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Assessing the Feasibility of a SIB to Target Overweight and Obese Children in Portugal – Assessing a Suitable Outcome Metric

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Abstract (100 words maximum)

Like many other countries, Portugal is witnessing the social issue of childhood obesity leading to an increased cost burden. This thesis aims to assess the feasibility of a SIB in tackling this social issue in Portugal. After conducting a thorough analysis of the issue, potential intervention options, and a suitable outcome metric, a SIB was developed through an Excel model. This study suggests that replicating a combination of MUN-SI and JOGG on the Azores for elementary school-aged children can be viable and likely to create social and financial value for all stakeholders.

Keywords: Impact Investment, SIBs, Childhood Obesity, Portugal

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Table of Content

Table of Figures

Table of Tables

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, this thesis will commence with *chapter 3*, providing a comprehensive exploration of SIBs, encompassing their conceptual framework, objectives, associated benefits, involved stakeholders, historic development, current landscape, and developmental process. *Chapter 4* 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. Subsequently, in *chapter 5,* five existing intervention models targeted at addressing childhood obesity within the context of a potential SIB will be delineated and evaluated based on their effectiveness. *Chapter 6* will delve into an analysis of diverse outcome metrics and measures employed to combat childhood obesity, considering the appropriateness of their incorporation within a SIB framework. Building upon the insights garnered from *chapters 3 to 6*, the subsequent chapters *7 to 9* will meticulously expound upon a potential SIB tailored to address childhood obesity in Portugal. *Chapter 7* will ascertain the feasibility of this SIB by examining its prospective framework and subjecting it to feasibility criteria. In *chapter 8,* 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 9* 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 10* 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 11.*

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 towards 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 for the *chapters 3 to 6*, where the concept of SIBs, childhood obesity as a social challenge, existing intervention models, and outcome metrics are examined. These chapters rely 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 7 to 9.* 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 developing of a SIB follows the guidelines proposed by Social Finance UK (2013). These are explained in further detail in *chapter 3.2.*

1

3. Assessing a Suitable Outcome Metric

3.1. The Importance of Outcome Metrics in SIBs

Selecting an appropriate outcome metrics is crucial for the success of a SIB, as it involves partnering with public and private entities in the context of an outcome-based contract. Trust and measurability are essential for all stakeholders to rely on an agreed-upon objective mechanism for measuring and evaluating the degree to which the target value has been achieved (Social Finance 2013). Effective outcome measurement not only provides a way of determining the outcome payment but allows a better understanding of the broader impact of the provided service (Deloitte n.d.) by enhancing transparency in evaluating the project's performance, both qualitatively and quantitively. It fosters public accountability, spurs citizen engagement and encourages collaboration across multiple organizations (Young n.d.). By focusing on the outcome rather than solely on the measures taken within the project, an outcome-based approach allows flexibility in choosing the most efficient interventions and freely adapting to developments within the project. This ensures efficiency and sustainable success of the intervention (Young n.d.). This ensures efficiency and sustainable success of the intervention (Young n.d.). Furthermore, outcome metrics hold program managers and service providers accountable for meeting the target values marking them critical to the success of a SIB as they ensure that the social issue is continuously addressed in the most efficient way (Deloitte n.d.).This ensures efficiency and sustainable success of the intervention (Young n.d.). Furthermore, outcome metrics hold program managers and service providers accountable for meeting the target values (Deloitte n.d.), marking them critical to the success of a SIB as they ensure that the social issue is continuously addressed in the most efficient way (Young n.d.).

To define the outcome of impact, however, is one of the most significant challenges in creating a sustainable and successful SIB (Young n.d.). Defining the desired outcome framework is challenging but essential (European Investment Advisory Hub 2021). Establishing the

framework contains the process of defining the outcome itself (i), deciding on its tool of measurement (ii), and specifying the targeted values that are strived to be achieved (iii) .

(i.) *Defining the Outcome*. When defining the desired outcomes, a distinction is made between primary and secondary outcomes. The primary outcome represents the most important target, while the secondary outcome encompasses goals that are related to the primary outcome. These outcomes should be aligned with the contract objective and can be categorized as hard or soft, depending on whether they are objectively or subjectively measured. The desired outcomes may also include proxy outcomes that serve as indicators of progress and advancement towards the primary target (Young, n.d.).

