID: 29449204.

Luger, M., Lafontan, M., Bes-Rastrollo, M., Winzer. E., Yumuk, V. & Farpour-Lambert, N. (2017) Sugar-sweetened beverages and weight gain in children and adults: a systematic review from 2013 to 2015 and a comparison with previous studies. *Obes Facts*. 10(6), 674–93. Available from: doi:10.1159/000484566 PMID: 29237159.

Lupafya, P.C., Mwagomba, B.L., Hosig, K., Maseko, L.M., Chimbali, H. (2016) Implementation of policies and strategies for control of noncommunicable diseases in Malawi: challenges and opportunities. *Health Education & Behavior.* 43(1), 64S-9S. Available from: doi: 10.1177/1090198115614313.

Lytle, L.A. & Kubik, M.Y. (2003) Nutritional issues for adolescents. *Best Pract Res Clin Endocrinol Metab*. 17, 177–189. Available from: doi: 10.1016/s1521-690x(03)00017-4.

Ma, Y., He, F. & MacGregor, G. (2015) High Salt Intake – Independent Risk Factor for Obesity? *Hypertension.* 66(4), 843-9. Available from: doi: 10.1161/HYPERTENSIONAHA.115.05948.

MacGregor, A., Sharp, C., Mabelis, J., Corbett, J. & ScotCen Social Research (2013) *An evaluation of the implementation of, and compliance with, the objectives of the Licensing (Scotland) Act 2005. Final Report*. Edinburgh, NHS Health Scotland.

Magnusson, R. & Reeve, B. (2015) Food reformulation, responsive regulation, and "regulatory scaffolding": strengthening performance of salt reduction Programs in Australia and the United Kingdom. *Nutrients*. 7(7), 5281–308. Available from: doi:10.3390/nu7075221.

Malik, V.S., Schulze, M.B. & Hu, F.B. (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr*. 84(2), 274–88. Available from: doi:10.1093/ajcn/84.1.274.

Marinho, A.R., Severo, M., Correia, D., Lobato, L., Vilela, S., Oliveira, A., et al. (2019) Total, added and free sugar intakes, dietary sources and determinants of consumption in Portugal: the National Food, Nutrition and Physical Activity Survey (IAN-AF 2015–2016). *Public Health Nutr*. 1–13. Available from: doi:10.1017/ s1368980019002519.

Marshall, A., Altman, D.G., Holder, R.L. & Royston, P. (2009) Combining estimates of interest in prognostic modelling studies after multiple imputation: current practice and guidelines. *BMC Med Res Methodol*. 9(1), 57. Available from: doi:10.1186/1471-2288-9-57.

Marshall, M.G., Cole, B.R. & Report G. (2014) Conflict, Governance and State Fragility: Center for Systemic Peace (Global Report 2014). Available from: http://www.systemicpeace.org/SFImatrix2010c.pdf [Accessed 30 june 2019].

Martins, I., Porto, A. & Oliveira, L. (2007) *Tabela de Composição de Alimentos*. Lisboa, Instituto Nacional de Saúde Doutor Ricardo Jorge.

Mary, RH., Linda, S., Anne, BP., Marjorie, W., Iveta, N., & Stella, B. (2018) Attitude, barriersand facilitators to smoking cessation among

central and eastern European nurses: a focus group study. *Eur J Oncol Nurs*. 35, 39–46.

Maskell, J. (2016) The Evolution of Medicine: Join the Movement to Solve Chronic Disease and Fall Back in Love with Medicine. Kew Publishing.

Maycraft Kall, W. (2014) Same law-same rights? Analyzing why Sweden's disability legislation failed to create equal rights in mental health. *International Journal of Law and Psychiatry*. 37(6), 609-618.

McGhee, SM., Ho, LM., Lapsley, HM., Chau, J., Cheung, WL., Pow, M., Lam, TH., &, Hedley, AJ (2006) Cost of tobacco related diseases including passive smoking in Hong Kong. *Tob Control.* 15(2), 125–30.

Mendes, S., Bica, M., Baleia, J., Goiana-da-Silva, F., & Rito, A. (2019) *Eight years of sugar-sweetened beverages consumption among Portuguese children aged 6 to 8 years old: COSI Portugal 2008 – 2016*. Available at: http://repositorio.insa.pt/handle/10400.18/7149.

McPherson, C., Ndumbe-Eyoh, S., Betker, C., Oickle, D., & Peroff-Johnston, N. (2016) Swimming against the tide: A Canadian qualitative study examining the implementation of a province-wide public health initiative to address health equity. *International Journal for Equity in Health*, 15, 129. Available from: doi: 10.1186/s12939-016-0419-4.

Michael, SS., Andrew, DA., Floyd, WT., Joon, SL., Vincent, MF., Suresh, RM. (2018) Impact of cigarette taxes on smoking prevalence from 2001-2015: a report using the behavioral and risk factor surveillance survey (BRFSS). *PLoS One*. 19(9), e0204416.

