A Work Project, presented as part of the requirements for the Award of a Master's degree in Management from the Nova School of Business and Economics.

Assessing the Feasibility of a SIB to Target Overweight and Obese Children in Portugal –Analyzing the Social Challenge

Lea Sophie Blodau | 50480

Work project carried out under the supervision of:

Antonio Miguel

Abstract (100 words maximum)

This thesis focuses on addressing childhood obesity in Portugal, which has become a significant concern leading to increased costs. The aim is to assess the feasibility of a Social Impact Bond in tackling this social issue in Portugal. After thoroughly analyzing the issue, a SIB was developed through an Excel model. This study suggests that replicating a combination of MUN-SI and JOGG programs on the Azores for elementary school-aged children can be viable and likely to create social and financial value for all stakeholders involved.

Keywords: Impact Investment, SIBs, Childhood Obesity, Portugal

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

Table of Contents

1. Introduction 4

2. Methodology 5

3. Analyzing the Social Challenge 6

3.1. Causes of Childhood Obesity 6

3.1.1. Biological Factors 7

3.1.2. Environmental Factors 9

3.1.3. Behavioral Factors 12

3.2. Consequences of Childhood Obesity 14

3.2.1. Health Consequences 14

3.2.2. Psychosocial Consequences 16

3.3. Current Situation and Interventions of Childhood Obesity in Portugal 17

3.3.1. Data and Facts 17

3.3.2. Governmental Interventions and Policy 18

3.4. Cost Estimate for Childhood Obesity in Portugal 19

3.5. Measuring Childhood Obesity 21

3.6. Literature Review of Obesity Intervention Models 22

3.7. Target Group for an Intervention Model 22

4. Determining the Feasibility of a JOGG/MUN-SI SIB 24

4.1. Framework of a JOGG/MUN-SI SIB 25

4.2. SIB Feasibility Criteria 27

5. Modelling of SIB 30

5.1. Intervention Scope 30

5.2. Intervention Costs 33

5.3. Cost Savings 35

5.4. Outcome Metrics 36

5.5. Payment Mechanism 38

5.6. Public Sector Value 39

5.7. Investment Structure 40

6. SIB as a Business Case 42

6.1. Sensitivity Analysis 43

6.2. Scenario Analysis 45

7. Limitations 46

8. Conclusion 48

9. Appendix 51

Table of Figures

Figure 1: JOGG/MUN-SI Social Impact Bond Structure 25
Figure 2: Public Sector Value Structure 40

Table of Tables

Table 1: Summary of total intervention cost over the 4 years 34
Table 2: Sensitivity analysis of the payout rate 44
Table 3: Sensitivity analysis of the costs of the success rate 44
Table 4: Sensitivity analysis of the costs of intervention 45

1. Introduction

Since 2010, Social Impact Bonds (SIBs) have emerged as a novel financing mechanism, aiming to address public social issues, such as homelessness or unemployment, through innovative partnerships between public, private, non-profit, and voluntary sectors. As a departure from conventional funding models, SIBs are designed to align financial investments of private investors with public social outcomes. The basic premise of a SIB is to attract private investors who fund social interventions targeting specific social issues. The success of these interventions is measured based on predetermined outcomes, and if the desired outcomes are achieved, the government repays the investors' initial investment with a return on investment. In this way, SIBs are designed to shift the financial risk from the public sector to private investors, providing an incentive for innovative, evidence-based interventions that effectively address social challenges (OECD 2016; The Government Outcomes Lab. n.d.; Social Finance n.d.; GoodFinance n.d.).

Despite the growing interest in SIBs as a funding mechanism for social programs, there is a notable research gap regarding their feasibility in addressing childhood obesity, particularly in the context of Portugal. Childhood obesity is a pressing public health concern worldwide, posing significant risks to the physical and mental well-being of children and adolescent and significant healthcare costs for the government in Portugal. The prevalence of childhood obesity has been steadily increasing in recent years. Addressing this issue requires innovative approaches that involve various stakeholders and explore new funding mechanisms. However, existing literature primarily focuses on SIBs in various social policy domains, but few studies specifically examine their potential application to combat childhood obesity. Thus, this thesis aims to fill this gap by assessing the feasibility of implementing a SIB to target overweight and obese children in Portugal.

To address the central research question, c*hapter 3* will shed light on the social challenge of "childhood obesity" that the SIB aims to tackle, emphasizing its underlying causes, consequences, current situation, costs, and measurement methodologies employed. Building upon the insights garnered, the subsequent chapters *4 to 8* will meticulously expound upon a potential SIB tailored to address childhood obesity in Portugal. *Chapter 4* will ascertain the feasibility of this SIB by examining its prospective framework and subjecting it to feasibility criteria. In *chapter 5,* the SIB will be modeled by elaborating on its intervention scope, intervention costs, outcome metrics, payment mechanism, public sector value, and investment structure. Continuing the analysis, *chapter 6* will assess the potential SIB as a business case, utilizing sensitivity analysis to evaluate its payout rate, success rate, cost of intervention, and scenario analysis. Finally, *chapter 7* will elaborate on the limitations inherent in this thesis, thereby presenting potential avenues for further research and exploration. Finally, this thesis will conclude with a conclusion of its findings in *chapter 8.*

By assessing the feasibility of implementing a SIB to address childhood obesity in Portugal, this research contributes significantly to the scholarly discourse on innovative financing models for public health by filling a critical gap in knowledge. The research work lays an essential foundation for exploring the theoretical application of SIBs in the context of childhood obesity and overweight problems in Portugal that was never addressed before. Although the thesis examines the feasibility of implementing a SIB in theory, the thesis's findings pave the way for pilot projects that could test the implementation of such a SIB in a real-world scenario. Therefore, this thesis can guide future research toward assessing the practical feasibility and effectiveness of SIBs in addressing childhood obesity in Portugal.

2. Methodology

This thesis employs a mixed research approach, combining quantitative data analysis and qualitative research methods. The methodology involves a literature review in *chapter 2*, where

childhood obesity as a social challenge is examined. This chapter relies on an extensive review of academic papers, reports, and case studies. The information derived from the literature review forms the basis for the subsequent *chapters 4 to 8.* These chapters utilize a combination of information from the literature review and the construction of a business case and financial model in Excel. These chapters assess the feasibility of the potential SIB, model its intervention scope, costs, outcome metrics, payment mechanism, public sector value, investment structure, and business case. Data used derived from various sources, besides others, information about the two programs JOGG/MUN-SI, discussions with professionals, and assumptions. The methodology regarding the development of a SIB follows the guidelines proposed by Social Finance UK (2013).

3. Analyzing the Social Challenge

The following chapter delves into the social challenge of childhood overweight and obesity in Portugal, starting with an in-depth analysis of the underlying causes and consequences. In chapter 3.3 of the thesis, the current situation in Portugal is analyzed, followed by an assessment of the associated costs. The next part provides a brief introduction to the measurements of childhood obesity and a literature review of types of intervention models. The insights gained serve as a basis for identifying a potential target group for an intervention model in Portugal.

3.1. Causes of Childhood Obesity

Obesity is a growing problem worldwide and understanding its causes can help to develop effective preventive strategies. This chapter aims to provide an overview and an analysis of these causes. In general, research has identified several factors that influence a child and classified them into three main groups: (i) biological, (ii) environmental and (iii) behavioral. In the following, these groups will be examined.

3.1.1. Biological Factors

Prior research has shown that demography and genetics significantly correlate with childhood obesity. These studies' results are summarized and evaluated in the subchapters below.

3.1.1.1. Demography

Demographic factors, comprising age and gender, have been identified as the main root causes of childhood obesity. Prior research on the correlation between age and childhood obesity identified that the older the children, the higher the risk of being overweight and obese. This can be attributed to changes in physical activity levels, diet and hormones during puberty (Bingham et al. 2013). More specifically, Simmonds et al. (2016) found that the risk of being obese in adulthood is five times higher for children who are obese than for those who are not.

Regarding gender, there are different studies that have identified contrary results during several experiments on which gender is most affected by childhood obesity. Although both genders are, to a certain extent, affected by obesity, Shah et al. (2020) have found that certain factors like prevalence, risk factors, and consequences of obesity exhibit some significant differences for boys versus girls.

Based on data analysis from the World Obesity Federation, Shah et al. (2020) hypothesized that boys have a higher likelihood of developing obesity compared to girls. A similar relationship has been identified in prior research. In particular, the data highlights the higher prevalence of obesity among boys (aged 5 to 19) living in middle- and higher-income countries. The researchers provide several arguments to support their hypothesis. First, sex differences related to different body compositions and biological processes in the first years, such as fetal growth measures, fat mass, metabolism, and hormone concentrations (e.g., leptin) affect obesity differently so that boys have a developmental disadvantage (Shah et al., 2020). Genetic predispositions also contribute to the sex-specific risks of obesity. Second, regarding social-cultural differences (gender), stereotypes influence the eating pattern of girls, reflecting social

norms that often promote a slimming ideal in the female gender (can be less sharp in some social classes). Furthermore, parents typically express concern about their daughters' weight status more than their sons', as the latter are often encouraged to eat more (Shah et al. 2020).
However, counter-arguments state that girls are more prone to obesity compared to boys due to differences in activity levels. Sallis, Prochaska, and Taylor (2000) examined this relationship and showed that girls are less active, i.e., engage in fewer sports activities. In contrast, boys are more likely to participate in physical activities that promote energy expenditure (Sallis, Prochaska, and Taylor 2000).
In sum, the available studies present conflicting perspectives regarding which gender is more affected by childhood obesity. This is attributed to the significant influence of the social environment, such as ethnicity, family, and societal norms.

3.1.1.2. Genetics

Studies have attempted to point out the relationship between genetics and childhood obesity in experiments about twins, families as well as adoption. The results suggest that BMI heritability ranges approximately from 47 % to 67 % (Elks et al. 2012; Maes, Neale, and Eaves 1997). The genes responsible for obesity affect metabolisms, like energy expenditure and appetite regulation. For example, mutations of the satiety hormone leptin (LEP)/the leptin receptor (LEPR) can lead to a constant feeling of hunger and overeating. Furthermore, mutations in the melanocortin-4 gene (MC4R), responsible for metabolism and energy balance regulation, were also detected in approximately 5.8 % of individuals with severe obesity. Thus, MC4R deficiency represents one of the most known monogenic obesity disorders (Farooqi et al. 2003). Furthermore, Frayling et al. (2007) added that the fat mass and obesity-associated gene (FTO) controls whether we store or burn fat and contributes to metabolic diseases like metabolic syndrome. In addition, this mutation is a risk factor for Type 2 diabetes (see chapter 3.2.1.).

Nevertheless, according to a study of childhood obesity, gene defects were found to account for less than 5 % of all cases, indicating that genes themselves are rarely solely responsible for obesity. This is because environmental and behavioral factors influence our genes, and the cause of childhood obesity rather results from a complex interaction between these factors (Sahoo et al. 2015).

3.1.2. Environmental Factors

The following subchapter examines the environmental factors of (i) ethnicity, (ii) family, (iii) school and community, (iv) advertising and (v) pandemic.

3.1.2.1. Ethnicity

There are significant differences in the prevalence of overweight and obesity between ethnic groups worldwide. Ethnicity is a socioeconomic construct that categorizes groups of people based on shared characteristics, including cultural, social, and historical factors (Caprio et al. 2008).

The association between ethnicity and childhood obesity has been examined in several research studies: A study carried out in the United States found that the prevalence of obesity was higher among African, Mexican and Native Americans than among white children (Caprio et al. 2008). This hypothesis is supported by a 2018 study by Isong et al. (2018) that stated that Asian children have the lowest BMI z-score on average compared to Native American children, who have the highest. Compared to the US, findings of a gender-specific study were conducted in the United Kingdom. Boys of Indian and Pakistani origin were most affected by obesity (age 2 to 20). In comparison, Afro-Caribbean and Pakistani girls have the highest prevalence of obesity. In both cases, Chinese children have one of the lowest prevalence rates of overweight/ obesity (Saxena et al. 2004).

Researchers enumerate different arguments for this correlation, which can be differentiated into biological, cultural and socioeconomic factors (Caprio et al. 2008). The biological factor

of infant weight gain based on the 9-month rate was the most robust predictor of children's BMI z-scores and showed significant variation based on race and ethnicity. Socioeconomic factors on an individual level, such as household economic resources and time for cooking, and a contextual level, e.g., the neighborhood of residence, also explain disparities, especially between the minor ethnical group of Hispanic children and white children (Caprio et al. 2008; Isong et al. 2018).

However, regarding the counterpart that there is no significant correlation, Vanessa Higgins and Angela Dale run a combined regression with additional variables for parental influence (e.g., mothers' and fathers' BMI). As a result, no statistically significant ethnic differences were found in the likelihood of being overweight/obese (Higgins and Dale 2010).

In sum, childhood obesity rates vary among ethnic groups depending on the country, influenced by biological, cultural, and socioeconomic factors.

3.1.2.2. Family

Families provide children's first socialization environment. Consequently, they have a key role in developing a healthy lifestyle. Huffman, Kanikireddy, and Patel (2010) conducted a study which indicates that children from *single-parent households* show a higher prevalence of overweight compared to children living in intact families; black children are particularly affected (Moens et al. 2009). Furthermore, significant differences between *single children* and *twins/siblings* in BMI-SDS could be found in the study of Bohn et al. (2022), with single children more likely to be at higher risk of being overweight in later childhood (ages 7 to 18). This correlation can be attributed to postnatal risk factors such as breastfeeding duration and level of physical activity. But not only the intra-family structure but also the *BMI of the parents* influence the obesity of children. A study by Janssen et al. (2004) found that the BMI of the parents is positively associated with the children’s BMI. This assumes that parents model

eating behavior and physical activity to their children. However, it is unclear whether a child's weight is more influenced by their father or mother.

In addition, a correlation between *the socioeconomic status (SES)* of the family and childhood obesity can be observed with changed geographic patterns over the years. In particular, Vazquez and Cubbin (2020) identified a negative relation between SES and obesity in children in high-income countries in their literature review. Research suggests that inadequate availability of fresh fruits and vegetables and abundant fast-food restaurants in low SES neighborhoods lead to poor childhood nutrition. Additionally, the lack of safe play space for children and parents' long working hours, which prevent them from caring for their children, can also be contributing factors. However, since there is no standard definition of SES, the studies sometimes yield different results (Vazquez and Cubbin 2020).