(ii.) *Tool of Measurement*. Selecting a tool of measurement that provides reliable and consistent results is a key element to ensure the success of innovation and the accuracy of payment mechanism. Only reliable measurements can function as a dependable foundation for payouts to investors. Selecting a tool of measurement that provides reliable and consistent results is a key element to ensure the success of innovation and the accuracy of payment mechanisms (Social Finance Ltd. 2013). Only reliable measurements can function as a dependable foundation for payouts to investors. Additionally, it is important to consider the potential impact of external factors that may influence the targeted issue of the SIB such as new governmental implementations or changes in local practices (Social Finance Ltd. 2013). The measurement of objectives can be evaluated according to primary or secondary either on the cohort or individual level, drawing on reference values from previous interventions providing predictabilities and comparison (Young, n.d.).

(iii.) *Defining Target Values.* The achievement of specified outcomes directly affects the payments made to providers and investors, making it crucial to choose targets that are achievable to ensure the success of the contract (Deloitte, n.d.). However, this increased

emphasis on outcome-based investor payout has raised the importance of preventing unethical practices. It is crucial to avoid perverse incentives in the selection of outcome measures and targets, such as "cherry-picking" or "parking" , deliberately choosing individuals who are beneficial to the targets, omitting individuals who might cause more costs negatively influencing the savings when selecting the cohort (Socha-Dietrich and Zweifel 2014), as this would intentionally misrepresent the results.

Based on the previous analysis, the following criteria should be considered when selecting outcome metrics to ensure long-term success of the contract.

(i.) Is the desired outcome aligned with long-term policy objectives and the established financial analysis (Young, n.d.)?

(ii.) Is the outcome measurable in a reliable way, at a reasonable cost, effort and within a certain time frame? If not, is there a suitable alternative in the proxy outcome available (European Investment Advisory Hub 2021)?

(iii.) Does the chosen outcome metric eliminate the opportunity of potential perverse incentives (Social Finance Ltd. 2013)?

(iv.) Are there any external factors that could influence the measurement of the outcome metrics and thus distort the results (European Investment Advisory Hub 2021)?

These will also form the basis for the decision of the most efficient outcome measure related to childhood obesity in the remainder of this chapter and provide the framework that will be referred to as the checklist below.

3.2. Defining Outcome Metrics for Measuring Childhood Obesity

3.2.1. Challenges of Measuring Child Obesity and Approaches

Effectively measuring the child's weight is a crucial aspect of monitoring and preventing childhood obesity as part of the SIB. The following will dive further into the analysis of the in chapter 4.5 briefly outlined measures of obesity. It will analyze the most relevant measures of

child obesity according to various research papers (Rönnecke 2020; Hu 2008; Zinn 2022) to evaluate their suitability as outcome measures in the context of a SIB.

Hydrodensitometry and Air-Displacement Plethysmography are two measurements of obesity that obtain the percentage of body fat mass by calculating body volume and density (Hu 2008). The feasibility of these methods is however limited, firstly, as the procedures take a large amount of time and spatial requirements, and secondly, by the limited acceptance of the test subjects and will therefore be disregarded in the further analysis (Rönnecke 2020).

3.2.2. Body-Mass-Index (BMI)

The most used indicator of child obesity is the BMI as it is the currently recommended tool of measurement by the World Health Organization (WHO 2022). The BMI is measured by the quotient of the individual's body weight in kg divided by the square of body length measured in meters (kg/m2) (CDC, n.d.). Its value correlates with obesity as it reflects the person's weight status, indicating potential negative effects on their health and life expectancy (WHO 2022). The BMI for children is calculated identical as for the adults but is then adjusted to their age, sex, and developmental stage. The initial score is plotted on provided growth charts to obtain a percentile ranking, illustrating how a child's BMI compares with other children of the same age and sex (WHO 2022). The WHO provides growth charts and recommends the following BMI percentiles for children aged 5 to 19 years as reference metrics (Kuczmarski et al. 2002).

Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obesity	Equal to or greater than the 95th percentile

Table 1: Data from the CDC (Centers for Disease Control and Prevention), 2020

The BMI as measurement has clear advantages compared to other tools, as it is simple to use and only requires two measures, the weight and height (Borga et al. 2018), which are easily obtained. Because the BMI is widely accepted and used, it is well suited for population-based assessments of obesity, ensures comparability and thus often forms the basis for health planning

and interventions (Hu 2008). Due to its longstanding recognition as norm, it is highly associated with health risks such as diabetes II and cardiovascular disease (Jastreboff et al. 2022), as well as certain cancers (NIH n.d.). This provides a wealth of reference data to easily link an increased risk of diseases to a specific index.