Ministério da Saúde (2018) *Retrato da Saúde em Portugal*. Lisbon: Ministry of Health; 2018. Available from: https://www.sns.gov.pt/wp-

content/uploads/2018/04/RETRATO-DA-SAUDE_2018_compressed.pdf, accessed 15 March 2018 [Accessed 30 june 2019].

Monteiro, C.A, Moubarac, J.C., Levy, R.B., Canella, D.S, Louzada, M.L. & Cannon, G. (2018) Household availability of ultra-processed foods and obesity in nineteen European countries. *Public Health Nutr*, 21(1), 18-26. Available from: doi:10.1017/S1368980017001379.

Munire, G., Onder, O., Ahmet, B., & Ahmet, A. (2010) The attitude toward tobacco dependence and barriers to discussing smoking cessation: a survey among Turkish general practitioners. *Int J Public Health*. 55(3), 177–83.

Mustafa, ZM. (2012) Effects of cigarettes smoking on common carotid arteries intima media thickness in current smokers. *Ozean J Applied Sci*. 5(4), 259–69.

National Institute of Statistics (2019) *Portugal Web Portal*. Available from: https://www.ine.pt/xportal/xmain?xpgid=ine_main&xpid=INE&xlang=en [Accessed 30 june 2019].

Nature (2018) Editorial: Back the idea of human capital with solid research. *Nature.* 562, 459-460.

NCD Alliance (2015) *NCDs (noncommunicable diseases) are the #1 cause of death and disability worldwide*. Available from: https://ncdalliance.org/why-ncds/NCDs [Accessed 15th ocotber 2020].

Nghiem, N., Blakely, T., Cobiac, L.J., Pearson, A.L. & Wilson, N. (2015) Health and economic impacts of eight different dietary salt reduction interventions. *PLoS One*. 10(4). Available from: doi:10.1371/journal.

Nghiem, N., Blakely, T., Cobiac, L.J., Cleghorn, C.L. & Wilson, N. (2016) The health gains and cost savings of dietary salt reduction interventions, with equity and age distributional aspects. *BMC Public Health.* 16(1), 423. Available from: doi:10.1186/s12889-016-3102-1.

Ni Mhurchu, C., Eyles, H. & Choi, Y.H. (2017) Effects of a Voluntary Front-of-Pack Nutrition Labelling System on Packaged Food Reformulation: The Health Star Rating System in New Zealand. *Nutrients*, 9, 918. Available from: doi: 10.3390/nu9080918

Nielsen (2012) *Battle of the Bulge & Nutrition Labels Healthy Eating Trends Around the World*. New York City, The Nielson Company.

Nielsen (2019) *Webpage*. Available from: http://www.nielsen.com/pt/pt [Accessed 30 june 2019].

Organization for Economic Co-operation and Development (OECD) (2008) *Promoting Sustainable Consumption—Good Practices in OECD Countries*. Paris, OECD Publishing.

Organization for Economic Co-operation and Development (OECD) (2010) *Obesity and the Economics of Prevention: Fit not Fat.* Paris, OECD Publishing. Available from: http://www.oecd.org/els/health-systems/obesity-and-the-economics-of-prevention9789264084865-en.htm [Accessed 30 june 2019].

Organization for Economic Co-operation and Development (OECD) (2017) *Health at a Glance 2017*. Paris, OECD Publishing. Available from: https://read.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2017_health_glance-2017-en#page1, accessed 26 March 2018 [Accessed 30 june 2019].

Organization for Economic Co-operation and Development (OECD) (2018) *Health at a Glance: Europe 2018: State of Health in the EU Cycle*. Paris, OECD Publishing Available from: https://doi.org/10.1787/health_glance_eur-2018-en [Accessed 30 june 2019].

Organization for Economic Co-operation and Development (OECD) (2019a) *Life expectancy and healthy life expectancy at age 65*. Available from: https://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2019_4dd50c09-en [Accessed 30 june 2019].

Organization for Economic Co-operation and Development OECD (2019b) *Life expectancy and healthy life years at age 65, by sex, 2017 (or nearest year)*. Available from: https://www.oecd-ilibrary.org/social-issues-migration-health/life-expectancy-and-healthy-life-years-at-age-65-by-sex-2017-or-nearest-year_b10d595d-en [Accessed 30 june 2019].

Organization for Economic Co-operation and Development (OECD) (2020) *Statistical Databases*. Available from: https://stats.oecd.org/ [Accessed 30 june 2019].

Oliveira, A., Araújo, J., Severo, M., Correia, D., Ramos, E., Torres, D. et al. (2018) Prevalence of general and abdominal obesity in Portugal: comprehensive results from the National Food, Nutrition and Physical Activity Survey 2015–2016. *BMC Public Health*.18(1), 614. Available from: doi:10.1186/s12889-018-5480-z.

Oliver, T.R. (2006) The politics of public health policy. *Annu Rev Public Health*. 27, 195–233. Available from: doi:10.1146/annurev.publhealth.25.101802.123126.