In summary, family factors significantly impact childhood obesity, shaping the early years of a child's life in many ways, both consciously and unconsciously.

3.1.2.3. School and Community

Besides the family, the school, and the community, in general, greatly influence children. Children spend a large part of their day in educational institutions, which can affect their behavior and lifestyle, especially their food knowledge, consumption (availability and accessibility) and physical activity (Harrison and Jones 2012). Several school policies and practices to reduce unhealthy food intake already exists. In addition, neighborhood poverty, associated with fewer physical activity opportunities, lack of functioning sidewalks and high crime rates, impacts children's weight (Suglia et al. 2016).

3.1.2.4. Advertising

Regarding cultural factors, advertising and product placements in entertainment content can influence childhood obesity by manipulating children's food preferences, patterns, and overall dietary habits. This is an increasingly important factor today as children's media consumption

increases. Especially since 89.4 % to 97.8 % of food advertising for children and young adults consists of unhealthy food products high in fat, sugar, or sodium, children are influenced subconsciously (Powell et al. 2007). A study found that banning food advertising can reduce obesity among U.S. children by 2.5 to 6.5 percentage points (Veerman et al. 2009).

3.1.2.5. Pandemic

The COVID-19 pandemic had significantly impacted children's lifestyles and habits, potentially exacerbating the already concerning issue of childhood obesity. The accompanying lockdowns, school closures, and reduction of social contacts have further contributed to this problem. As a result, children spend more time indoors due to remote schooling, social distancing measures, and closures of leisure facilities, leading to decreased physical activity levels and increased sedentary behavior (Tsenoli, Moverley Smith, and Khan 2021). Furthermore, the psychological impact of COVID-19, including isolation, family breakdowns, and loneliness, can also influence children's eating habits in a bad way. In addition, the relationship is bidirectional, with obese children at a higher risk of experiencing serious COVID-19 symptoms (Tsenoli, Moverley Smith, and Khan 2021).

3.1.3. Behavioral Factors

In the following, (i) lifestyle and (ii) psychological factors contributing to childhood obesity will be discussed.

3.1.3.1. Lifestyle

Changes in *eating patterns*, including increased portion sizes worldwide for out-of-home and at-home eating (Livingstone and Pourshahidi 2014), consumption of Western-style[1] diet (Mu et al. 2017) and sugary beverages (Sahoo et al. 2015), negatively impact children’s weight. Nevertheless, studies do not found a linkage between snacks and obesity (Sahoo et al. 2015).

---

[1] Among others, high intakes of sweets, red meat, high-sugar, and pre-packaged foods

The level of *physical activity* is known to influence the development of childhood obesity significantly. Sedentary behaviors among children have become increasingly prevalent as outdoor play has declined in favour of the digital entertainment (Sahoo et al. 2015). As mentioned, insufficient safe play areas, less adult supervision, and televisions in the bedroom have contributed to this decline. Consequently, a vicious cycle ensues whereby affected children gain weight, and develop reduced physical capacity and shortness of breath, ultimately affecting their ability to engage in energy-intensive activities (Niehoff 2009).

Research suggests a significant correlation between *sleep* and childhood obesity, especially for boys. The risk of obesity decreases by approximately 9 % for each additional hour of sleep. Inadequate sleep can alter the hormones that regulate appetite, leading to overeating and unhealthy food choices (Chen, Beydoun, and Wang 2008). Moreover, sleep-deprived children are less inclined to participate in physical activities (Hirshkowitz et al. 2015).

3.1.3.2. Psychology

Studies on psychological distress and obesity found a positive association. Referring to a systematic study by Kanellopoulou et al. (2022), an association between depression and obesity exists, but unclear in which direction. The tendency of the studies examined is that obesity triggers depression and is, therefore the cause of obesity. However, some studies challenge this assumption and argue that depression may be a consequence of obesity. Therefore, it is hypothesized that there is a bidirectional relationship between childhood obesity and psychological suffering. However, more investigation is required to comprehend the relationship entirely (Kanellopoulou et al. 2022).

In conclusion, prior research has identified several important root causes of childhood obesity categorized into three subgroups: (i) biological, (ii) environmental and (iii) behavioral factors. Most importantly, age, family, media (ads), school, pandemic, lifestyle and psychology have been identified as major factors influencing children's weight. However, measuring the

influence and correlation of individual factors is challenging. The causes of childhood obesity are complex and can be attributed to several factors and their interaction. These can vary from one person to another and between populations. The ecological model also captures this complex correlation (see Appendix 1). Children's behavior must be viewed within the context of the individual, interpersonal, and community level (Davison and Birch 2001).

3.2. Consequences of Childhood Obesity

Childhood obesity seriously threatens the body, psyche, and economy in the short- and long-term. Referring to Lee (2009), the consequences can be categorized into two parts: (i) health conditions and (ii) psychosocial factors. In addition, to these personal factors, obesity has economic consequences for the health system, analyzed in chapter 3.4.

3.2.1. Health Consequences

Obesity is a complex disease, but also a risk factor for other health conditions. These can be divided into (i) metabolic and (ii) mechanical consequences.

3.2.1.1. Metabolic Consequences

Starting with metabolic consequences, one possible risk that individuals may face is the development of *insulin resistance*, which leads to chronically elevated glucose concentrations in the blood. In obese children, this condition is highly predictive of the onset of *type 2 diabetes*, as discussed in Lee's research in 2009. Further analysis has highlighted this association (Chatterjee, Khunti, and Davies 2017).

In addition, *cardiovascular risks* are also related to childhood obesity, for example, hypertension. Being overweight and obese increases resistance in the blood vessels, so the heart must pump against higher resistance and, accordingly, do more work. This extra workload on the heart causes higher blood pressure. The risk is three times higher for obese children than normal-weight ones to develop this medical condition (Sorof and Daniels 2002).

Other possible consequences are *gallstones* (cholelithiasis) and *non-alcoholic fatty liver* (NAFLD). Gallstones are crystals in the gallbladder or bile ducts. Cholesterol levels increase at higher body fat levels, contributing to gallstone development (Lee 2009). NAFLD is one of the most common liver diseases worldwide and includes conditions ranging from non-alcoholic steatohepatitis (NASH) to fatty liver cirrhosis (Schattenberg 2015). This disease is significantly correlated with the severity of childhood obesity (Kelly et al. 2013).

Respiratory diseases such as asthma can also be a consequence of childhood obesity. The likelihood of developing asthma, especially its severe form, is significantly higher among overweight and obese children (Black et al. 2013).

In addition, the increased *risk of cancer* in adulthood has also been identified as a long-term consequence of childhood obesity, which differs between subgroups (Mohammadian Khonsari et al. 2023). Obesity is a cause of at least 13 different types of cancer (WHO 2022).

It is important to mention that obesity is not the only factor leading to these diseases, but at least increases their incidence. Other examples of diseases are menstrual abnormalities, skin problems, and neurological consequences.

3.2.1.2. Mechanical Consequences

Childhood obesity has detrimental effects on children's health, including long-lasting mechanical health consequences that can persist into adulthood. One consequence can be *obstructive sleep apnea* (OSA). It is a condition by which breathing stops and restarts while asleep due to upper airway collapse. Kelly et al. (2013) determined a positive correlation between severe obesity in children and OSA, with the severity of the condition being more pronounced with higher levels of obesity than in normal-weight children. In addition, complications related to the lower extremity include *knee deformity* and, in extreme cases, the need for an artificial knee joint. This can contribute to reduced mobility and exacerbate the underlying condition by creating a vicious cycle that leads to weight gain (Lee 2009).

3.2.2. Psychosocial Consequences

Obesity is among the most unaccepted and stigmatizing childhood illnesses worldwide (Schwimmer 2003).

One consequence of childhood obesity is *bullying* at school. Bullying is defined as every form of negative action by one or more persons that occurs repeatedly. Janssen et al. (2004) identified that overweight and obese children have a higher likelihood of being victims or perpetrators of bullying compared to their normal-weight peers. More precisely, the association between victimization and obesity was identified in all age groups studied (11 to 16 years). Overweight and obese children are more likely to experience verbal, physical, and relational bullying than their normal-weight peers. While according to Janssen et al. (2004) the association with bullying perpetration was limited to the older cohort in both genders (ages 15 to 16).

In connection with bullying is also the *self-esteem* of the children. Self-esteem is defined as the subjective judgement about one own value, which can be negative or positive. In a meta-analysis, Tsaousis (2016) examined that bullying victims exhibit lower levels of self-esteem, while on the contrary, the link between bullying perpetration and self-esteem is relatively weak. Thus, childhood obesity can lead to negative social experiences for children, such as peer bullying, discrimination, and social exclusion. These experiences can harm a child's self-esteem and academic performance, and, thus, in all likelihood, on their career development (Schwimmer 2003). Furthermore, the long-term mental health consequences of such experiences may increase the risk of anxiety and depression during adulthood (De Sousa et al. 2012).

Consequently, childhood obesity has short- and long-term effects that can persist and worsen into adulthood, including metabolic, mechanical, and psychosocial risks. These consequences can limit all areas of a child's life and even increase the risk of early death, as 25 % of adults

who suffered from childhood obesity were found to have obesity-related causes of death (Lindberg et al. 2020).

3.3. Current Situation and Interventions of Childhood Obesity in Portugal

This chapter gives an overview of the current situation and policies implemented in Portugal.

3.3.1. Data and Facts

The prevalence of childhood obesity has increased worldwide, and Portugal is no exception to this trend. As for the European region, Portugal has the fifth highest prevalence of childhood obesity. According to statistics from the WHO, around 9.7 % of children between 0 to 19 years in Portugal are obese and 16.81 % are overweight (WHO 2022). Notably, the CHO Risk score (tool to measure the risk of having/developing a significant problem with childhood obesity) is 7.5 out of 11 points, and the chance to meet the 2025 target to stop the increase in childhood obesity prevalence is only 26 % (World Obesity Federation 2020). Thus, these statistics show that Portugal has a major health issue.

Some causes mentioned in chapter 3.1. also apply to the Portuguese population. The National child nutrition surveillance system (COSI) conducts a survey every three years to analyze the characteristics of primary school children aged 6 to 10 years with respect to the causes of childhood obesity (Rito et al. 2021). The survey results revealed trends suggesting that certain socio-demographic and behavioral factors may influence childhood obesity in Portugal, a link that has been analyzed by Bingham et al. (2013). First, girls are more likely to be overweight/obese than boys (aged 3 to 7). Besides others, age, no breastfeeding, parental obesity, and low educational level (SES) are significant risk factors. In addition, sedentary factors like playing electronic games on phones or laptops and watching TV (while eating) also influence children’s weight (Bingham et al. 2013).

Nevertheless, it should be mentioned that the factors mentioned are limited to children and do not include adolescents. Furthermore, not all factors discussed in chapter 3.1. have been thoroughly studied in children in Portugal, so there is still a need for further research.

3.3.2. Governmental Interventions and Policy

The increasing prevalence of childhood obesity in Portugal has led the government to adopt several policies and preventive measures, especially between 2008 and 2020, strengthened by the existing international guidelines (Graça, Gregório, and Freitas 2020) (see Appendix 2). Starting in 2008, the Directorate-General of Health established a national "Platform against Obesity" to address the goals set out in the European Charter on counteracting obesity. It focuses mainly on primary prevention interventions. In addition, four years later, the Ministry of Health introduced the first national food and nutrition strategy, the so-called "Program for the Promotion of Healthy Eating" (PNPAS). The goal is to improve the Portuguese population's nutritional status by educating them about healthy eating, increasing access to healthy foods, and promoting physical activity. In 2017, several ministries collaborated to create an integrated strategy for the promotion of healthy eating (EIPAS) based on proposals of the WHO and European Commission as well as Portuguese data regarding dietary intake. It consists of around 52 actions that PNPAS coordinates (Graça et al. 2018). Besides others, they established the soft drink tax, a law limiting food marketing to children (TV advertising) and improvements in food standards, access to healthy meals in several public settings (e.g., in academic and health care institutions) and reformulation of food products, like reduction of salt, and sugar. Moreover, local community-based interventions have been developed to support healthy eating and physical activity, and a Childhood Obesity Surveillance Initiative (COSI) was introduced to measure obesity every three years (Graça, Gregório, and Freitas 2020).

Overall, the Portuguese Government has established several policies and restrictions to reduce or even stop the increasing trend of childhood obesity (see Appendix 2). Especially the

regulatory approaches show more impact than self-regulation initiatives, as they are legally binding and carry consequences for non-compliance (Graça, Gregório, and Freitas 2020). Overall, the percentage of childhood overweight and obesity in Portugal has decreased slightly (Rodrigues et al. 2021), which can be attributed to the implemented policies. For example, regarding the elementary school age (age 6 to 8) overweight was reduced by 8.3 % (37.9 % to 29.6 %) from 2008 to 2019 and obesity by 3.3 % (15.3 % to 12 %) (Rito et al. 2021). Nevertheless, the percentage is still high, and more must be done to address the problem and ensure health.

3.4. Cost Estimate for Childhood Obesity in Portugal

Childhood obesity not only has personal consequences but is also an economic burden. Two types of costs are associated with the treatment: (i) direct and (ii) indirect costs (see Appendix 4). Direct costs (i) include medical costs to treat various health conditions as a consequence of obesity, like hospitalization and drug therapy, and non-medical costs, for example, transportation and home modifications. Indirect costs (ii) are associated with the loss of productivity, divided into mortality and morbidity costs. Mortality costs include premature death. Studies have shown that having a higher BMI increases the risk of death (Lehnert et al. 2013). Regarding morbidity costs, these consist of presenteeism, absenteeism and disability. While this is irrelevant in younger years, it will be when growing up and starting with work. Presenteeism is the reduction in productivity while working. Being overweight or obese is positively related to the inability to work at full capacity (Lehnert et al. 2013). But also, the academic performance at school suffers from this disease which can have enormous consequences for the professional future (Schwimmer 2003). Absenteeism is the absence from work because of being ill. Costs arise due to low productivity and increased sick leave payments. Furthermore, disability can lead to a temporary or prolonged absence from the labor

market due to physical or mental incapacity. In Europe, these disability payments are paid by the government/insurance (Trogdon et al. 2008).