However, while ease of use and broad acceptance are two significant benefits of the BMI, there are numerous challenges associated with its use. One of the main drawbacks of using BMI as measure is that it does not differentiate between factors such as body composition and ethnicities (Krause 2014; Ko et al. 2012). The numerator within the formula does not distinguish lean muscle from fat mass, disregarding body composition. This oversight could potentially lead to ignoring health risks in a child with a standard BMI but a high level of visceral fat (WHO 2022). Neglecting the body composition of a child might potentially lead to misconceptions, as an athlete for example might reach a score that would indicate obesity, even though they in fact have a high muscle mass and low body fat (CDC n.d.). Similarly, body composition changes throughout a child's development, particularly during puberty, which can lead to misinterpretation of the results when compared to its peers. Identical measurements of BMI could indicate different relevance to health risks in different development stages (Krause 2014; Rönnecke 2020). Furthermore, issues of comparability might arise due to potential differences in the body composition among different ethnic groups, which require a more differentiated tool to ensure a comprehensive measurement (Borga et al. 2018).

In summary, the BMI is easily measurable due to its low cost, comparability, and ease of use in measurement. However, the lack of consideration of the child's body composition in the BMI and its potential proneness to errors can possibly interfere with accurately measuring the reduction of child obesity reliably.

3.2.3. Waist Circumference

A different approach of measuring obesity is waist circumference as a simple and non-invasive way to assess abdominal fat. The measurements are taken by wrapping a tape measure around the child's waist, specifically at the upper part of the hip bones, the iliac crest. (Ross et al. 2020). Subsequently, the measured index will be plotted against the percentile growth chart in order to draw implications on the child's weight status. This measuring procedure can be performed by professional health workers with minimal training, ensuring widespread accessibility (Hu 2008). It is however essential to take the measurements constantly at the same time and in the same position to ensure accuracy.

Violating those recommendations might lead to errors in measurement, distorting the results (Schienkiewitz et al. 2013).

Waist circumference is a valuable measurement for assessing abdominal fat content for patients before and during weight loss treatment, as it helps detecting early-stage obesity-related health risks (The American Journal of Clinical Nutrition 1998). Several studies have demonstrated evidence that it provides independent and additive information to the BMI in measuring obesity and predicting health conditions. For instance, Ko et al. (2012), identified a high relevance for waist circumference as an addition to the BMI regarding mortality risk, while other studies found evidence that waist circumference is more accurate in predicting cardiovascular diseases (Darbandi et al. 2020).

However, there are notable issues reaching consensus in reference values for waist circumference measurement. Literature reports up to four different recommended reference points of measurement on the waist (Schienkiewitz, Damerow, and Schaffrath Rosario 2019), significantly influencing the interpretation of collected data. Unlike adults, there is furthermore a lack of agreed-upon cut-off values for children (Schienkiewitz et al. 2013). The American Academy of Pediatrics (AAP) recommends using the 90th percentile as threshold for defining

abdominal obesity in children, but there are significant differences in the reference percentiles in international comparison (Flynn, Kaelber, and Baker Smith, 2017). It remains however unclear whether these differences are due to the age of studies or actual international disparities (Schienkiewitz et al. 2013). Hence, waist circumference should not be examined as a stand-alone measurement but rather be used in conjunction with other measurements, such as BMI, to get a comprehensive picture of a child's weight status (Ross et al. 2020; World Health Organization 2011).

3.2.4. Waist-To-Hip Measurement (WHR) and Waist-to-Height Measurement (WHtR)

The waist-to-hip measurement (WHR) and waist-to-height measurement (WHtR) are additional measures used to assess abdominal obesity. The WHR is calculated by dividing the waist measurement by the hip measurement while the WHtR divides the waist measurement by the child's height (Savva et al. 2000; Schienkiewitz et al. 2013). These measures offer clear advantages such as the ease of use and cost-effectiveness (Hu 2008). However, they also bear challenges. The lack of acknowledged cut-off points for the WHR of children makes it impossible to compare results (Schienkiewitz et al. 2013). Additionally, WHR is a less suitable indicator for the determination of body fat, fat distribution or overweight and thus associated cardiovascular risk factors compared to BMI or waist circumference (Savva et al. 2000; World Health Organization 2011). Measuring the WHR might also pose the risk of errors in interpretation of results, as an increase of the index could be either be due to the increase of abdominal fat or the decrease of lean mass around the hips. The child's weight reduction could therefore potentially lead to a decrease in waist and hip circumference equally, resulting in an unchanged WHR despite leaner body proportions (Hu 2008). In contrary to the WHR, the WHtR, is generally accepted to use the age-independent reference value of 0.5 for obesity (Schienkiewitz, Damerow, and Schaffrath Rosario 2019), allowing comparability of results. However, the improved accuracy in findings compared with waist circumference or BMI in