Osório, A. (06 July 2020) António Horta Osório anuncia saída do Lloyds Bank. *Jornal Público*. Available from: https://www.publico.pt/2020/07/06/economia/noticia/antonio-horta-osorio-anuncia-saida-lloyds-bank-1923186 [Accessed 15 october 2020].

O'Toole, L., Slade, C., Brewer, G. & Gase, L. (2011) Barriers and facilitators to implementing primary stroke center policy in the United States: Results from 4 case study states. *American Journal of Public Health*, 101(3), 561-566. Available from: doi: 10.2105/AJPH.2010.197954.

Paiva, I., Pinto, C., Queirós, L., Meister, M.C., Saraiva, M., Bruno, P., et al. (2011) Baixo valor calórico e elevado teor de sal. *Acta Médica Portuguesa*. 24, 215-22. Available from: https://pubmed.ncbi.nlm.nih.gov/22011592/ [Accessed 30 june 2019].

Panagopoulos, T. & Barreira, A. (2013) *Understanding the Shrinkage Phenomenon in Portugal.* Faro, University of Algarve. Available from: https://sapientia.ualg.pt/bitstream/10400.1/3983/1/cities%20growing%20smaller%20portugal.pdf, acessed 20 March 2018 [Accessed 30 june 2019].

Campos, P.A. & Reich, M.R. (2019) Political Analysis for Health Policy Implementation. *Health Systems & Reform*. 5(3), 224-235, Available from: doi:10.1080/23288604.2019.1625251.

Polonia, J., Martins, L., Pinto, F., Nazare, J. (2014) Prevalence, awareness, treatment and control of hypertension and saltintake in Portugal: changes over a decade. The PHYSA study. *Journal of*

hypertension. 32(6), 1211-21. Available from: doi: 10.1097/HJH.0000000000000162.

PORDATA. (2020) *Esperança de vida à nascença: total e por sexo.* Available from: https://www.pordata.pt/Portugal/Esperan%C3%A7a+de+vida+%C3%A0+nascen%C3%A7a+total+e+por+sexo+(base+tri%C3%A9nio+a+partir+de+2001)-418 [Accessed 15th june 2015].

Portugal (2009) *Lei nº 75/2009, de 12 de agosto*. Available from: https://dre.pt/pesquisa/-/search/493513/details/maximized [Accessed 30 june 2019].

Portugal (2015) *XXI Portuguese Constitutional Government. Government Programme.* Lisbon: Portuguese Constitutional Government. Available from: https://www.portugal.gov.pt/ficheiros-geral/programado-governo-pdf.aspx [Accessed 30 june 2019].

Portugal (2016a) Council of Ministers Deliberation nº334/2016. Available from: https://www.portugal.gov.pt/pt/gc21/governo/comunicado-de-conselho-de-ministros?i=110 [Accessed 30 june 2019].

Portugal. (2016b) *Diário da República nº 248/2016 Série I de 2016-12-28. Lei 42/2016. Orçamento do Estado para 2017*. Secção *III. Impostos especiais de consumo. Artigo 211. Imposto sobre o álcool, as bebidas alcoólicas e as bebidas adicionadas de açúcar ou outros edulcorantes (IABA)*. Available from: https://dre.pt/home/-/dre/105637672/details/maximized [Accessed 30 june 2019].

Portugal. (2017) *Order No. 11418/2017 of 29 December 2017 (Portuguese Official State Gazette No. 249). Approve the Integrated*

Strategy for the Promotion of Healthy Eating. Available from: https://dre.pt/pesquisa/-/search/114424591/details/normal?l=1 [Accessed 30 june 2019].

Portugal. (2018) Impacto do imposto especial sobre o consumo de bebidas açucaradas e adicionadas de edulcorantes. Relatório do Grupo de Trabalho (Despacho n.º 2774/2018). Available from: https://www.portugal.gov.pt/download-ficheiros/ficheiro.aspx?v=a3743967-dd85-4030-87a9-b92dd2d21d77 [Accessed 30 june 2019].

Prentice, W.C. (2004) *Understanding Leadership* (Editorial). Harvard Business Review. Available from: https://hbr.org/2004/01/understanding-leadership [Accessed 30 june 2019].

Pressman, J.L. & Wildavsky, A.B. (1973) *Implementation: how great expectations in Washington are dashed in Oakland : or, why it's amazing that federal programs work at all, this being a saga of the economic development administration as told by two sympathetic observers who seek to build moral*. Berkeley, University of California Press.

Public Health England. (2017a) *Sugar reduction: achieving the 20%. A technical report outlining progress to date. guidelines for industry. 2015 baseline levels in key foods and next steps*. London, Public Health England.

Public Health England. (2017b) *Salt reduction targets for 2017*. London, Public Health England.

Rachael, J., Federica, B., Emma, M.M., Jacqui, W. & Julie, B. (2017) Consumer acceptance of reformulated food products: A systematic review

and meta-analysis of salt-reduced foods. *Critical Reviews in Food Science and Nutrition*. 57(16), 3357-3372. Available from: doi:

Ralston J, S. (2013) NCD and civil society: a history and a roadmap. In: McQueen, D. V. (ed.) *Global handbook on noncommunicable diseases and health promotion* [Internet]. New York, NY, Springer New York, pp. 2013 411–5.