The world obesity federation estimated that direct cost account for 32 %, with only 1 % in non-medical costs. Indirect costs account for around 68 % of overall costs, with around 69 % in premature mortality. There is no differentiated consideration between adults and children (Okunogbe et al. 2022). Direct costs such as drug therapy are relevant for children and adults. Therefore, these costs can also be assumed for childhood obesity but will be somewhat lower regarding the total amount, as diseases only worsen with age. Indirect costs resulting from lost productivity do not significantly apply to children as they primarily affect the working adolescent segment, representing only a minor fraction of the overall child population. Although more than half of the costs are associated with premature mortality, only an insignificant proportion is likely to occur at younger ages. Consequently, direct costs are the primary economic consideration. However, the consequences of obesity in children often persist into adulthood, so it can be assumed that the long-term economic burden is similar in both age groups (Lee 2009).

Regarding Portugal, the overall cost of obesity is estimated at 3 bn EUR per year, with 1.2 bn direct costs accounting for approx. 0.6 % of GDP and 6 % of health expenditure (Expatica 2021b) Assuming that children represent about 2.5 % of these total costs, the estimated cost attributable to overweight and obese children accounts for approx. 0.6 % of GDP and 6 % of health expenditure (Expatica 2021a). Out of this amount, obese children account for 60 %, while overweight children account for 40 % of these costs, according to the assumptions made in the model. As mentioned, research by the WHO has shown that around 26.51 % (9.7 % obese and 16,81% overweight) of children in Portugal are overweight or obese, which equates to approx. 0.5 m children. Thus, on average, the cost per obese child is approx. 248 EUR and per overweight child is 96 EUR per year. However, it should be noted that the actual cost per

person may vary depending on, e.g. health status and increases sharply with age (see Excel file "1.4. Cost Savings").

Based on Simmonds et al. (2016) assumption that 80 % of children with obesity are likely to persist obese in adulthood and 20 % of non-obese children are at risk of becoming obese, it is projected that 425,967 children will impose an estimated economic burden of 637 m EUR in adulthood. However, these costs could be mitigated by implementing early intervention measures and reducing the government's economic burden (see Excel file "1.11. Future cost burden").

3.5. Measuring Childhood Obesity

Accurately measuring childhood obesity is especially important as it allows timely interventions to prevent the mentioned long-term health and psychosocial consequences. However, the measurement of obesity is complex and can be done by various methods. In numerous studies referenced in this research, BMI is used to measure total body fat mass and, thus, the prevalence of obesity. Moreover, the World Health Organization uses BMI as an official index to define overweight and obesity. It is measured by the quotient of the person's weight in kilograms divided by the square of their height in meters (kg/m^2). For children, the BMI depends on age and gender since girls and boys differ in their body fat percentage (World Health Organization 2021). BMI is an easy and inexpensive indicator for measuring body fat worldwide. Nevertheless, it does not consider body fat distribution, which can lead to misinterpretation (Chung 2019). Therefore, other field methods are used as additional or alternative measuring methods to overcome these disadvantages, such as waist circumference or skinfold thickness. To sum, each method has strengths and limitations, making determining which is best challenging. The mentioned measures correlate with body fat percentage and can be considered indices of childhood obesity (primary outcome). A comprehensive approach

beyond medical measures, such as behavioral and educational metrics (intermediary outcomes), would provide a more holistic view.

3.6. Literature Review of Obesity Intervention Models

To address the issue of childhood obesity, interventions have been developed that can be classified into three parts based on the targeted audience size (see Appendix 3). Firstly, primary prevention, also known as universal or general prevention, focuses on reducing the prevalence of childhood obesity in the entire population. The secondary (selective) prevention approach targets a potential risk group for genetic, biological, and other reasons. Third, tertiary (targeted) prevention targets children and adolescents who are overweight and at increased risk for health problems or who are already classified as obese (Weihrauch-Blüher et al. 2018).

Two models can be differentiated within this scope, as seen in the ecological model (see Appendix 1). The behavior-oriented intervention (individual-based) addresses individual behavior and habits. In contrast, the community-/environment-based intervention (context-related) focuses on the surrounding of the child, like family, school (teachers) and community, to create a supportive environment at different levels (Weihrauch-Blüher et al. 2018). It is worth noting that a combination of both intervention models, known as a multi-component approach, is also feasible. This would combine educational, environmental, and behavioral activities, enabling a comprehensive intervention strategy addressing all aspects of a child's life.

3.7. Target Group for an Intervention Model

As various individual factors cause childhood obesity, there's no one-size-fits-all intervention model. However, considering the causes can help define a target group. The ecological model, which includes individual, interpersonal, community, and policy factors, can be useful in approaching this issue (as discussed in the previous subchapters).

Starting with children, most intervention models divide this potential target group into three age classes. Firstly, pre-schoolers from 0 to 5. Secondly, elementary school children aged 6 to 12 and, thirdly, adolescents aged 13 to 18/19. Research considers elementary school children as the main target group, as prevention programs implemented at younger ages positively affect BMI (Weihrauch-Blüher et al. 2018). This is mainly because the age of 5 to 7 is when children experience rapid weight gain, the so-called second adiposity rebound (Rito et al. 2021). Implementing intervention models at that critical phase can positively impact the children's weight. In general, younger ages offer more potential settings for intervention models like school, sports clubs, and kindergarten. In addition, it is more difficult to reduce obesity in adolescents and adults once it is established. Therefore, prevention models starting at early ages are important (Dehghan, Akhtar-Danesh, and Merchant 2005).

Another possible target group can be the family, especially the parents. As mentioned in chapter 3.1.2.2., the parents contribute to genetic factors and behavior that influence the child (Huiberts et al. 2022). Cultural and socioeconomic aspects, such as the duration of breastfeeding, the family structure, the parents' BMI and eating patterns, as well as their physical activity, can have an impact (see chapter 3.1.).

The school and educators can also be a possible target group due to their long-term and in-depth relation to the child. In addition, the change in family dynamics, such as long working hours for both parents, makes it difficult to significantly impact children's health behavior. As a result, school is getting an important setting for developing a child's habits (Puga et al. 2020).

Regarding the community (local level), sports teams or grocery stores can support by promoting a healthy lifestyle and providing resources and programs at a municipal level. As mentioned, this can include improving access to physical activity facilities such as playgrounds and environmental safety (see chapter 3.1.2.3).

As a complement to the ecological model, policymakers (national level) are also an important target group to consider. As the actions in Portugal have shown (see chapter 3.3.2.), the development of policies and bans on unhealthy foods or their ingredients as well as programs for a healthy life can be effective. They can thus address a broader mass of the population.

One effective way to approach this is to define children as the main target group and establish intermediary target groups, including parents, teachers, educators, and policymakers, who can provide support, resources, and guidance to the target group, which can help to reinforce healthy behaviors and make the intervention more effective.

Besides the environment, other possible options to divide the target group refer to the causes of childhood obesity, like ethnicity, SES, or gender. Nevertheless, most existing intervention models focus on the general approach. The reasons may be to avoid stigmatization and exclusion, which may exacerbate existing inequalities. Instead, interventions should tackle the root of poverty and inequality, such as limited access to healthy food options, safe physical activity spaces, and less diet knowledge (environmental factors). In addition, a general approach can spread a new culture. Furthermore, Portugal has a mostly homogenous population, so differentiation by ethnicity may be ineffective. Therefore, this research will focus on the mentioned target groups and not go into detail about other characteristics.

In conclusion, an effective approach for an intervention program in Portugal could be to target elementary school children aged 5 to 12 (primary prevention), involving multiple stakeholders (intermediary target group) without segregating them according to other risk factors.

4. Determining the Feasibility of a JOGG/MUN-SI SIB

The MUN-SI and JOGG intervention programs demonstrated the most significant outcomes in addressing childhood obesity, thus, making it interesting to assess whether a SIB constitutes a suitable financing method to enable a combination of MUN-SI and JOGG- program interventions to address childhood overweight and obesity in Portugal. In line with the research

question, this chapter will focus on determining the feasibility criteria of a SIB in Portugal to tackle childhood overweight and obesity in Portugal. The framework of the potential JOGG/MUN-SI SIB, inspired by the JOGG/MUN-SI program, is outlined in the first step. In the next step, the feasibility of the SIB is assessed based on three main criteria.

4.1. Framework of a JOGG/MUN-SI SIB

Based on the SIB framework outlined in chapter 3.1.2. and inspired by successful childhood obesity prevention programs JOGG and MUN-SI, the potential JOGG/MUN-SI SIB framework presents an innovative approach to addressing childhood obesity in Portugal and would involve multiple key stakeholders (see Figure 4).

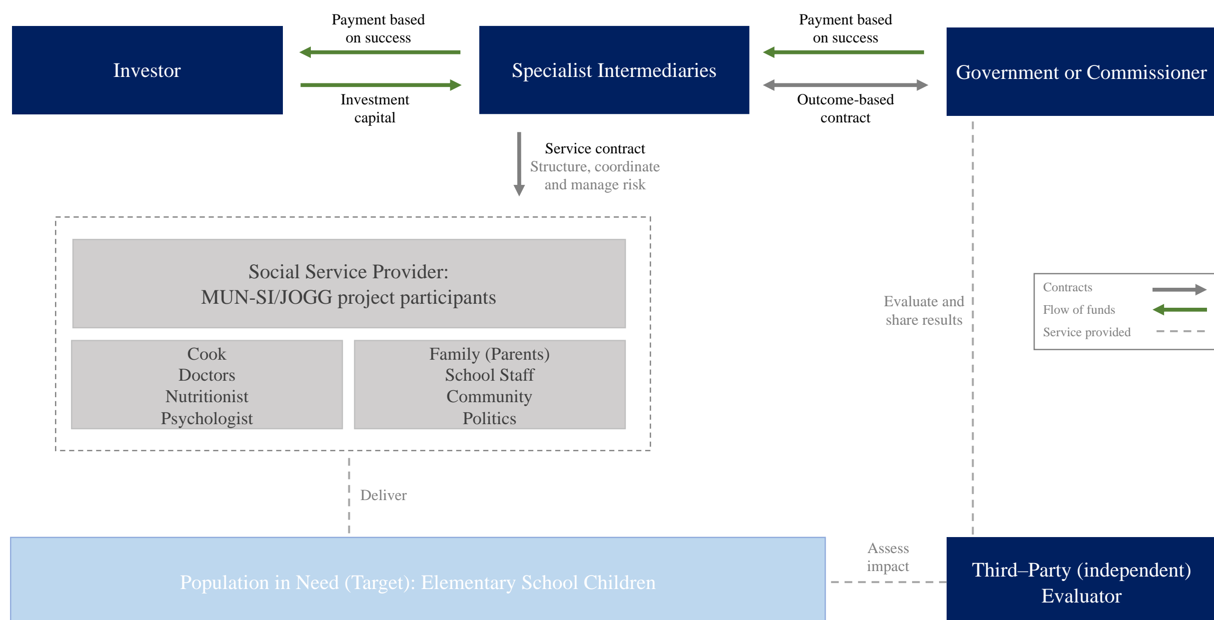


Figure 1: JOGG/MUN-SI Social Impact Bond Structure

Investors in SIBs, designed to tackle childhood obesity, can include impact investors motivated by both financial returns and the measurable impact on the health outcomes of children. Moreover, private individuals interested in promoting healthy lifestyles and preventing chronic diseases may also provide upfront capital. Non-profit organizations focused on improving health outcomes or private sector companies driven by their corporate social responsibility, and

the desire to improve their public image are also potential sources of investment (see Figure 4).

Commissioners may be a government agency or a consortium of government agencies responsible for addressing health-related issues in Portugal. The National Health Service (Serviço Nacional de Saúde) in Portugal is a potential candidate for serving as the commissioner for a SIB aimed at reducing childhood obesity rates. Other government agencies such as the Ministry of Health, Ministry of Education, and the Portuguese Directorate-General for Health (Direção-Geral da Saúde) may also play a supportive role in a SIB tackling childhood obesity. In addition to government agencies, local municipalities or districts, health agencies, and other community organizations may also be considered potential commissioners, depending on the specific design and implementation of the SIB (see Figure 4).

Service Providers may include organizations with experience and expertise in delivering effective interventions to address the problem. Educational providers, such as schools and their staff, are vital in offering nutrition education programs, healthy food options, and physical activity. Healthcare providers such as psychologists, nutritionists, cooks, and doctors offer interventions such as counseling, medical assessments, and treatment plans. Private service providers such as community members and family members promote healthy eating and activity habits (see Figure 4).

Intermediaries should have technical expertise in designing SIBs that target health outcomes such as childhood obesity and ensure that all stakeholders work together effectively in the Portuguese cultural and political environment (see Figure 4). One important intermediary that could support the implementation of the childhood obesity SIB in Portugal is 'Maze Impact'. Maze is an intermediary that helped to structure and launch the first SIB in Portugal in January 2015 (Anselmo 2022). In addition, 'Portugal Social Innovation', another intermediary, is a

public initiative that mobilizes European Funds to promote social innovation and boost the social investment market in Portugal (Portugal Inovação Social n.d.).

The target population or beneficiaries of the JOGG/MUN-SI SIB consists of elementary school children in a school on the Azores between the age of 5 and 12, regardless of their weight. However, chapter 5.1 will further elaborate on the target population at hand.

4.2. SIB Feasibility Criteria

Transitioning from the framework of the JOGG/MUN-SI SIB targeting childhood obesity in Portugal, it is crucial to delve deeper into the specific criteria necessary for the feasibility of such a project. A feasibility study is a critical step in developing an effective SIB program, as it assesses the SIB's potential success and risks. In line with various research papers, there are no standardized criteria to measure the feasibility of a SIB, thus, leading to a varying range of different feasibility criteria. Therefore, this chapter mainly focuses on the following three main criteria: (i) *meaningful and measurable outcomes for a clearly defined target population* (ii) *prior evidence of success in achieving outcomes,* and (iii) *reasonable time horizon to achieve outcomes* (UNDP 2021; KPMG 2013).

(i) *Meaningful and measurable outcomes for a clearly defined target population***.** Since the entire cashflow of a SIB mechanism is based on the achievement of predefined outcomes, the outcomes should have a meaningful and significant impact on the defined JOGG/MUN-SI SIB target population – for example, having children's grades (obesity affects the psyche and therefore also the grades) instead of BMI as an outcome of the program does not yield to a meaningful impact in the form of reducing obesity for the children at hand. While focusing not only on the reduction of BMI but also on healthy eating behaviors and activity levels, the JOGG/MUN-SI SIB effectively addresses the leading root causes of this issue, as outlined in chapter 3.1., and thus, fulfils the criteria of meaningful outcomes that target a reduction in childhood obesity. Moreover, if those

outcomes are not measurable and linked to the target population, it is difficult to measure the success and areas of improvement of the intervention. Since the BMI, healthy eating patterns, and activity levels can be tracked with various methods and are easy to implement and adapt due to the flexibility of the project approach; the JOGG/MUN-SI SIB fulfils the second outcome criteria as well.