relation to cardiovascular risk factors are not proven (Schienkiewitz et al. 2013), raising questions of its effectiveness in use.

To summarize, the limited additional evidence and less widely accepted cut-off ranges are significant challenges in measurement, both for the waist-to-hip ratio (WHR) and the waist-to-height ratio (WHtR). While these measurements provide some valuable information, their use as standalone measures may not be sufficient to accurately assess a child's weight status and associated health risks.

3.2.5. Skinfold Thickness

Skinfold thickness measurement is a technique commonly used to estimate body fat percentage (Rönnecke 2020). This method measures the thickness of a fold of skin at various points on the body, such as the triceps, biceps, subscapular and suprailia regions using a caliper. (Hu 2008). The values will then be adjusted to age and reference values and calculated according to various formulas as for example the following introduced by Deurenberg (Zinn 2022).

Boys	D = 1.1133 - 0.0561 · log (Sum of 4 skinfolds) + 1.7 · Age · 0.001
Girls	D = 1.1187 - 0.063 · log (Sum of 4 skinfolds) + 1.9 · Age · 0.001

Table 2: Formulas to evaluate Skinfold Thickness (Zinn 2022)

Skinfold thickness is an accessible, affordable, non-invasive and effective tool for tracking progress of weight loss over time (Hu 2008; Silveira et al. 2020). However, it's accuracy and consistency of measurement can potentially be influenced by various factors, including the proficiency of the person conducting the measurements, the type of caliper used, and the natural variation in skin and fat thickness in different parts of the body (Louer et al. 2017). It may also yield variable results depending on the time of day, hydration levels, and chronic diseases (Maastricht UMC+ n.d.). Moreover, the method might not be useful on children that exceed or undercut a certain value, indicating obesity or malnourishment. Studies declared skinfold thicknesses to be accurate in predicting body fat percentage, but stated that the measurement is prone to errors in measurement for children above the 95th percentile, as well as tends to

underestimate body fat percentage by up to 9 % if the child's percentage of body fat is too low (Freedman, Ogden, and Kit 2015).

Furthermore, there is a lack of globally accepted cut-off points, with different studies recommending various formulas to calculate the reference points (Zinn 2022). The WHO offers charts as reference points for the average of children according to age but does not provide a standard of calculation of reference point (World Health Organization n.d.). The potential errors in measurement due to its complexity, the lack of comparable data and standardized cut-off points as well as limited proof of relevance (McGee 2018), limits the effectiveness of the Skinfold thickness as a tool of measurement. As the direct comparison of measured values to previous data is a key aspect in the effectiveness of the outcome measurement does not qualify as stand-alone metrics. However, it qualifies as an additional measurement to interpret and assess child obesity in combination with the measure of BMI (Zinn 2022).

3.2.6. Bioelectrical Impedance Analysis (BIA)

Bioelectrical impedance analysis (BIA) is a method used to measuring body composition by passing a low-level electric current through the body and measuring the resistance encountered by the electric signal (Rönnecke 2020). The current faces more resistance when passing through body fat than it does when faced with lean body mass and water. The resistance indicates either total body water, body cell mass, extra cellular mass, fat free mass or fat mass (Walter-Kroker et al. 2011). Even though the BIA is a convenient and relatively inexpensive procedure, becoming increasingly attractive in use (Orsso et al. 2022), it does suffer from a lack of standardized methods and quality control procedures (Kyle 2004). The values are also hard to calibrate, and the ratio of the body water might differ during periods of dehydration, illness or weight loss (Kyle 2004). Additionally, the prognostic significance and clinical usefulness of BIA measurements in children is still not well-established due to limited evidence (Marra et al. 2019). While BIA techniques are considered safe and feasible, the absence of standardized

protocols and potential misinterpretation of results may compromise the validity of BIA measurements in children and adolescents (Orsso et al. 2022).