Ramos, E. & Barros, H. (2007) Family and school determinants of overweight in 13-year-old Portuguese adolescents. *Acta Paediatr*. 96(2), 281-6. Available from: doi:10.1111/j.1651-2227.2007.00107.x.

Ramos, E., Lopes, C. & Barros, H. (2004) Investigating the effect of nonparticipation using a population-based case-control study on myocardial infarction. *Ann Epidemiol*. 14(6), 437–41. Available from: doi:10.1016/j.annepidem.2003.09.013.

Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers. Available from: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R1169 [Accessed 30 june 2019].

Rippin, H.L., Hutchinson, J., Jewell, J., Breda, J.J. & Cade, J.E. (2018) Child and adolescent nutrient intakes from current national dietary surveys of European populations. *Nutr Res Ver*. 3(nov), 1-32. Available from: doi:10.1017/S0954422418000161.

Rito, A., Cruz de Sousa, R., Mendes, S. & Graça, P. (2016) *Childhood Obesity Surveillance Initiative (COSI) Portugal 2016*. Lisbon, Instituto Nacional de Saúde Doutor Ricardo Jorge. Available from:

http://www.insa.min-saude.pt/childhood-obesity-surveillance-initiative-cosi-portugal-relatorio-2016 [Accessed 30 june 2019].

Rito, A., Cruz de Sousa, R., Mendes, S. & Graça, P. (2017) *Childhood Obesity Surveillance Initiative: COSI Portugal 2016.* Available from: http://hdl.handle.net/10400.18/4857 [Accessed 30 june 2019].

Rito, A.I., Mendes, S., Santos, M., Goiana-da-Silva, F., Cappuccio, F.P., Whiting, S., Dinis, A., Rascôa, C., Castanheira, I., Darzi, A., & Breda, J. (2020) Salt Reduction Strategies in Portuguese School Meals, from Pre-School to Secondary Education—The Eat Mediterranean Program. *Nutrients.* 12, 2213. Available from: doi: 10.3390/nu12082213

Roberts, M.J., Hsiao, W., Berman, P. & Reich, M. (2004) *Getting health reform right: a guide to improving performance and equity*. New York (NY), Oxford University Press.

Roth, G.A., Abate, D., Abate, K.H., Abay, S.M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A. & Abdollahpour, I. (2018) Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*. 392(10159), 1736-88. Available from: doi: 10.1016/S0140-6736(18)32203-7

Rouhani, M.H., Haghighatdoost, F., Surkan, P.J. & Azadbakht, L. (2016) Associations between dietary energy density and obesity: a systematic review and meta-analysis of observational studies. *Nutrition*. 32(10), 1037–47. Available from: doi:10.1016/j.nut.2016.03.017.

Rudolph, L., Caplan, J., Ben-Moshe, K., Dillon, L. (2013) *Health in All Policies: A Guide for State and Local Governments*. Washington, DC and Oakland, CA: American Public Health Association and Public Health Institute. Available from: http://www.phi.org/uploads/files/Health_in_All_PoliciesA_Guide_for_State_and_Local_Governments.pdf [Accessed 30 june 2019].

Sacco, R.L., Smith, S.C., Holmes, D., Shurin, S., Brawley, O., Cazap, E., Glass, R., Komajda, M., Koroshetz, W., Mayer-Davis, E. & Mbanya, J.C. (2013) Accelerating progress on non-communicable diseases. *The Lancet*. 382(9895), e4-5. Available from: doi: 10.1016/S0140-6736(11)61477-3

Santos, C.M. (2018) *Imposto sobre as bebidas não alcoólicas adicionadas de açúcar ou outros edulcorantes: qual efetividade? Uma análise exploratória*. Lisbon, National School of Public Health.

Sardinha, L.B., Santos, D.A., Silva, A.M., Coelho-e-Silva, M.J., Raimundo, A.M., Moreira, H. et al. (2012) Prevalence of overweight, obesity, and abdominal obesity in a representative sample of Portuguese adults. *PloS One*. 7(10), e47883-e. Available from: doi: 10.1371/journal.pone.0047883.

Scarborough, P., Harrington, R.A., Mizdrak, A., Zhou, L.M. & Doherty, A. (2014) The preventable risk integrated ModEl and its use to estimate the health impact of public health policy scenarios. *Scientifica*. 748750. doi: Available from: doi:10.1155/2014/748750.

Schwendicke, F. & Stolpe, M. (2017) Taxing sugar-sweetened beverages: impact on overweight and obesity in Germany. *BMC Public Health*. 17(1), 88. Available from: doi:10.1186/s12889-016-3938-4.

Scrinis, G. & Parker, C. (2016) Front-of-Pack Food Labeling and the Politics of Nutritional Nudges. *Law Policy*. 38, 234–249. Available from: doi: 10.1111/lapo.12058.