(ii) Prior evidence of success in achieving outcomes. As the heart of the SIB lies in private funding for social public sector interventions, it is more than crucial to building trust and credibility with future investors of the SIB to secure their investment. As investors get financial returns based on the achievements of outcomes, a track record of successful outcomes of the defined intervention reduces the perceived risk of investing in the SIB. In sum, if a SIB intervention has a good track record of success in achieving the desired outcomes, the financial viability of this SIB is enhanced by attracting even more investors who aim to get a favorable rate of return (Nazari Chamaki, Jenkins, and Hashemi 2019; Fraser et al. 2020). On the other hand, the evidence of the success of similar interventions holds the service provider accountable to reach the desired intervention results of the SIB. Since the MUN-SI program measured a reduction of 11.2 % in the prevalence of overweight and 10.3 % of obesity over ten years and the JOGG project measured a reduction in obesity prevalence of 9.09 % (see chapter 5.5.), the evidence of success regarding these two programs builds a promising case for scaling and replicating these interventions in the form of a JOGG/MUN-SI SIB for tackling childhood obesity in Portugal.

(iii) Reasonable time horizon to achieve outcomes. For a SIB to be feasible, the desired outcomes must be achieved in a reasonable time horizon. Since investors expect to see the SIB program demonstrate positive results as soon as possible, but in a maximum of 5 to 6 years, previous time horizons of achieving similar outcomes are crucial to assess (OECD

2016; Arias et al. 2017). However, it is vital to balance a short enough timescale between the intervention, impact measurement, and payment to instill investor confidence and a long enough timescale for monitoring, learning and adjustment to ensure a sustainable long-term SIB success (OECD 2016; Davies 2014). In the last ten years, the MUN-SI program successfully reduced childhood obesity within two consecutive years. The JOGG program decreased childhood obesity within 2 to 4 years. Thus, it can be assumed that a replication of the JOGG/MUN-SI interventions in the form of a SIB in Portugal would yield similar results (Chrodis n.d.; Youth Health Community n.d.) As provided by chapter 5.5., this assumption is proved, since the potential JOGG/MUN-SIB provides a robust investment case for potential investors, which would get a 43 % return in Year 4. In addition, the cost savings to the commissioner/government must equal the sum of the costs incurred by providers to derive the SIB interventions plus the payments to the investors. As outlined later in chapter 5.5, the modeled JOGG/MUN-SI SIB would provide potential governmental savings of 688,556 EUR.

Based on the three main SIB feasibility criteria above, the JOGG/MUN-SI SIB can be defined as feasible for effectively addressing childhood obesity in Portugal. As mentioned above, while the feasibility criteria for a SIB encompass essential considerations such as meaningful and measurable outcomes, prior evidence of outcome success, and a reasonable time to achieve those outcomes, there are additional criteria that warrant extensive future research that is out of the scope for this thesis. These criteria may entail the Portuguese government support and legal structures in place to support and enforce the SIB, the presence of interested impact investors and outcome payer(s), and appropriate service providers (Gustafsson-Wright, Gardiner, and Putcha 2015). Having evaluated the feasibility of the JOGG/MUN-SI SIB to tackle childhood obesity in Portugal, the next step is to delve deeper into the SIB feasibility study by modeling the JOGG/MUN-SI SIB in detail.

5. Modelling of SIB

The modelling of a SIB involves several steps. First, the target population and the intervention model used to achieve the desired social outcomes are analyzed (*Intervention scope*). Secondly, the *intervention costs* were calculated to determine the financial resources to launch and sustain the project. Thirdly, the *public sector value* created by the SIB for JOGG/MUN-SI project is evaluated. Fourthly, the *payment mechanism* was built, settling the relevant outcome metrics and the reward for achieving them. The fifth step is to develop the *investment structure*, which brings together all of the preceding findings and shows how they work together to achieve the desired results.

5.1. Intervention Scope

Target population. As recommended in chapter 3, this model adopts a broad approach, focusing on a multi-component program. Consequently, the project's target population does not include demographic or behavioral risk factors. This pilot program targets an elementary school in a rural area namely in the Azores, as it has one of the highest rates of overweight and obesity among children in Portugal, at 35.9 % (Rito et al. 2021). Thus, the eligibility criteria for the study entail elementary school children aged between 5 to 12 regardless of their weight. Intermediary target groups are families (parents), school staff (teachers), health professionals (doctors, psychologists, nutritionists, cooks) and local policymakers.

Cohort delivery model. The program is expected to last four years, aligning with the elementary school timeframe. Regarding target size, at the beginning of the intervention, 336 students participate, given that one grade consists of four classes with 21 students each, based on the average class size in Portugal (OECD 2022). Moreover, the number of students starting school each year equals the number leaving elementary school, which amounts to 84 students per year. Therefore, the cohort size remains the same throughout the program. However, the overall target population increases by 84 incoming students each year, thereby amounting to 588

students overall. As the program focuses on elementary school children, students leaving school after grade four will stop participating in the program.

Intervention model. Figure 5 gives an illustration of the project tailored to the target population used for this program, which was derived from interventions of existing programs, namely MUN-SI in Portugal and JOGG in the Netherlands (see Excel-file 1.1. Intervention Model). The program combines the most suitable aspects of both, given the Portuguese context. Thereby, it focuses on eight pillars that address two main causes of childhood obesity, as explained in chapter 3.1.: environmental and behavioral factors. To target the first cause, four pillars, also called intervention areas, were established (see Appendix 5):

(i) *School.* This intervention area specifically focuses on school-based topics, such as healthy lunches and nutritional education. The interventions include but are not limited to increasing water intake while decreasing the sweet beverage intake, improving canteens by making the meals healthier and offering daily vegetables and fruits in the breaks, as well as implementing nutrition education, e.g., cooking classes (Chrodis n.d.). Furthermore, the teachers undergo training to impart the principles of the intervention program in their classes and guarantee adherence to the regulations. Additionally, they receive psychological instruction to assist in promoting the mental and emotional well-being of the children. This approach aims to ensure educators are equipped with the necessary skills to create a safe learning environment. This will be measured by the percentage of children consuming vegetables and fruits at least once daily. The interventions mentioned will be implemented at the start of the intervention program in Year 1 and will focus on the children and the school predominantly. During the third and fourth year, while continuing the intervention programs, the focus will expand to local communities and to a national level, given the success in the first years.

(ii) *Work.* This area aims to encourage a healthy work environment through healthy canteens or the promotion of active transportation modes. As this area is relevant for adolescents rather than elementary school children, it will not be considered for this program. However, the flexibility of the intervention model based on JOGG suggests this pillar, given a target group that includes adolescents up to 19 years.

(iii) *Neighborhood.* An important aspect of this program is the inclusion of the local community, including supermarkets and local shops to enhance easier access to healthy food. Thus, partnerships with these are aimed to be mainly formed during the last two years of the intervention model, whilst the first years focus on creating or renovating playgrounds and green spaces in the community to promote physical activity. Considering the project's limited scope, as it focuses solely on one municipality, the intervention model incorporates a partnership over the four years with only one sports club/gym to enable children to join a club at discounted rates and does not include a renovation or building of a leisure option for now. This can be considered when scaling up the project. The outcome metric to be measured after the program is the proportion of green spaces and playgrounds in the city.

(iv) *Family.* The intervention aims to increase awareness in families to improve eating patterns at home, achieved through regular information sessions in school, cooking workshops and various child-school-parent activities.

As for the behavioral factors causing childhood obesity, three additional intervention areas were determined:

(i) *Leisure.* Improving children's free-time activities from focusing on computer games and watching TV to playing outside while being physically active is the goal of this intervention area. This program does not incorporate specific interventions as other areas already address them.

(ii) *Media.* This program includes a free online toolkit and an inspiration kit addressing physical activity after school and aiming to increase social media awareness of children and family members. Moreover, it is possible to introduce advertisements on TV in the later years of the intervention, however, as this program targets one school only, this option will not be executed.

(iii) *Sport.* This intervention area is very important to tackle childhood obesity and is included in other areas already like the partnership with local sports club. In addition, the program aims to introduce several interventions to increase further physical activity of children, such as the "Daily Mile" (move for 15 minutes every day during school hours, equivalent to walking one mile.).

(iv) *Evaluation*. In the first two years, the focus lies on measuring the children's BMI as well as their eating and physical activity patterns while further planning intervention programs and searching for possible partnerships. During the latter half of the program, the interventions are also evaluated through feedback sessions from all involved stakeholders in order to identify possible gaps or failures in the model.

5.2. Intervention Costs

The structure and the amount of intervention costs depend highly on the intervention scope and cohort size. Thus, these costs are separated by program categories and per year. There are two main categories of costs: (i) intervention costs including school, neighborhood, family, media, evaluation as well as (ii) project management and general costs (overhead costs). These costs begin in Year 0 when the evaluation process is initiated to determine the current state of the school, followed by initial actions to implement the intervention measures. Table 5 shows the total cost per category over the four years for all participating children. These costs are estimated based on the intervention structure of MUN-SI and JOGG and were determined through research and expert agreement. As previously stated, the intervention model is not

tailored to specific target groups. Thus, as mentioned in chapter 3.7., all children undergo the same intervention program, regardless of weight. Consequently, all costs are separated equally between the children and are consistent over time. The estimated costs have been calculated, assuming an inflation rate of 2 %, the average inflation rate over the last 10 years in Portugal (Pordata 2023) (see Excel file "1.6. Intervention Costs").

Cost description		**Total**	**Share**
Intervention Costs	EUR	254.129	91 %
School	EUR	195.536	70 %
Neighborhood	EUR	24.192	9 %
Family	EUR	10.485	4 %
Media	EUR	5.800	2 %
Evaluation	EUR	18.116	6 %
Project management & general costs (10% of costs)	EUR	25.413	9 %
Share M&G of intervention costs	%	10 %	
Total costs without inflation	**EUR**	**279.542**	100 %
Total costs with inflation (2 %)	**EUR**	**288.041**	

Table 1: Summary of total intervention cost over the 4 years

In general, these costs include materials used for different activities with the children and are therefore variable, depending on the cohort size. "School" costs refer to all interventions integrated into the school day, accounting for around 70 % of the total costs. The cost factors mainly focus on dietary improvements, nutrition knowledge and increased physical activity. As mentioned in chapter 5.1. "Intervention Scope" the programme integrated healthy food in the cafeteria and during breaks. It is assumed that the children already receive a range of meals at school subsidized by the state. Therefore, replacing the previous meal with healthy options increases costs only slightly (Assumption: 0.2 EUR per meal). Furthermore, new sports equipment for breaks and physical education classes, as well as various materials for project weeks about nutrition basics are included in this cost factor. The knowledge learned during the project week is complemented by materials like workbooks used in the classroom. Furthermore, the training sessions for educators are also encompassed in this area. As mentioned, "neighborhood" includes reduced memberships in sports clubs. The "family" cost

factor consists of diverse training and additional documents for the parents. "Media" includes the cost of implementation and maintaining the online tool kit that gamifies the learning experience about healthy lifestyles for children after school. Moreover, the "evaluation" is also a cost factor, as a doctor is involved at the beginning and every end of the year to take the BMI. In addition to the intervention costs, management, and general cost (incl. personal costs, insurance etc.) must be included, calculated as 10 % of all the interventions costs. These costs represent fixed costs and account for only 9 % of total costs.

Overall, the intervention model costs 288,041 EUR for all respective years, with 214 EUR for one child per year (see Appendix 6). Based on these costs, outcome payments and cost savings to the government are calculated below.

5.3. Cost Savings

This chapter summarizes the calculation of expected cost savings for the government as a result of the intervention. The base case is assuming a 2 % inflation rate p.a. and an expected lifetime of an adult in Portugal of 82 years. Important to note is that the target childhood group has an average assumed age of 8.5 years (uniformly distributed from age 5 to 12). Therefore, after another 11 years, a child is expected to reach adulthood on average and cost the state 1,241 EUR vs 248 EUR as a child due to the increased occurrence of costly illnesses and decreased productivity when obese (overweight: 370 EUR vs 96 EUR). The government savings are the expenses the government would have had to bear in case an obese or overweight child would have stayed obese or overweight during his entire adulthood. Total savings over the remaining lifetime of 102,464 EUR for former obese children and 100,739 EUR for former overweight children are calculated. Dividing these total costs by 73 years the cost savings per child per year are computed. Thus, 1,308 EUR for an obese child and 1,404 EUR for an obese child can be saved annually. These savings will be used to calculate the payout for the investors (see 8.6. Payment mechanism).

5.4. Outcome Metrics

The evaluation of childhood obesity and the selection of appropriate outcome metrics have sparked a controversial debate. The goal is to identify the most suitable measurement tool that effectively captures the complex nature of this issue.

After careful consideration, the SIB will be based on the measurement of the BMI for primary outcome metrics as previously recommended, drawing upon its previous usage in assessing the success of the chosen projects JOGG and MUN-SI, its simplicity and global comparability. Specifically, the success of the intervention will be assessed by evaluating the children who have successfully reduced their BMI from a value previously indicating overweight or obesity to a value within the normal BMI range. The measurement will take place at the end of each year of intervention and will be performed by professionals to prevent any potential measurement error or manipulation of results. By targeting the normalization of BMI, the SIB will aim to not only address the immediate concern of obesity but also promote sustainable lifestyle changes that will benefit children in the long term. Ongoing monitoring and evaluation allow to continuously refine and adapt the intervention strategies to optimize outcomes and improve the children's overall health. The progress of the interventions will be measured against previously established success rates. The target values are based on the projected ten-year success rate of the MUN-SI project. The prevalence of overweight children was reported to decrease 11.2 % within the ten years, while the prevalence of obese children decreased by 10.3 %. If the total of each individual rate of 10.3 % and 11.2 % is achieved equally per year, the model assumes a yearly success rate of 1.12 % for overweight children and 1.03 % for obese children. However, to obtain a comprehensive understanding of the interventions' effectiveness, a combination of primary and intermediary metrics is used, instead of only focusing on the physical outcome measures with the BMI. It is important to note that the intermediate outcome metrics are not directly linked to payouts for investors and therefore do

not provide direct financial incentives. Instead, they will serve as indicators to assess the short-term success of the interventions. By employing these metrics, the model aims to gain insights into crucial aspects of children's health: Physical activity and nutrition. To collect data for these metrics, the SIB will rely on family questionnaires, ensuring a holistic perspective by involving parents or guardians in the evaluation process. However, even though the questionnaires offer valuable insights, the evaluation through family members might be prone to bias and based on subjective assumptions, disqualifying these metrics as primary outcome metrics for this model. With regards to physical activity, our target measurement is a weekly participation of 420 minutes, aligning with the recommendations set forth by the World Health Organization (WHO), recommending that children participate in at least 60 minutes of moderate physical activity each day to ensure physical health. Given that children should participate for 60 minutes each day for seven days a week, the weekly participation equals 420 minutes. By emphasizing the significance of physical activity, the SIB aims to promote healthier lifestyles and combat the rising rates of childhood obesity.