3.2.7. Dual-energy X-Ray Absorptiometry (DXA)

Dual-energy X-ray Absorptiometry (DXA) is a highly accurate tool for measuring obesity (Hu 2008; Rönnecke 2020). The method measures the person's estimated bone mineral density, lean mass and fat mass by simultaneously using two X-rays with different energy levels (Marra et al. 2019; Rönnecke 2020). The DXA measures the absorption of X-rays as they pass through the body. Materials with different densities show different attenuation characteristics depending on the energy of the X-rays, indicating body composition and thus obesity (Wilms and Schmid 2021; Radiologienetz n.d.). DXA is not only very accurate and precise in its measurement, making it very reliable, but it also analyzes the composition of the bones and soft tissue and determines the bone health of the child (Kelly, Wilson, and Heymsfield 2009).

However, the procedure is very costly as it requires specialized technology and trained professionals to perform the scan, making it more expensive than the previously mentioned measures (Wilms and Schmid 2021). Because of the high costs, it is less suitable for population-based analyses and rather used for research settings used on a person-based analysis (Hu 2008). It should also be noted that due to the radiation, the method might not be advisable to use for children in general and specifically not suitable for children with certain health conditions (Guglielmi et al. 2016; Rönnecke 2020).

3.2.8. Intermediary Outcome Measures of Obesity

SIBs commonly incorporate intermediate outcomes in addition to the primary outcomes to address people's varying needs and measure the process on an ongoing basis (Young n.d.). When tackling childhood obesity, integrating educational and behavioral outcome measures can be highly beneficial (Kyle 2004). Given that the impact of the intervention on the absolute

number of overweight children may require time, incorporating intermediary metrics becomes crucial to measure success or failure in the short-term (Young n.d.).

Behavioral measures could include achieving a certain physical of nutritional target, such as increasing time spent exercising, or measuring the consumption of certain foods, such as vegetables or fruits, and aiming for a percentage increase. Another approach includes educational measures, such as raising awareness of healthy eating habits or health issues related to obesity (Van Koperen. e.a 2014). However, as the educational impact is difficult to define and measure, it is important to link these interventions to a specific target measure that results from these activities (Young n.d.)

3.2.9. Key Learnings

The previously mentioned measurement tools each present different challenges as part of the controversially discussed predictive power of the individual parameters. The most accurate measurement tool, the DXA method, is costly and poses potential health risk for children. Despite its limitations, the BMI remains a reliable tool due to its global comparability and ease of measurement. Although the waist circumference and skinfold thickness are each not recommendable as a stand-alone measure, they might be a valuable additional measure in combination with the BMI. BIA, WHR and WHtR appear to be less recommendable in measurement due to the lack of standardized methods.

To comprehensively measure obesity, it is furthermore recommendable to add intermediary outcomes to the primary measures, targeting behavioral or educational patterns. These additional measures contribute to a more holistic understanding of the issue.

3.3. Best Practices from International Projects targeting Child Obesity

The following subchapter will focus on outcome metrics that were utilized in the in chapter 5 presented projects. The aim will be to pinpoint key learnings to glean valuable insights and learn from the knowledge gained from other projects. The chapter will then briefly outline the

best practices in those projects and subsequently identify optimal approaches used in other nations to assess their suitability of use for a SIB in Portugal.

3.3.1. JHB

The project Join the Healthy Boat (JHB), established in Germany chose a variation of primary and secondary outcomes to efficiently measure the success of their educational activities. The measurements for the study in Baden Württemberg were separated into physical activity, leisure activities, nutrition and health status. The chosen measures to examine each aspect were a six-minute run, the reduction of screen time and the number of children not eating breakfast before school. The primary metrics of measuring the child's weight status were the skinfold thickness and waist circumference (Kesztyüs and Steinacker 2017).

The results of the children running the six-minute run increased within one year of the project life span, with the distance growing at 11.5 meters for elementary school children and 21.01m for preschoolers. The screentime of children in elementary school using digital media for more than one hour a day decreased by 1.2 for the girls in one year within the project, and the number of 2nd graders not eating breakfast before school decreased by 0.2 % (Join the Healthy Boat n.d.; n.d.). While examining abdominal obesity, the results indicated an odds ratio of 0,48, indicating a significant decrease in the probability of incidental abdominal obesity for participants of the intervention (Join the Healthy Boat, n.d.; n.d.). The costs incurred for those reductions were 25.04 EUR per child a year (Kesztyüs and Steinacker 2017).