Seulggie, C., Jooyoung, C., Kyuwoong, K., Sang, MP., & Kiheon L. (2018) Effect of smoking cessation and reduction on the risk of cancer in Korean men: a population based study. *Cancer Res Treat*. 50(4), 1114–20.

Sharma, M. (2006a) International school-based interventions for preventing obesity in children. *Obes Rev*. 8(2), 155–167. Available from: doi:10.1111/j.1467-789x.2006.00268.x.

Sharma, M. (2006b) School-based interventions for childhood and adolescent obesity. *Obes Rev*. 7(3), 261–269. Available from: doi:10.1111/j.1467-789x.2006.00227.x.

Silva da Costa, A., Ribeiro da Silva, C., Jakubowski, E. & Nogueira, P. (2018) Europe WHORO for. Noncommunicable diseases 2030: assessing Portugal's progress towards the noncommunicable disease-related target of the Sustainable Developmental Goals. *Public Heal Panor*. 4(3), 321–9. Available from: https://apps.who.int/iris/handle/10665/324925 [Accessed 30 june 2019].

Slimani, N., Deharveng, G., Southgate. D.A., Biessy, C., Chajès, V., Van Bakel, M.M. (2009) Contribution of highly industrially processed foods to the nutrient intakes and patterns of middle-aged populations in the European Prospective Investigation into Cancer and Nutrition study. *Eur J Clin Nutr.* 63(Suppl 4), 206-25. Available from: doi:10.1038/ejcn.2009.82.

Smith-Spangler, C.M., Juusola, J.L., Enns, E.A., Owens, D.K. & Garber, A.M. (2010) Population strategies to decrease sodium intake and the burden of cardiovascular disease: a cost-effectiveness analysis. *Ann Intern Med*. 152(8), 481–7. Available from: doi:10.7326/0003-4819-152-8- 201004200-00212.

Sobol-Goldberg, S., Rabinowitz, J. & Gross, R. (2013) School-based obesity prevention programs: A meta-analysis of randomized controlled trials. *Obesity*. 21(12), 2422–2428. Available from: doi:10.1002/oby.20515.

Sodium initiatives (2018) *New York City Health Department*. Available from: https://www1.nyc.gov/site/doh/health/health-topics/national-salt-reduction-initiative.page [Accessed 30 june 2019].

Statistics Portugal (2014) *Balança alimentar Portuguesa (1990–2012).* Madrid: Statistics Portugal.

Stuckler, D. & Basu, S. (2013) Malignant neglect: the failure to address the need to prevent premature non-communicable disease morbidity and mortality. *PLoS medicine.* 10(6), e1001466. Available from: doi:10.1371/journal.pmed.1001466.

Swinburn, B., Kraak, V., Rutter, H., Vandevijvere, S., Lobstein, T., Sacks, G., et al. (2015) Strengthening of accountability systems to create healthy food environments and reduce we count? *Int J Behav Nutr Phys Act.* 3,33. Available from: doi: 10.1016/S0140-6736(14)61747-5.

Swinburn, Boyd, et al. (2019) The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission Report. *Lancet*. 393 (10173), 791–846.

Thaler, R. and Sunstein, C. (2008) *Nudge*. Alfragide, Academia do Livro.

The Lancet (2015) How can governments support healthy food preferences?. Available from: https://www.thelancet.com/infographics/obesity-food-policy [Accessed 30 june 2019].

Teng, A.M., Jones, A.C., Mizdrak, A., Signal, L., Genc, M. & Wilson, N. (2019) Impact of sugar-sweetened beverage taxes on purchases and dietary intake: systematic review and meta-analysis. *Obes Rev*. 20(9), 1187–204. Available from: doi:10.1111/obr.12868.

Thow, A.M., Jones, A., Schneider, C.H. & Labonté, R. (2019) Global Governance of Front-of-Pack Nutrition Labelling: A Qualitative Analysis. *Nutrients*.11, 268. Available from: doi: 10.3390/nu11020268.

Trevena, H., Neal, B., Dunford, E. & Wu, J.H. (2014) An evaluation of the effects of the Australian Food and Health Dialogue targets on the sodium content of bread, breakfast cereals and processed meats. *Nutrients*. 6(9), 3802–17. Available from: doi:10.3390/nu6093802.

Tuangratananon, T., Wangmo, S., Widanapathirana, N., Pongutta, S., Viriyathorn, S., Patcharanarumol, W., Thin, K., Nagpal, S., Nuevo, C.E., Padmawati, R.S., Puyat-Murga, M.E. (2019) Implementation of national action plans on noncommunicable diseases, Bhutan, Cambodia, Indonesia, Philippines, Sri Lanka, Thailand and Viet Nam. *Bulletin of the World Health Organization*. 97(2):129. Available from: 10.2471/BLT.18.220483.

United Nations (2012) *United Nations General Assembly Resolution A/RES/66/2. Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases.*

New York, United Nations. Available from: https://digitallibrary.un.org/record/720106/ files/A_RES_66_2-EN.pdf [Accessed 30 june 2019].