The inclusion of nutrition as a key aspect of evaluation is imperative. By examining the food consumption patterns, the dietary habits that may contribute to childhood obesity are better understood. Using family questionnaires, valuable information is gathered regarding the types of food consumed, enabling us to identify potential areas for improvement and implement targeted interventions. The target value will be based on previous success rates within the MUN-SI project, utilizing its measurement of positive perception of foods, such as vegetables and fruits as part of the children’s nutritional daily routine. Data published by the project stated an increase of children’s preference for fruits and vegetables throughout the years of 16 % from 2014 to 2015, 2.3 % from 2015 to 2016 and 11.9 % in 2017 to 2018. Assuming that the preference simultaneously leads to an increase of consumption, the averaged value of 10 %

will be used as the target value, indicating success of the interventions targeting nutritional behavioral patterns.

In conclusion, the selection of outcome metrics for evaluating childhood of the SIB will prioritize the multifaceted approach, measuring physical, behavioral, and nutritional metrics. Building upon previous analysis, the BMI has emerged as a suitable measurement tool to encompass weight. The decrease of overweight and obese children by 1.12 % and 1.03 % will be directly linked to the investors' payout by measuring. By prioritizing physical activity, targeting a weekly participation of 420 minutes a week, and healthy nutrition, with an increase of fruit and vegetable consumption by 10 %, the SIB aims to continuously measure the interventions against these targets to ensure the most efficient approach in the fight against childhood obesity. As prioritizing accuracy and gaining comprehensive perspectives is vital, the combination of measurements of the BMI by professionals and family questionnaires will provide a continuously reliable basis for evaluation.

5.5. Payment Mechanism

The payment mechanism describes how payments for success are made. It is important to clarify that outcome payments compensate investors who assume the financial risk associated with the program. The payment mechanisms for this project are tied to the primary outcome metrics discussed in the previous chapter, specifically the weight prevalence measured by BMI. The investors' payout is contingent upon achieving the target success rates of 1.12 % per year for overweight children and 1.03 % for obese children, totaling an overall success rate of 4.48 % and 4.12 % over the whole intervention period of four years, respectively. If the success rates are met, investors will receive a single payment in Year 4 amounting to 43 % [2] of the total savings per child over their remaining lifetime of 73 years, provided that the child reduces their

[2] The payout rate of 43% is an assumption based on the Sensitivity Analysis as it is the first payout rate that generated a positive investor IRR.

BMI to a normal range. The total savings per child throughout their lifetime is 101,602 EUR, calculated by averaging the total cost savings over the lifetime of an obese child of 102,464 EUR and an overweight child of 100,739 EUR. The metric of the average was used due to challenges in predicting the child's weight development in future lifetime within the range of overweight and obesity.

Considering the target population of 156 obese and overweight children, totaling 99 overweight and 57 obese children, achieving success rates of 4.48 % and 4.12 % would result in approximately 6.78 children successfully reducing their BMI to a normal range. Multiplying the number of children with the individual savings leads to a total governmental saving of 688,556 EUR throughout the whole intervention of four years. Assuming a payout rate of 43 % the investors receive a payout of 296,079 EUR at the end of the intervention.

When considering the total amount of years needed for the potential savings to cover the intervention costs per obese or overweight child, two different approaches can be considered. The first approach of payment mechanism I is based on the total savings during the child's remaining lifetime, calculated equally throughout the years, with the total savings divided by 73 years, resulting in a yearly saving of 1,392 EUR per child. With the intervention costs per child adjusted for inflation at 857 EUR, this method covers the costs in the first year.

The second payment mechanism II follows a weighted savings approach, accounting for a gradual increase in savings during the early years of life and a more rapid increase starting in year 12 (turning adult), as health costs tend to rise with age. In this method, the savings exceed the costs by Year 3, with a total saving of 1,053 EUR.

5.6. Public Sector Value

For this purpose of evaluating the public sector savings, the project IRR without investors is evaluated in the first step. To ensure the profitability of a SIB for the investors and the government, it is essential that the IRR without investors needs to be positive. This is the case

for the MUN-SI/JOGG project as a slightly positive return is calculated (see Excel-file 1.4. Cost savings). This demonstrates that successful interventions implemented early in a child's life have the potential for the government to save money. Therefore, this model presents a good foundation for developing a SIB.

Moving on to the potential cost savings for the government through a SIB for this intervention. By developing a SIB for the mentioned project, the risk of not achieving the success rate of 4.48 % (overweight) and 4.12 % (obese) over the whole intervention period of four years is transferred to the investor, who pays the cost of the intervention. In exchange for the reduced risk, the government gives the investor a certain percentage of the savings, namely 43 % of the total cost savings. Thus, the public sector value is calculated by subtracting the costs for the intervention and the outcome payments from the calculated cost savings. Assuming that the success rate is achieved, the government is projected to have a financial surplus of 104,436 EUR.

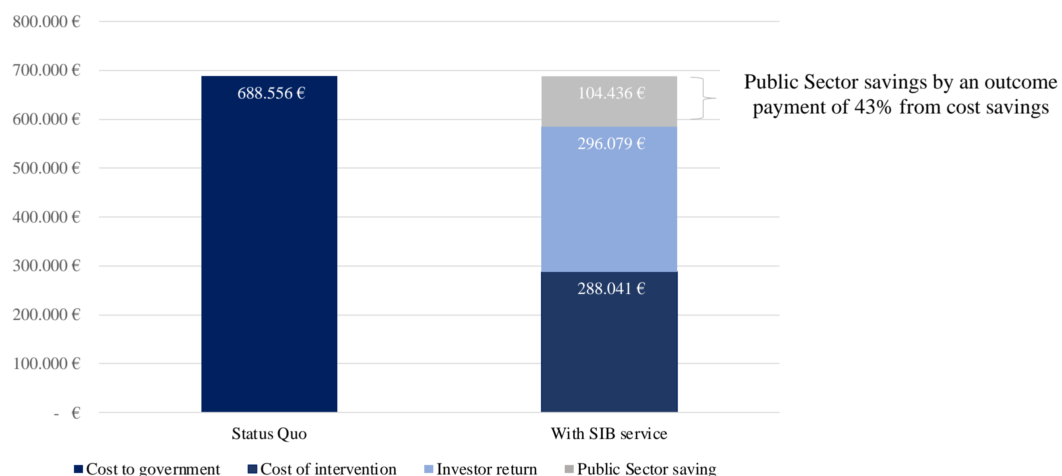


Figure 2: Public Sector Value Structure

5.7. Investment Structure

The following chapter explains the financial statement of the investor in accordance with the payment mechanisms in the previous chapter. For this, the Income Statement, Cash Flow Statement, and Investor IRR will be described (see Excel file “1.7. Financial Statement”).

Income Statement. The revenue of the project comes from the outcome payments to the investors, which amount to 296,079 EUR as explained in the last subchapter. The amount will only be paid out in the program's last year, thus setting revenue in the first years to zero. In order to calculate the profit, the intervention costs, following delivery costs, need to be deducted, which amount to 69,885 EUR in Year 0, due to investments made prior to the start of the interventions. During the following years, an inflation of 2 % p.a. is taken into account, thereby increasing the delivery cost each year, whereas no additional delivery costs are considered in the last year, as the intervention ends. The cumulative delivery costs in Year 4 equals negative 288,041 EUR. While the profit in the last year accounts for 296,079 EUR, the cumulative project profit is 8,039 EUR, given that costs are lower than the revenue.

Cash Flow Statement. The cash flow statement distinguishes between operating and financing cash flow. For the operating cash flow, all payments and revenues related to the operation of the project are considered. The cash revenue, therefore, equals 296,079 EUR in the last year of the project, while the cash delivery costs are equal to the delivery costs of the interventions each year. The financing cash flow is calculated by summing up the investments made into the project and deducting the payouts to the investors. Given that payouts will only be considered in Year 4 and investments start in Year 0, the financing cash flow in Year 0 amounts to positive 69,885 EUR. In the following years, the financing cash flow equals the positive delivery cost amount, as no other investment is made in the project. As Year 4 is the last year of the project, and no additional investments will be considered, the financing cash flow in Year 4 equals negative 296,079 EUR. To assess both operating and financing cash flows in relation to each other, the net cash flow is calculated, which is the sum of both. Since operating and financing cash flow amount to the same number, with the only difference being that one is a positive and the other a negative number, the net cash flow sums up to zero. The cash balance at the

beginning of each period was also calculated and compared to the cash balance at the end of the period and equalled net cash flow.

Investor IRR. The calculation of the Internal Rate of Return (IRR) is a crucial step in assessing the profitability of this SIB and provides investors with critical information to facilitate their investment decision-making. The investor IRR calculation only takes into account the financing cash flows, as otherwise costs would be considered twice and thereby produce an incorrect result. The IRR is computed by setting the net present value of all cash flows to zero. The calculation shows a positive IRR of 1 %, making the SIB profitable to investors. Although it is a rather low number, investors might be interested in investing in this SIB since the outcome is not only financially based, but the social aspect plays an important role. Nevertheless, the following subchapter will analyze the sensitivity of some variables used regarding investor IRR.

6. SIB as a Business Case

The following chapter focuses on the analysis of the business case and aims to provide a comprehensive overview of the project's profitability across different scenarios and variations in key variables. To present these findings effectively, a sensitivity analysis and a scenario analysis were conducted, revealing potential project opportunities and risks.

The analysis is based on the baseline values of 101,620 EUR as total savings per successful child, resulting in a total of 688,556 EUR in public savings and 288,041 EUR in total intervention costs. The payout rate describes the percentage of the overall governmental savings generated by the intervention that will be used to repay investors for their initial investment, along with a surplus. The base case assumes a payout rate of 43%, implying a single payout of 296.079 EUR for the investors. The reasoning behind the choice of rate will be explained in more detail in the subchapter 6.1. the sensitivity analysis for the payout rate.

6.1. Sensitivity Analysis

The sensitivity analysis plays a crucial role in evaluating the potential financial outcomes of a SIB, providing investors with a broader perspective on the project's profitability. By adjusting different variables and assessing their impact on the investment structure, the analysis reveals potential weak points and offers valuable insights into the project's financial performance (Stanciu et al. 2009). In the context of this model, variables of the project's key assumptions, namely the success rate, the payout rate and potential changes of the total intervention costs were analyzed. The changes were then examined on total payouts to the investors and the Investor internal rate of return (IRR).

Payout rate. The payout rate is a significant factor in assessing the investor returns and our project's financial viability. The rate was evaluated ranging from 20 % to 60 % to explore various scenarios for investors, see table 6. Using an Excel data tool, the results were calculated by replacing the original value in the formula with each percentage of payout. The results first indicated a positive development with an Investor IRR of 1 % at a payout rate of 43 %, as stated in table 6. At this payout rate, the IRR increased by 14 % in comparison to the previously strong negative IRR at a 30 % payout rate. Consequently, the assumption of a 43 % savings rate was adopted for further evaluations due to its positive IRR, as it signifies a financially viable project that holds appeal for investors. Although profitability based on IRR is only slightly positive, the payoff of 43 % of the total lifetime savings of a single successful child of 43,689 EUR covers the intervention costs of 857 EUR for additional 50.96 children in a new intervention cycle. This illustrates the sustainability of the intervention in addressing childhood obesity over the long term. It is however further worth noting that while a higher payout rate is desirable, each increase simultaneously reduces government savings and may affect the project's overall acceptance. For example, a payout rate of 50 % resulted in a total payout of 344,278 EUR and a positive IRR of 7 %, with a governmental saving of 56,238 EUR. However, a further increase

to 60 % proved to be unprofitable, as the costs of the intervention and the payout totaled 701,174 EUR and outweighed the total governmental savings of 688,556 EUR.

	20 %	30 %	43 %	50 %	60 %
ABSOLUT PAYOUT	137,711	206,567	296,079	344,278	413,134
IRR	-28 %	-13 %	1 %	7 %	15 %

Table 2: Sensitivity analysis of the payout rate

Success Rate. One of the most influential aspects when considering the profitability of this model is the success rate. The results were calculated based on the assumption of equal success rates among obese and overweight children, ranging between 4 % and 12 % in total, with a baseline of 8.6 %. The chosen success rate underlying this model was calculated referencing a conservative estimate of the project MUN-SI, which increases the relevance of the analysis for higher success rates. The findings indicated that even a small increase in the success rate can significantly impact the Investor IRR. For instance, a 1.4 % increase to a success rate of 10 % resulted in a 6 % rise in the IRR, while further increasing the success rate to 12 % raised the IRR to 15 %. Since the interventions originally taken by MUN-SI were optimized and broadened, it can be assumed that the increase in success rate to 10 % or 12 % is realistic and therefore allows for a more optimistic forecast of project profitability.

	4.0 %	6.0 %	8.6 %	10.0 %	12.0 %
ABSOLUT PAYOUT	136,183	204,275	296,079	340,458	408,550
IRR	-28 %	-13 %	1 %	7 %	15 %

Table 3: Sensitivity analysis of the costs of the success rate

Costs of Intervention. Intervention costs play a crucial role in evaluating the project's profitability and sustainability. Unforeseen changes within the intervention costs introduce potential risks for the investors. To comprehensively analyze potential consequences, an increase and decrease of intervention costs by 10 % and 20 % relative to the original costs were considered. The delta to the original costs was added and subtracted to the annual costs in Y0. The findings revealed that the profitability of the project appears to be more volatile in cost decreases. Lowering the costs by 20 % raised the IRR by 11 % while an increase of 20 % only

decreased the IRR by 7 %. This indicates that cost reductions have a more significant impact on project profitability compared to cost increases, emphasizing the potential benefits of cost reduction strategies in improving the project's overall financial performance. Potential cost-saving measures in our project could involve costs that are incurred as part of the school costs, as these represent 70 % of our total costs. Existing government subsidies could, for instance, potentially cover the total cost of meals provided by the school or the healthy breaks, which would significantly impact our project finances and lead to a further increase in IRR.