United Nations (2015a) *United Nations General Assembly Resolution A/RES/70/1. Transforming our world: the 2030 Agenda for Sustainable Development*. New York, United Nations. Available from: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E [Accessed 30 june 2019].

United Nations (2015b) *Transforming our world: the 2030 Agenda for Sustainable Development*. New York, United Nations.

Vall Castello, J. (2018) *Impact of SSB taxes on consumption. Food and Health Economics Workshop Jun 7–8, Toulouse*. Available from: XXX https://www.upf.edu/documents/3223410/7582912/CRESWP201804110. pdf/c888c03c-06e2-7c2b-415f-accae486a9c7 [Accessed 30 june 2019].

Van Kleef, E., Van Trijp, H., Paeps, F. & Fernández-Celemín, L. (2008) Consumer preferences for front-of-pack calories labelling. *Public Health Nutr*. 11, 203–213. Available from: doi: 10.1017/S1368980007000304.

Vandevijvere, S., Dominick, C., Devi, A. & Swinburn, B. (2015) The healthy food environment policy index: findings of an expert panel in New Zealand. *Bull World Health Organ. 93*,294–302. doi: http://dx.doi.org/10.2471/BLT.14.145540

Verrotti, A., Penta, L., Zenzeri, L., Agostinelli, S. & De Feo, P. (2014) Childhood obesity: prevention and strategies of intervention. A systematic review of school-based interventions in primary schools. *Journal of*

Endocrinological Investigation. 37(12), 1155–1164. Available from: doi: 10.1007/s40618-014-0153-y.

Viegas, C., Torgal, J., Graça, P. & Martins, M. (2015) Evaluation of salt content in school meals. *Rev. Nutr*. 28(2), 165-174.

Vilela, S., Oliveira, A., Ramos, E., Moreira, P., Barros, H. & Lopes, C. (2014) Association between energy-dense food consumption at 2 years of age and diet quality at 4 years of age. *Br J Nutr*. 111(7), 1275–82. Available from: doi:10.1017/S0007114513003620.

Vyth, E.L., Steenhuis, I.H., Roodenburg, A.J., Brug, J. & Seidell J.C. (2010) Front-of-pack nutrition label stimulates healthier product development: A quantitative analysis. *Int. J. Behav. Nutr. Phys. Act*. 7, 65. Available from: doi: 10.1186/1479-5868-7-65.

Ward health (2011) *Chronic diseases claim at least 75% of health care spending in most developed countries; pose a growing economic burden on low-and middle-income countries.* Available from: http://www.wardhealth.com/articles/chronic-diseases-claim-least-75-health-care-spending-most-developed-countries-pose-growing- [Accessed 15th october 2020].

Weatherall, D.J. (1995) *Science and the quiet art : the role of medical research in health care*. New York, W.W. Norton & Company.

World Health Organization (WHO) (2003) *Globalization, diets and noncommunicable diseases.* Geneva, WHO. Available from: https://apps.who.int/iris/bitstream/handle/10665/42609/9241590416.pdf;sequence=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2004) *Global Strategy on Diet, Physical Activity and Health.* Geneva, WHO. Available from: https://www.who.int/NCD/prevention/global-strategy-diet-physical-activity-2004-goals/en/ [Accessed 30 june 2019].

World Health Organization (WHO) (2006) *A tool for the development of school nutrition programmes in the European Region, Programme for Nutrition and Food Security.* Copenhagen, WHO Regional Office for Europe.

World Health Organization (WHO) (2007) *The challenge of obesity in the WHO European Region and the strategies for response*. Available from: https://www.euro.who.int/en/publications/abstracts/challenge-of-obesity-in-the-who-european-region-and-the-strategies-for-response-the [Accessed 30 june 2019].

World Health Organization (WHO) (2010) *Comissão para os Determinantes Sociais da Saúde. Redução das desigualdades no período de uma geração: igualdade na saúde através da acção sobre os seus determinantes sociais (Relatório Final).* Lisbon, World Health Organization. Available from: http://cmdss2011.org/site/wpcontent/uploads/2011/07/Redu%C3%A7%C3%A3o-dasDesigualdades-no-per%C3%ADodo.pdf [Accessed 30 june 2019].

World Health Organization (WHO) (2011a) *World Health Statistics 2011*. Available from: https://www.who.int/gho/publications/world_health_statistics/2011/en/ [Accessed 30 june 2019].

World Health Organization (WHO) (2011b) How can the sustainability of a public health (food fortification) program be ensured? . Available from: https://www.who.int/evidence/resources/country_reports/RRSPHprograms.pdf [Accessed 30 june 2019].

World Health Organization (WHO) (2012) *Guideline: Sodium intake for adults and children*. Available from: https://www.who.int/publications/i/item/9789241504836 [Accessed 30 june 2019].

World Health Organization (WHO) (2013a) *World Health Assembly Resolution WHA66.10. Follow-up to the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases*. Geneva, World Health Organization. Available from: http://apps.who.int/gb/ebwha/pdf_files/WHA66/A66_R10-en.pdf?ua=1[Accessed 30 june 2019].

World Health Organization (WHO) (2013b) *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva, World Health Organization. Available from: https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf;jsessionid=029C81DFE52CD78FFB821D8EF8BDBDD4?sequence=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2013c) Prevention and control of noncommunicable diseases in the European Region: A progress report. Available from: https://www.drugsandalcohol.ie/21003/1/Prevention-and-control-of-noncommunicable-diseases-in-the-European-Region-A-progress-report-Eng.pdf [Accessed 30 june 2019].

World Health Organization (WHO) (2013d) *Health in All Policies – Framework for Country Action*. Geneva, World Health Organization. Available from: https://www.who.int/healthpromotion/frameworkforcountryaction/en/. [Accessed 30 june 2019].

World Health Organization (WHO) (2013e) Map*ping salt reduction initiatives in the WHO European Region*. Available from: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/publications/2013/mapping-salt-reduction-initiatives-in-the-who-european-region [Accessed 30 june 2019].

World Health Organization (WHO) (2014a) *What you need to know about Health in All Policies. Geneva, World Health Organization*. Available from: http://www.who.int/social_determinants/publications/healthpolicies-manual/key-messages-en.pdf?ua=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2014b) *Global status report on noncommunicable diseases 2014*. Geneva, World Health Organization.

World Health Organization (WHO) (2015a) NCD progress monitor. Available from: https://apps.who.int/iris/bitstream/handle/10665/184688/9789241509459_eng.pdf?sequence=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2015b) *Guideline: sugars intake for adults and children.* Geneva, World Health Organization.

World Health Organization (WHO) (2015c). *Eliminating trans fats in Europe. A policy brief*. Copenhagen, World Health Organization Regional Office for Europe.

World Health Organization (WHO) (2016a) *Salt reduction*. Geneve, World Health Organization. Available from: https://www.who.int/news-room/fact-sheets/detail/salt-reduction [Accessed 30 june 2019].

World Health Organization (WHO) (2016b) *The shake technical package for salt reduction.* Geneva, World Health Organization. Available from: https://apps.who.int/iris/rest/bitstreams/1061141/retrieve [Accessed 30 june 2019].

World Health Organization (WHO) (2016c) *Report of the Commission on Ending Childhood Obesity*. Available from: https://www.who.int/end-childhood-obesity/publications/echo-plan-executive-summary/en/ [Accessed 30 july 2020].

World Health Organization (WHO) (2017a) *'Best buys' and other recommended interventions for the prevention and control of noncommunicable diseases.* Available from: apps.who.int/iris/bitstream/handle/10665/259232/WHO-NMH-NVI-17.9-eng.pdf?sequence=1 [Accessed 30 july 2020].

World Health Organization (WHO) (2017b) *Monitoring noncommunicable disease commitments in Europe. Theme in focus: progress monitor indicators*. Copenhagen, WHO Regional Office for Europe. Available from: http:// www.euro.who.int/en/health-topics/noncommunicablediseases/pages/who-european-office-for-the-preventionand-control-of-noncommunicable-diseases-ncd-office/ publications-and-tools/monitoring-noncommunicablediseases-commitments-in-europe.-theme-in-focus-progressmonitor-indicators-2017 [Accessed 9 january 2020].

World Health Organization (WHO) (2017c) *NCD progress monitor*. Available from: https://apps.who.int/iris/bitstream/handle/10665/258940/9789241513029-eng.pdf?sequence=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2017d) *Cardiovascular diseases (CVDs).* Geneva, World Health Organization. Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) [Accessed 30 june 2019].

World Health Organization (WHO) (2017e) *NCD Tackling NCD*. Geneva, World Health Organization; Available from: http://www.who.int/NCD/management/best-buys/en [Accessed 10 january 2020].

World Health Organization (WHO) (2018a) *Noncommunicable diseases.* Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases [Accessed 15th october 2020].

World Health Organization (WHO) (2018b) *Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000–2016.* Geneva, World Health Organization.

World Health Organization (WHO) (2018c) *Strengthening nutrition action: a resource guide for countries based on the policy recommendations of the Second International Conference on Nutrition (ICN2).* Available from: https://www.who.int/publications/i/item/9789241550253 [Accessed 30 june 2019].

World Health Organization (WHO) (2018d) *Physical activity*. Geneva, World Health Organization. Available from: https://www.who.int/news-room/fact-sheets/detail/physical-activity/

World Health Organization (WHO) (2018e) *World Health Assembly Resolution WHA71.1. Thirteenth General Programme of Work, 2019–2023*. Geneva, World Health Organization. Available from: http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_R1-en.pdf [Accessed 30 june 2019].

World Health Organization (WHO) (2018f) Thirte*enth General Programme of Work, 2019–2023.* Geneva, World Health Organization. Available from: http://www.who.int/about/what-wedo/gpw-thirteen-consultation/en/ [Accessed 30 june 2019].

World Health Organization (WHO) (2018g) *Noncommunicable diseases country profiles.* Available from: https://www.who.int/nmh/publications/ncd-profiles-2018/en/ [Accessed 5 may 2020].