	↓20 %	↓10 %	↓↑ 0%	↑ 10%	↑ 20%
IRR	12 %	6 %	1 %	-3 %	-6 %

Table 4: Sensitivity analysis of the costs of intervention

In summary, the sensitivity analysis provided essential insights into the profitability of this model by evaluating variables such as success rate, payout rate, and intervention costs. The results underscore the importance of a balanced payout ratio, with a 43 % savings rate being the most efficient assumption due to its positive impact on the investor's IRR. In addition, the analysis highlighted the importance of the success rate, illustrating that even small increases can significantly improve the investor's IRR. Furthermore, the potential benefits of cost-reduction strategies became apparent during the analysis, as reducing intervention costs had a stronger positive impact on profitability compared to cost increases.

6.2. Scenario Analysis

Another important analysis tool is the scenario analysis. It provides valuable insights into potential risks or improvements in planning, strategy optimization and general outlook. By looking at different scenarios, decision makers can gain a deeper understanding of the potential outcomes of the project to maximize success and effectively manage risks (Hayes 2022).

In the context of our model, intervention costs are one of the main components affecting project profitability. The costs cover an annual number of 336 children, however, not all of them are

eligible for the outcome payments, as the BMI of 180 of them is already in the normal range at the start of the intervention. Since this severely affects the IRR of the model, a scenario was calculated which considers an intervention model that focuses only on overweight and obese children. To calculate the profitability of this scenario, the total costs were adjusted to only the obese and overweight children, excluding those in the normal BMI range. The costs were lowered to that of the total of 156 children, covering 99 overweight and 57 obese children, rather than the usual 336 students per year. The total inflation-adjusted cost of this intervention scenario was 133,733 EUR. With the other assumptions held constant, the Investor Internal Rate of Return (IRR) in this scenario was calculated to be 35 %. This indicates a potentially very profitable project under these specific conditions. However, it is important to consider the limitations and implications of this scenario. Because most of the interventions target environmental changes, such as school and meal programs, implementation of the reduced scenario would exclude more than half of the annual student population from overall health-related improvements in circumstances. However, this approach tends to be discriminatory and unrealistic in practice, as it does not ensure equality and inclusivity within the intervention program. Specifically targeting children based on their weight status might also lead to bullying and thus an overall decrease in the well-being of the children in the intervention. Furthermore, as one of the SIB's main goals is awareness and prevention, the initiatives could also positively impact children with BMIs in the normal range in their potential future weight development and thus represent government savings, although these impacts cannot yet be quantified. Therefore, a holistic approach that considers the different needs of all students, regardless of their current BMI status, is critical.

7. Limitations

The following chapter will discuss the limitations of this feasibility study by dividing this part into two categories: Data and project limitations. Starting with the first, the amount of available

data and studies regarding overweight and obesity are insufficient and outdated. While some studies were available to identify the causes of the social issue, e.g., the COSI study, there was no analysis of the correlation between these factors in the Portuguese population. Thus, this makes it difficult to get meaningful interpretations. Therefore, further research should be done and updated regarding factors of childhood overweight and obesity in Portugal. In addition, already existing intervention programs are limited in their accessibility to information regarding program structure, costs, and outcomes. Moreover, the social impact evaluation is not always measured, or if done, it is neither continuously nor adequately evaluated. This makes it difficult to analyze an intervention model and thus, makes it difficult to understand their social impact.

The most prevalent issue regarding project limitations is the complexity of this topic. As mentioned in chapter 3.1., several factors influence and impact a child's weight differently. Moreover, all trends cannot be considered and differ between populations and regions worldwide. The lack of understanding of the impacts on the child presents a challenge in interpreting the results, especially when evaluating which factor influences the individual most. Deciding on the most suitable outcome metric poses a challenge as no measurement considers all these factors influencing the child. Most of the studies use BMI as a measure to validate the weight change over the years. Even though BMI is used most of the time as an outcome measurement, it is important to acknowledge certain limitations that may impact the interpretability of the results obtained in this project. Further research should take these limitations into consideration to ensure a comprehensive understanding of the findings. Furthermore, intermediate measures should also be considered as they better evaluate short-term behavioral changes without focusing on weight as the primary outcome. Considering these measures would go beyond the scope of this thesis and is complicated to measure as these factors rely on the reliability of the parents. Another limitation to consider is the potential for

side effects, such as the influence on previously normal-weight children to avoid becoming overweight or obese in the future. While this could lead to cost savings, it is important to note that this aspect was not accounted for in this intervention model, thus representing a potential source of bias.

In addition, regarding the target group, including all children in the evaluation and success rate is difficult. Given that after every school year, children enter and leave elementary school, it is complicated to measure the impact of the intervention program based on the duration of the child's participation. The scenario analysis highlights that solely focusing on one grade or only on overweight or obese children can be another option. Nevertheless, this approach can lead to discrimination, perpetuating a vicious circle in which a child overeats due to psychological factors, such as mobbing (see chapter 3.2.2.).

As the intervention program is mainly focusing on one school on the Azores and its municipality, the individuality in the implementation of the program varies on the infrastructure of the community and the size. Consequently, costs also differ between regions. Moreover, costs could increase by integrating more complex interventions and stakeholders, such as local politicians. For the sake of simplicity, this research disregards these.

To sum it up, the lack of data and the complexity of the social issue limits the implementation, structure, and evaluation. Existing and further research should account for these factors.

8. Conclusion

Overweight and obesity remain a pressing and costly problem in Portugal, with an annual financial burden on the government of up to 3 bn EUR. Early intervention is crucial so that long-term consequences can be mitigated. Despite its increasing significance, governments often struggle to address and prioritize prevention measures effectively. This creates the need for innovative solutions such as a SIB to fill the gap. By reducing financial and implementation risks for the government and providing an option for investors to achieve both social and

financial objectives, SIBs offer a promising financing mechanism to address this issue. In light of this context, our analysis confirms the feasibility of implementing a SIB as a viable approach to tackle childhood overweight and obesity in Portugal. The proposed SIB employs a multifaceted intervention strategy that targets both nutritional and behavioral changes, aiming for sustainable reductions in childhood obesity rates. The objective goes beyond immediate weight reduction within the program, encompassing the prevention of further weight gain. The ultimate goal is not only short-term weight reduction but also long-term cost reduction in government healthcare expenditures, alongside an improvement in the quality of life resulting from the weight loss of the children.

Although the financial returns of the project are modest, with an IRR of 1 %, the selected results indicate that a reasonable payout rate of 43 %, based on conservative calculations, can cover the intervention costs for a significant number of about 51 children. This highlights the long-term sustainability of the SIB in effectively addressing childhood obesity. Furthermore, to enhance the financial sustainability of the model, it is worth exploring the utilization of existing government subsidies to reduce costs and consider additional funding sources.

The interventions draw on findings and outcomes from established projects such as the JOGG/MUN-SI project, which are adapted to the specific cultural context of Portugal, ensuring the project's success. By leveraging existing knowledge and tailoring interventions to align with the Portuguese cultural context, we increase the probability of achieving positive outcomes.

However, it is important to acknowledge that continuous improvement and refinement of the SIB model are necessary. Collaboration with stakeholders, including government agencies and relevant organizations, will facilitate the fine-tuning of the intervention approach, optimization of cost-effectiveness, and overall enhancement of the impact on childhood obesity in Portugal.

Finally, the analysis conducted in this thesis marks the pioneering application of a SIB in the

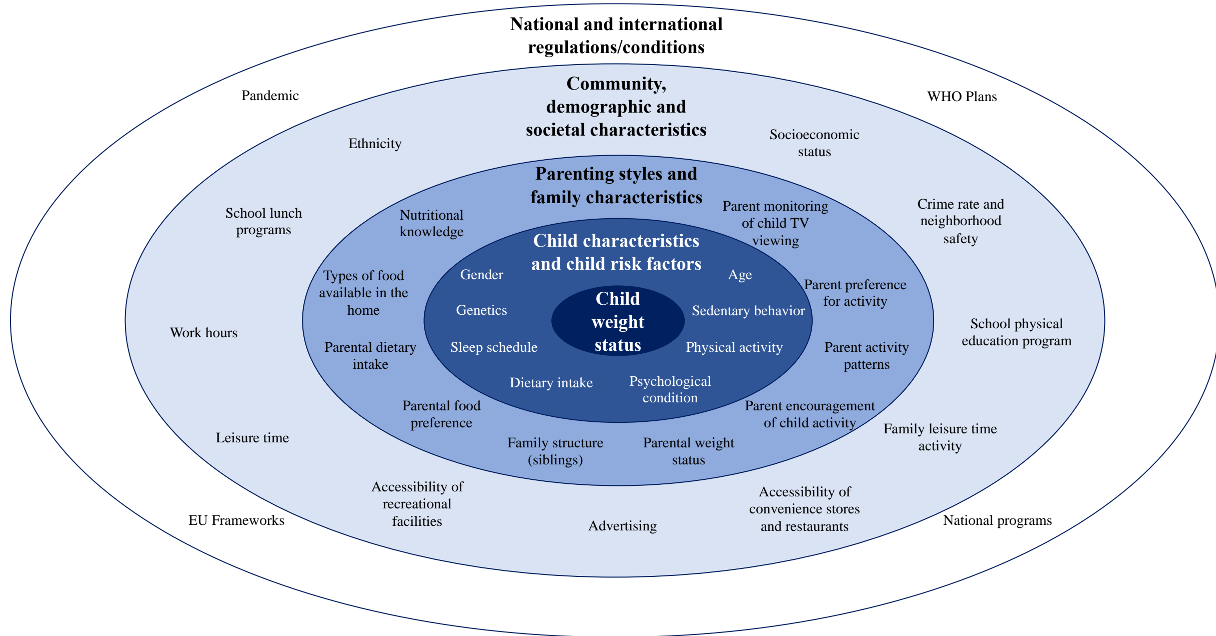
context of childhood obesity in Portugal. Consequently, it serves as a valuable foundation for future research in this area.

9. Appendix

List of Appendices

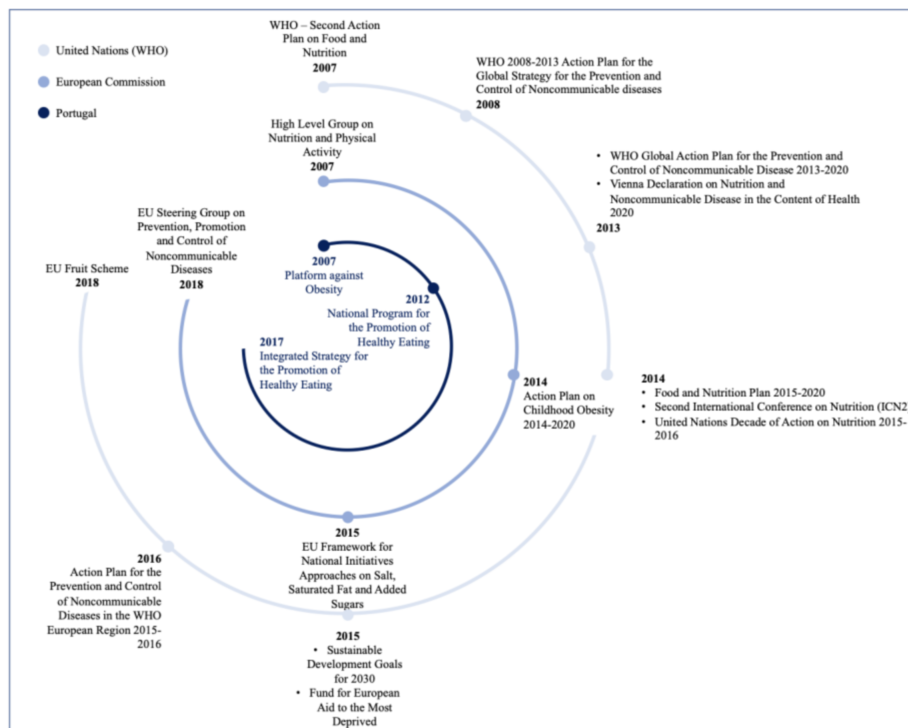
Appendix 1	Ecological Model
Appendix 2	Regulations regarding Nutrition
Appendix 3	Intervention Model
Appendix 4	Cost Categories of Obesity
Appendix 5	Intervention Model JOGG/MUN-SI
Appendix 6	Average Annual Cost per Child
Appendix 7	Table of Abbreviations

1. Appendix – Ecological Model



This ecological model refers to the model of Davison and Birch (2001) for childhood overweight and obesity. It identifies factors influencing children's weight.