World Health Organization (WHO) (2018h) *Better food and nutrition in Europe – a progress report.* Copenhagen, WHO Regional Office for Europe. Available from: http://www.euro.who.int/__data/assets/pdf_file/0005/355973/ENP_eng.pdf?ua=1 [Accessed 30 june 2019].

World Health Organization (WHO) (2020a) *Portugal brings down obesity by taxing sugary* drinks. Available from: https://www.euro.who.int/en/health-topics/noncommunicable-

diseases/obesity/news/news/2020/3/portugal-brings-down-obesity-by-taxing-sugary-drinks [Accessed 30 june 2020].

World Health Organization (WHO) (2020b). Improving dietary intake and achieving food product improvement. Available from: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/publications/2020/improving-dietary-intake-and-achieving-food-product-improvement-2020 [Accessed 30 november 2020].

World Health Organization (WHO) (2020c) *Implementation guide on health-related food and drink taxation*. Copenhagen, WHO Europe.

World Health Organization (WHO) (2020d) *Physical inactivity a leading cause of disease and disability, warns WHO*. Available from: https://www.who.int/mediacentre/news/releases/release23/en/

World Health Organization (WHO) (2020e) *Healthy diet.* Available from: https://www.who.int/news-room/fact-sheets/detail/healthy-diet.

World Health Organization (WHO) (2021) *Diet, nutrition and the prevention of chronic diseases. Report of the joint WHO/FAO expert consultation.* Available from: https://www.who.int/dietphysicalactivity/publications/trs916/intro/en/

WHO/FAO Expert Consultation (2003) *Technical Report Series no. 916.* Geneva, World Health Organization; Available from: https://apps.who.int/iris/bitstream/handle/10665/42665/WHO_TRS_916.pdf;jsessionid=EBC44FFF46A59BECE4352FE155FC349C?sequence=1 [Accessed 30 june 2019].

Wilson, N., Nghiem, N., Eyles, H., Mhurchu, C.N., Shields, E., Cobiac, L.J. et al. (2016) Modeling health gains and cost savings for ten dietary salt reduction targets. *Nutr J*. 15(1), 44. Available from: doi: 10.1186/s12937-016-0161-1.

Withrow, D. & Alter, D. (2011) The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obes Rev*. 12, 131-41. Available from: doi:10.1111/j.1467-789X.2009.00712.x.

Woodward-Lopez, G., Kao, J., Ritchie, L. (2011) To what extent have sweetened beverages contributed to the obesity epidemic? *Public Health Nutr*. 14(3), 499–509. Available from: doi:10.1017/S1368980010002375.

World Bank (2015) *Analytic classification*. Available from: http://databank.worldbank.org/data/download/site-content/OGHIST.xls [Accessed 30 june 2019].

World Bank (2018) *The world by region. SDG* Atlas 2018. Available from: http://datatopics.worldbank.org/sdgatlas/the-world-by-region.html [Accessed 30 june 2019].

World Bank (2020a) *The Human Capital Project*. Available from: http://www.worldbank.org/en/publication/human-capital [Accessed 30 june 2019].

World Bank (2020b) *Human Capital Index*. Available from: https://datacatalog.worldbank.org/dataset/human-capital-index [Accessed 30 june 2019].

Wright, A. (2017) *What's so important about healthpolicy implementation?.* Available from:

https://www.researchgate.net/publication/320101578_What's_so_important_about_health_policy_implementation [Accessed 30 june 2019].

Wyness, L.A., Butriss, J.L. & Stanner, S.A. (2012) Reducing the population's sodium intake: the UK Food Standards Agency's salt reduction programme. *Public Health Nutr*. 15(2), 254–61. Available from: doi:10.1017/ S1368980011000966.

Yeo, G. (2015) *On Bonsai, Banyan and the Tao*. Singapore: World Scientific Publishing.

Yoon, Y.S. & Oh, S.W. (2013) Sodium density and obesity; the Korea National Health and Nutrition Examination Survey 2007-2010. *Eur J Clin Nutr*. 67(2), 141–6. Available from: doi:10.1038/ejcn.2012.204.

Zhu, H., Pollock, N., Kotak, I., Gutin, B., Wang, X., Bhagatwala, J. et al. (2014) Dietary sodium, adiposity, and inflammation in healthy adolescents. *Pediatrics*. 133(3), e635–42. Available from: doi: 10.1542/peds.2013-1794

Zulman, D.M., Vijan, S., Omenn, G.S. & Hayward, RA. (2008) The relative merits of population-based and targeted prevention strategies. *Milbank Q*. 86(4), 557–80. Available from: doi:10.1111/j.1468-0009.2008. 00534.x.

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- Goiana-da-Silva, F., Cruz-e-Silva, D., Gregório, M., Nunes, A., Calhau, C., Hercberg, S., Rito, A., Bento, A., Cruz, D., Almeida, F., Darzi, A. and Araújo, F., 2019. Nutri-Score: A Public Health Tool to Improve Eating Habits in Portugal. **Acta Médica Portuguesa**, 32(3), p.175.

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