2. Appendix – Regulations regarding Nutrition



Historical milestones in the field of nutrition regulations for the period 2007-2019 from Portugal, the European Commission and United Nations (Graça, Gregório, and Freitas 2020)

3. Appendix – Intervention Model

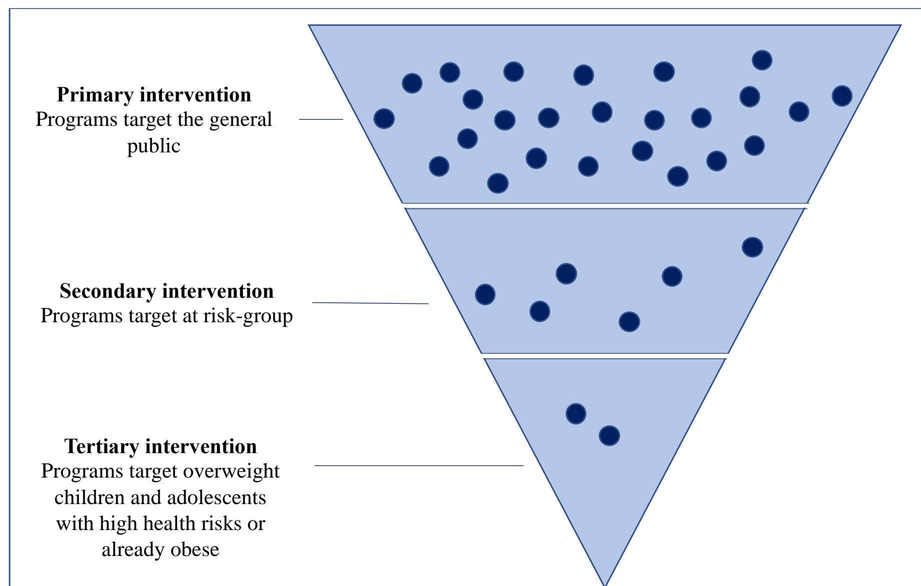
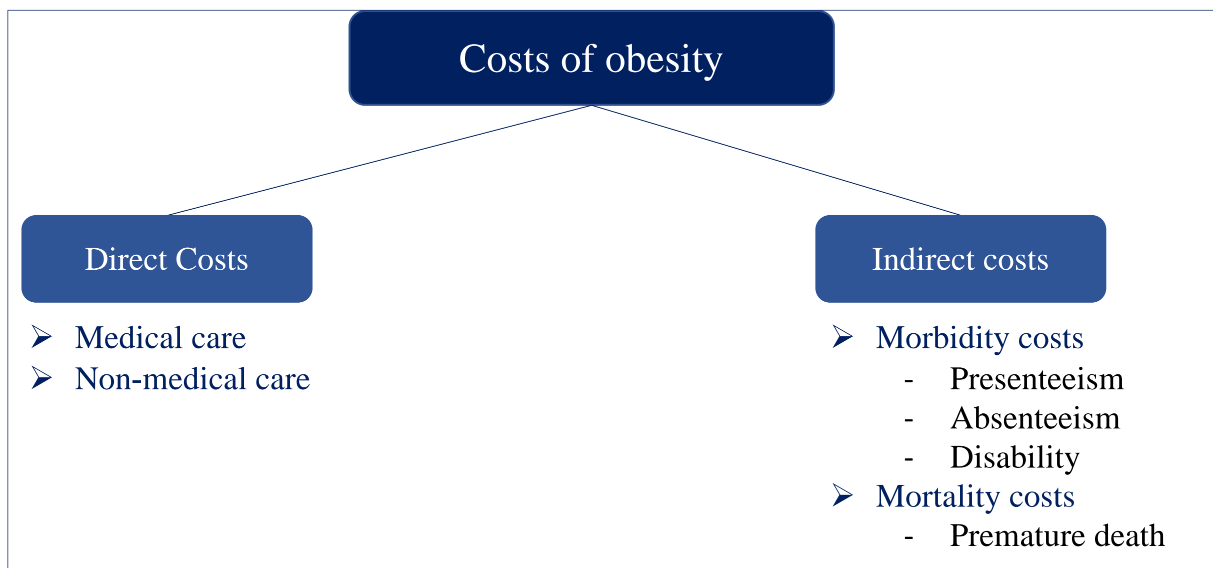


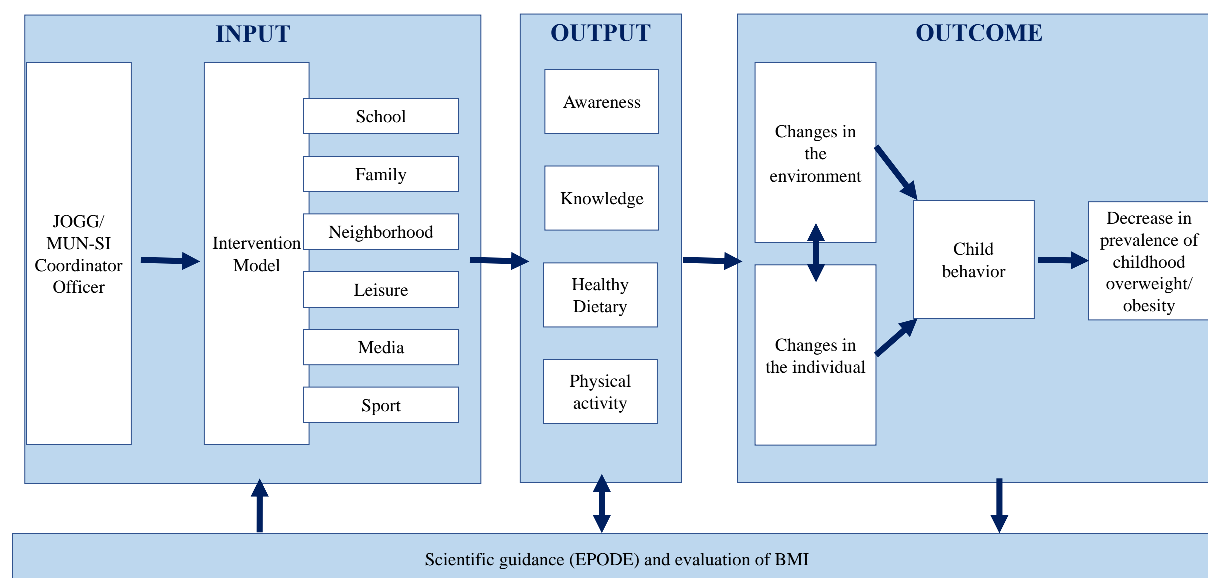
Illustration of the three different intervention models for childhood overweight and obesity, which focus on different target groups (Weihrauch-Blüher et al. 2018)

4. Appendix – Cost Categories of Obesity



Overview of obesity and overweight costs (Lehnert et al. 2013)

5. Appendix – Intervention Model JOGG/MUN-SI



llustration of the JOGG/MUN-SI Project for an elementary school on the Azores

6. Appendix – Average Annual Cost per Child

Average annual cost per child		
School	EUR	145
Neighborhood	EUR	18
Family	EUR	8
Media	EUR	4
Evaluation	EUR	13
Total costs for intervention	**EUR**	**189**
Management & General	EUR	19
Overall total costs	**EUR**	**208**
Overall total costs with inflation p.a. per child	EUR	214
Children in target group	#	336

Overview average cost per child per year

7. Appendix – Table of Abbreviations

AFHK	Action for Healthy Kids
Approx.	approximately
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
CEIDSS	Centre for Study and Research on Social Dynamics and Health
Chafea	Consumers, Health, Agriculture, and Food Executive Agency
CVD	Cardiovascular Diseases
EU	European Union
Et al.	and others
GDP	Gross Domestic Product
IRR	Internal Rate of Return
JANPA	Joint Action on Nutrition and Physical Activity
JHB	Join the Healthy Boat
JOGG	Jongeren op Gezond Gewicht
LEP	Leptin
MC4R	Melanocortin 4 gene
MSD	Musculoskeletal Disorders
MUN-SI	Programa de Promoção de Saúde Infantil em Municípios
NASH	Non-alcoholic steatohepatitis
OECD	Organization for Economic Development and Cooperation
OSA	Obstructive sleep apnea
PNPAS	Promotion of Healthy Eating
SIB	Social Impact Bonds
SES	Socioeconomic status
SPV	Special Purpose Vehicle
US	United States

WHR	Waist to Hip Measurement
WHO	World Health Organization
WHtR	Waist to Height Measurement
WSCC	Whole School, Whole Child, Whole Community

References

Anselmo, Margarida. 2022. "MAZE and Social Impact Bonds: A 7-Year Journey." Maze. January 25, 2022. https://maze-impact.com/article/maze-and-social-impact-bonds-a-7-year-journey.

Arias, Omar, Samer Al-Samarrai, Emily Gustafsson-Wright, Avnish Gungadurdoss, Diane Mak, and Simon Bell. 2017. "CAN IMPACT BONDS DELIVER BETTER RESULTS, FASTER AND CHEAPER? - Panel Discussion on Social and Development Impact Bonds as a Results Based Financing (RBF) Approach in Education." World Bank.

Bingham, Daniel D., Maria I. Varela-Silva, Maria M. Ferrão, Gama Augusta, Maria I. Mourão, Helena Nogueira, Vitor R. Marques, and Cristina Padez. 2013. "Socio-Demographic and Behavioral Risk Factors Associated with the High Prevalence of Overweight and Obesity in Portuguese Children: Overweight and Obesity in Portuguese Children." *American Journal of Human Biology* 25 (6): 733–42. https://doi.org/10.1002/ajhb.22440.

Black, M. H., H. Zhou, M. Takayanagi, S. J. Jacobsen, and C. Koebnick. 2013. "Increased Asthma Risk and Asthma-Related Health Care Complications Associated With Childhood Obesity." *American Journal of Epidemiology* 178 (7): 1120–28. https://doi.org/10.1093/aje/kwt093.

Bohn, Claudia, Mandy Vogel, Tanja Poulain, Andreas Hiemisch, Wieland Kiess, and Antje Körner. 2022. "Having Siblings Promotes a More Healthy Weight Status—Whereas Only Children Are at Greater Risk for Higher BMI in Later Childhood." Edited by Andreas Beyerlein. *PLOS ONE* 17 (7): e0271676. https://doi.org/10.1371/journal.pone.0271676.

Caprio, Sonia, Stephen R. Daniels, Adam Drewnowski, Francine R. Kaufman, Lawrence A. Palinkas, Arlan L. Rosenbloom, and Jeffrey B. Schwimmer. 2008. "Influence of Race, Ethnicity, and Culture on Childhood Obesity: Implications for Prevention and Treatment." *Diabetes Care* 31 (11): 2211–21. https://doi.org/10.2337/dc08-9024.

Chatterjee, Sudesna, Kamlesh Khunti, and Melanie J Davies. 2017. "Type 2 Diabetes." *The Lancet* 389 (10085): 2239–51. https://doi.org/10.1016/S0140-6736(17)30058-2.

Chen, Xiaoli, May A. Beydoun, and Youfa Wang. 2008. "Is Sleep Duration Associated With Childhood Obesity? A Systematic Review and Meta-Analysis." *Obesity* 16 (2): 265–74. https://doi.org/10.1038/oby.2007.63.

Chrodis. n.d. "Young People at a Healthy Weight ˊJOGGˊ Netherlands." Chrodis. Accessed December 5, 2023. http://chrodis.eu/wp-content/uploads/2017/03/young-people-at-a-healthy-weight-jogg.pdf.

Chung, Sochung. 2019. "Body Composition Analysis and References in Children: Clinical Usefulness and Limitations." *European Journal of Clinical Nutrition* 73 (2): 236–42. https://doi.org/10.1038/s41430-018-0322-8.

Davies, Ron. 2014. "Social Impact Bonds Private Finance That Generates Social Returns." European Parliamentary Research Service. https://www.europarl.europa.eu/EPRS/538223-Social-impact-bonds-FINAL.pdf.

Davison, K. K., and L. L. Birch. 2001. "Childhood Overweight: A Contextual Model and Recommendations for Future Research." *Obesity Reviews* 2 (3): 159–71. https://doi.org/10.1046/j.1467-789x.2001.00036.x.

De Sousa, Avinash, Gurvinder Kalra, Sushma Sonavane, and Nilesh Shah. 2012. "Psychological Issues in Pediatric Obesity." *Industrial Psychiatry Journal* 21 (1): 11. https://doi.org/10.4103/0972-6748.110941.

Dehghan, Mahshid, Noori Akhtar-Danesh, and Anwar T Merchant. 2005. "Childhood Obesity, Prevalence and Prevention." *Nutrition Journal* 4 (1): 24. https://doi.org/10.1186/1475-2891-4-24.

Elks, Cathy E., Marcel den Hoed, Jing Hua Zhao, Stephen J. Sharp, Nicholas J. Wareham, Ruth J. F. Loos, and Ken K. Ong. 2012. “Variability in the Heritability of Body Mass Index: A Systematic Review and Meta-Regression.” *Frontiers in Endocrinology* 3. https://doi.org/10.3389/fendo.2012.00029.

Expatica. 2021a. “Obesity Costs Portugal 1.2 Billion Euros a Year.” Expatica Portugal. October 26, 2021. https://www.expatica.com/pt/news/obesity-costs-portugal-1-2-billion-euros-a-year-103471/.

———. 2021b. “Obesity Costs Portugal 1.2 Billion Euros a Year.” Expatica Portugal. October 26, 2021. https://www.expatica.com/pt/news/obesity-costs-portugal-1-2-billion-euros-a-year-103471/.

Farooqi, I. Sadaf, Julia M. Keogh, Giles S.H. Yeo, Emma J. Lank, Tim Cheetham, and Stephen O’Rahilly. 2003. “Clinical Spectrum of Obesity and Mutations in the Melanocortin 4 Receptor Gene.” *New England Journal of Medicine* 348 (12): 1085–95. https://doi.org/10.1056/NEJMoa022050.

Fraser, Alec, Stefanie Tan, Annette Boaz, and Nicholas Mays. 2020. “Backing What Works? Social Impact Bonds and Evidence-Informed Policy and Practice.” *Public Money & Management* 40 (3): 195–204. https://doi.org/10.1080/09540962.2020.1714303.

Frayling, Timothy M., Nicholas J. Timpson, Michael N. Weedon, Eleftheria Zeggini, Rachel M. Freathy, Cecilia M. Lindgren, John R. B. Perry, et al. 2007. “A Common Variant in the *FTO* Gene Is Associated with Body Mass Index and Predisposes to Childhood and Adult Obesity.” *Science* 316 (5826): 889–94. https://doi.org/10.1126/science.1141634.

GoodFinance. n.d. “Social Impact Bonds.” GoodFinance. https://www.goodfinance.org.uk/social-impact-bonds.

Graça, Pedro, Maria João Gregório, Sofia Mendes De Sousa, Sónia Brás, Tatiana Penedo, Telmo Carvalho, Narcisa M. Bandarra, et al. 2018. “A New Interministerial Strategy for the Promotion of Healthy Eating in Portugal: Implementation and Initial Results.” *Health Research Policy and Systems* 16 (1): 102. https://doi.org/10.1186/s12961-018-0380-3.

Graça, Pedro, Maria João Gregório, and Maria da Graça Freitas. 2020. “A Decade of Food and Nutrition Policy in Portugal (2010–2020).” *Portuguese Journal of Public Health* 38 (2): 94–118. https://doi.org/10.1159/000510566.

Gustafsson-Wright, Emily, Sophie Gardiner, and Vidya Putcha. 2015. “The Potential and Limitations of Impact Bonds.” Brookings.

Harrison, Flo, and Andrew P. Jones. 2012. “A Framework for Understanding School Based Physical Environmental Influences on Childhood Obesity.” *Health & Place* 18 (3): 639–48. https://doi.org/10.1016/j.healthplace.2011.12.009.

Hayes, Adam. 2022. “Scenario Analysis: How It Works, Examples and FAQs.” May 17, 2022. https://www.investopedia.com/terms/s/scenario_analysis.asp.

Higgins, Vanessa, and Angela Dale. 2010. “Ethnic Differences in Overweight and Obese Children in England.” The University of Manchester. https://hummedia.manchester.ac.uk/institutes/cmist/archive-publications/working-papers/2010/2010-07-ethnic-differences.pdf.

Hirshkowitz, Max, Kaitlyn Whiton, Steven M. Albert, Cathy Alessi, Oliviero Bruni, Lydia DonCarlos, Nancy Hazen, et al. 2015. “National Sleep Foundation’s Updated Sleep Duration Recommendations: Final Report.” *Sleep Health* 1 (4): 233–43. https://doi.org/10.1016/j.sleh.2015.10.004.

Huffman, Fatma G., Sankarabharan Kanikireddy, and Manthan Patel. 2010. “Parenthood—A Contributing Factor to Childhood Obesity.” *International Journal of Environmental Research and Public Health* 7 (7): 2800–2810. https://doi.org/10.3390/ijerph7072800.

Huiberts, Irma, Amika Singh, Frank J. van Lenthe, Mai Chinapaw, and Dorine Collard. 2022. "Evaluation Proposal of a National Community-Based Obesity Prevention Programme: A Novel Approach Considering the Complexity Perspective." *International Journal of Behavioral Nutrition and Physical Activity* 19 (1): 31. https://doi.org/10.1186/s12966-022-01271-7.

Isong, Inyang A., Sowmya R. Rao, Marie-Abèle Bind, Mauricio Avendaño, Ichiro Kawachi, and Tracy K. Richmond. 2018. "Racial and Ethnic Disparities in Early Childhood Obesity." *Pediatrics* 141 (1): e20170865. https://doi.org/10.1542/peds.2017-0865.

Janssen, Ian, Wendy M. Craig, William F. Boyce, and William Pickett. 2004. "Associations Between Overweight and Obesity With Bullying Behaviors in School-Aged Children." *Pediatrics* 113 (5): 1187–94. https://doi.org/10.1542/peds.113.5.1187.

Kanellopoulou, Aikaterini, George Antonogeorgos, Konstantinos Douros, and Demosthenes B. Panagiotakos. 2022. "The Association between Obesity and Depression among Children and the Role of Family: A Systematic Review." *Children* 9 (8): 1244. https://doi.org/10.3390/children9081244.

Kelly, Aaron S., Sarah E. Barlow, Goutham Rao, Thomas H. Inge, Laura L. Hayman, Julia Steinberger, Elaine M. Urbina, Linda J. Ewing, and Stephen R. Daniels. 2013. "Severe Obesity in Children and Adolescents: Identification, Associated Health Risks, and Treatment Approaches: A Scientific Statement From the American Heart Association." *Circulation* 128 (15): 1689–1712. https://doi.org/10.1161/CIR.0b013e3182a5cfb3.

KPMG. 2013. "Social Impact Bonds Planting for Future Growth." KPMG. https://assets.kpmg.com/content/dam/kpmg/pdf/2013/04/social_impact_bonds_web.pdf.

Lee, Yung See. 2009. "Consequences of Childhood Obesity." *Annals of the Academy of Medicine, Singapore* 38 (1): 75–81. https://doi.org/10.47102/annals-acadmedsg.V38N1p75.

Lehnert, Thomas, Diana Sonntag, Alexander Konnopka, Steffi Riedel-Heller, and Hans-Helmut König. 2013. "Economic Costs of Overweight and Obesity." *Best Practice & Research Clinical Endocrinology & Metabolism* 27 (2): 105–15. https://doi.org/10.1016/j.beem.2013.01.002.

Lindberg, Louise, Pernilla Danielsson, Martina Persson, Claude Marcus, and Emilia Hagman. 2020. "Association of Childhood Obesity with Risk of Early All-Cause and Cause-Specific Mortality: A Swedish Prospective Cohort Study." Edited by Lars Åke Persson. *PLOS Medicine* 17 (3): e1003078. https://doi.org/10.1371/journal.pmed.1003078.

Livingstone, M. Barbara E., and L. Kirsty Pourshahidi. 2014. "Portion Size and Obesity." *Advances in Nutrition* 5 (6): 829–34. https://doi.org/10.3945/an.114.007104.

Maes, Hermine H. M., Michael C. Neale, and Lindon J. Eaves. 1997. "Genetic and Environmental Factors in Relative Body Weight and Human Adiposity." *Behavior Genetics* 27 (4): 325–51. https://doi.org/10.1023/A:1025635913927.

Moens, Ellen, Caroline Braet, Guy Bosmans, and Yves Rosseel. 2009. "Unfavourable Family Characteristics and Their Associations with Childhood Obesity: A Cross-Sectional Study." *European Eating Disorders Review* 17 (4): 315–23. https://doi.org/10.1002/erv.940.

Mohammadian Khonsari, Nami, Ehsan Shahrestanaki, Amir Ehsani, Sara Asadi, Leily Sokoty, Sahar Mohammadpoor Nami, Benyamin Hakak-Zargar, and Mostafa Qorbani. 2023. "Association of Childhood and Adolescence Obesity with Incidence and Mortality of Adulthood Cancers. A Systematic Review and Meta-Analysis." *Frontiers in Endocrinology* 14 (January): 1069164. https://doi.org/10.3389/fendo.2023.1069164.

Mu, Min, Li-Fa Xu, Dong Hu, Jing Wu, and Ming-Jie Bai. 2017. “Dietary Patterns and Overweight/Obesity: A Review Article.” *Iranian Journal of Public Health* 46 (7): 869–76.

Nazari Chamaki, Foroogh, Glenn Paul Jenkins, and Majid Hashemi. 2019. “Social Impact Bonds: Implementation, Evaluation, and Monitoring.” *International Journal of Public Administration* 42 (4): 289–97. https://doi.org/10.1080/01900692.2018.1433206.

Niehoff, Vonzie. 2009. “Childhood Obesity: A Call to Action.” *Bariatric Nursing and Surgical Patient Care* 4 (1): 17–23. https://doi.org/10.1089/bar.2009.9996.

OECD. 2016. “Understanding Social Impact Bonds.” OECD. 2016. https://www.oecd.org/cfe/leed/UnderstandingSIBsLux-WorkingPaper.pdf.

———. 2022. “Average Number of Students per Primary Level Class in Selected European Countries in 2019.” Statista. March 2022.

Okunogbe, A, R Nugent, G Spencer, J Powis, J Ralston, and J Wilding. 2022. “The Economic Impact of Overweight & Obesity in 2020 and 2060.” 2nd Edition with Estimates for 161 Countries. BMJ Global Health 2022. https://data.worldobesity.org/publications/WOF-Economic-Impacts-2-V2.pdf.

Pordata. 2023. “Inflation Rate (Growth Rate - Consumer Price Index): Total and Individual Consumption by Purpose.” Pordata. December 4, 2023. https://www.pordata.pt/en/Portugal/Inflation+Rate+(Growth+Rate+++Consumer+Price+Index)+total+and+individual+consumption+by+purpose-2315.

Portugal Inovação Social. n.d. “PORTUGAL SOCIAL INNOVATION.” Accessed May 14, 2023. https://inovacaosocial.portugal2020.pt/en/about-us/portugal-inovacao-social/?doing_wp_cron=1683409880.3055160045623779296875.

Powell, Lisa M., Glen Szczypka, Frank J. Chaloupka, and Carol L. Braunschweig. 2007. “Nutritional Content of Television Food Advertisements Seen by Children and Adolescents in the United States.” *Pediatrics* 120 (3): 576–83. https://doi.org/10.1542/peds.2006-3595.

Puga, Ana M., Alejandra Carretero-Krug, Ana M. Montero-Bravo, Gregorio Varela-Moreiras, and Teresa Partearroyo. 2020. “Effectiveness of Community-Based Interventions Programs in Childhood Obesity Prevention in a Spanish Population According to Different Socioeconomic School Settings.” *Nutrients* 12 (9): 2680. https://doi.org/10.3390/nu12092680.

Rito, Ana, Sofia Mendes, Joana Baleia, and Maria João Gregório. 2021. “Childhood Obesity - Surveillance Initiative COSI Portugal 2019.” Instituto Nacional de Saúde Doutor Ricardo Jorge. https://www.ceidss.com/wp-content/uploads/2021/10/COSI_Portugal_2019_out2021.pdf.

Rodrigues, Daniela, Magdalena Muc, Aristides M. Machado-Rodrigues, and Cristina Padez. 2021. “Less Obesity but Higher Inequalities in Portuguese Children: Trends of Childhood Obesity between 2002–2016.” *Acta Paediatrica* 110 (5): 1526–33. https://doi.org/10.1111/apa.15708.

Sahoo, Krushnapriya, Bishnupriya Sahoo, AshokKumar Choudhury, NighatYasin Sofi, Raman Kumar, and AjeetSingh Bhadoria. 2015. “Childhood Obesity: Causes and Consequences.” *Journal of Family Medicine and Primary Care* 4 (2): 187. https://doi.org/10.4103/2249-4863.154628.

Sallis, James F., Judith J. Prochaska, and Wendell C. Taylor. 2000. “A Review of Correlates of Physical Activity of Children and Adolescents:” *Medicine & Science in Sports & Exercise*, May, 963–75. https://doi.org/10.1097/00005768-200005000-00014.

Saxena, S., G. Ambler, T. J. Cole, and A. Majeed. 2004. “Ethnic Group Differences in Overweight and Obese Children and Young People in England: Cross Sectional Survey.” *Archives of Disease in Childhood* 89 (1): 30–36.

Schattenberg, Jörn M. 2015. “Nicht-alkoholische Fettleber (NAFLD) und nicht-alkoholische Steatohepatitis (NASH): Pathophysiologie und Ernährungsaspekte.” *Ernährungs Umschau*, February, M92–100.

Schwimmer, Jeffrey B. 2003. “Health-Related Quality of Life of Severely Obese Children and Adolescents.” *JAMA* 289 (14): 1813. https://doi.org/10.1001/jama.289.14.1813.

Shah, Bindra, Katherine Tombeau Cost, Anne Fuller, Catherine S. Birken, and Laura N. Anderson. 2020. “Sex and Gender Differences in Childhood Obesity: Contributing to the Research Agenda.” *BMJ Nutrition, Prevention & Health* 3 (2): 387–90. https://doi.org/10.1136/bmjnph-2020-000074.

Simmonds, M., A. Llewellyn, C. G. Owen, and N. Woolacott. 2016. “Predicting Adult Obesity from Childhood Obesity: A Systematic Review and Meta-Analysis: Adult Obesity from Childhood Obesity.” *Obesity Reviews* 17 (2): 95–107. https://doi.org/10.1111/obr.12334.

Social Finance. n.d. “Impact Bonds.” Social Finance. https://www.socialfinance.org.uk/what-we-do/social-impact-bonds.

Sorof, Jonathan, and Stephen Daniels. 2002. “Obesity Hypertension in Children: A Problem of Epidemic Proportions.” *Hypertension* 40 (4): 441–47. https://doi.org/10.1161/01.HYP.0000032940.33466.12.

Stanciu, Cristian, Sabin Rizescu, Cristi Spulbăr, and Narcis Mitu. 2009. “Will Eastern European Countries Join the Single European Currency Rapidly?” Annals of the University of Petrosani.

Suglia, Shakira F., Rachel C. Shelton, Amber Hsiao, Y. Claire Wang, Andrew Rundle, and Bruce G. Link. 2016. “Why the Neighborhood Social Environment Is Critical in Obesity Prevention.” *Journal of Urban Health* 93 (1): 206–12. https://doi.org/10.1007/s11524-015-0017-6.

The Government Outcomes Lab. n.d. “Impact Bonds.” Golab.Bsg.Ox.Ac.Uk. https://golab.bsg.ox.ac.uk/the-basics/impact-bonds/#the-benefits-and-limitations-around-impact-bonds.

Trogdon, J. G., E. A. Finkelstein, T. Hylands, P. S. Dellea, and S. J. Kamal-Bahl. 2008. “Indirect Costs of Obesity: A Review of the Current Literature: Indirect Costs of Obesity.” *Obesity Reviews* 9 (5): 489–500. https://doi.org/10.1111/j.1467-789X.2008.00472.x.

Tsaousis, Ioannis. 2016. “The Relationship of Self-Esteem to Bullying Perpetration and Peer Victimization among Schoolchildren and Adolescents: A Meta-Analytic Review.” *Aggression and Violent Behavior* 31 (November): 186–99. https://doi.org/10.1016/j.avb.2016.09.005.

Tsenoli, Maido, Jane Elizabeth Moverley Smith, and Moien AB Khan. 2021. “A Community Perspective of COVID-19 and Obesity in Children: Causes and Consequences.” *Obesity Medicine* 22 (March): 100327. https://doi.org/10.1016/j.obmed.2021.100327.

UNDP. 2021. “Assessment of the Feasibility of Impact Bonds in Kyrgyzstan.” https://www.undp.org/sites/g/files/zskgke326/files/2022-06/INFF%20FInal%20Report.pdf.

Vazquez, Christian E., and Catherine Cubbin. 2020. “Socioeconomic Status and Childhood Obesity: A Review of Literature from the Past Decade to Inform Intervention Research.” *Current Obesity Reports* 9 (4): 562–70. https://doi.org/10.1007/s13679-020-00400-2.

Veerman, J. L., E. F. Van Beeck, J. J. Barendregt, and J. P. Mackenbach. 2009. “By How Much Would Limiting TV Food Advertising Reduce Childhood Obesity?” *The European Journal of Public Health* 19 (4): 365–69. https://doi.org/10.1093/eurpub/ckp039.

Weihrauch-Blüher, Susann, Kartin Kromeyer-Hauschild, Christine Graf, Kurt Widhalm, Ulrike Korsten-Reck, Birgit Jödicke, Jana Markert, et al. 2018. "Current Guidelines for Obesity Prevention in Childhood and Adolescence." *Obesity Facts* 11 (3): 263–76. https://doi.org/10.1159/000486512.

WHO. 2022. "WHO European Regional Obesity: Report 2022." Copenhagen: WHO, Regional Office for Europe.

World Health Organization. 2021. "Obesity and Overweight." World Health Organization. June 9, 2021. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

World Obesity Federation. 2020. "Portugal." Global Obesity Observatory. 2020. https://data.worldobesity.org/country/portugal-174/.

Youth Health Community. n.d. "Build to Last: Sustaining Long Term Support of a Healthy Lifestyle." Youth Health Community. Accessed December 5, 2023. https://youthhealthcommunity.com/scaling-up-progressively/mun-si.