3.3.2. MUN-SI Project

The MUN-SI Project in Portugal targeted behavioral as well as health outcome metrics. It examined the preference of fruit and vegetables in school lunches, acquired knowledge about Mediterranean cuisine, the measurement of regular physical activity and an overall reduction of obesity scores. The results were measured by family questionnaires and according to the WHO child nutrition status criteria. They indicated an increase in the preference for including

fruit and vegetables in the school lunches that were prepared at home of 16 % in 2014 - 2015, 2,3 % in 2015-2016 and further 11.9 % in 2017 - 2018. They further measured a 4 % increase of regular physical activity and a reduction of 11.2 % in the prevalence of overweight 35.5 % to 24.3 % and 10.3 % of obesity (Rito, Mendes, and Lopes 2020).

3.3.3. JOGG

One of the main objectives of the JOGG project is the reduction of obesity prevalence, measured by BMI points. The results indicated a positive trend with a decrease of the BMI by 0.37 points throughout the project lifespan (OECD n.d.). The project further broadens its focus on intermediate outcome indicators, reflecting the children's behavior. Some of the by JOGG chosen measures are improvements enhancing the proportion of children who consume vegetables at least once daily or reducing the average consumption of sugary drinks and increasing the percentage of children who engage in at least 60 minutes of moderate physical activity daily (OECD n.d.). Another key priority of the project is its focus on evaluations of its implemented approaches, advising the dedication of 15 % of overall budget to constant monitoring in order to ensure the project's success (Van Koperen. e.a 2014).

3.3.4. AFHK and JANPA

Both the Action for Healthy Kids (AFHK) project and the Joint Action on Nutrition and Physical Activity (JANPA) project have established broad guidelines to measure success, with indicators such as political influence, guidelines, or successful participation of institutions. (Jackson and Pollock 1985; AFHK 2020) On the one hand, AFHK project places a strong emphasis on creating a healthy school environment that includes offering healthy food options and opportunities for physical activity. On the other hand, the JANPA project focuses on the collection and dissemination of nutritional information about foods to public health authorities, stakeholders, and families at JANPA (JANPA 2015).

3.3.5. Key Learnings

Upon analyzing the chosen projects, two main learnings became apparent. Firstly, employing a multifaceted approach seems crucial to the project's structure in combating childhood obesity. Implementing various activities aimed at reducing childhood obesity requires multiple outcome metrics to measure the project's outcome and development as efficiently as possible. Selecting a set of primary and intermediate outcome measures is essential to effectively monitor progress in children's weight status, as well as track their behavioral patterns, particularly their eating habits and physical activity. Secondly, it is crucial to prioritize the evaluation of the measures taken. A constant and comprehensive evaluation approach ensures agility in adapting to developments and changes in the project environment and children's behavior.

3.4. Suitability of the Covered Outcome Metrics for a SIB

As mentioned in subchapter 6.1, the criteria that determine whether an outcome metric is suitable or not in the context of a SIB is tied to four pillars. Its results must be reliable and financially actionable, ensuring the best possible measurement of project progress. It further must be aligned with the long-term contract objectives and needs to shield from potential perverse incentives. Lastly, it is indispensable that the measurement is resistant to external factors to ensure the project's success.

One of the most pressing issues that became apparent when evaluating the various metrics is the lack of standardized cutoff values that have been agreed upon. Waist circumference, skinfold thickness, waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) measurements each indicated a lack of global consistency in cut-off values for obesity. The differences in estimates limit the reliability of the measurement results, making these metrics less suitable as primary outcome measures in a SIB. Consequently, they do not meet criteria 1 of being aligned with the contract objective as they can't ensure reliable results. Although the measures are each inexpensive to measure, the lack of clear comparability may create perverse incentives that

favor achieving the initial target rather than achieving the goal of reducing child obesity, by utilizing the cut-off that is the most beneficial to achieve the target rates. Nonetheless, they should not be disregarded as an additional measure to a primary outcome measure, such as BMI, as their combination provides a more comprehensive measure of children's weight status. Similarly, the BIA method suffers from inconsistent cutoff values and is also prone to measurement errors due to variations in protocols and methods of measurement. This undermines the reliability of potential result measurements and increases the risk of misinterpretation and manipulation. Furthermore, the BIA method is more expensive than other measurement tools like BMI, skinfold thickness, or waist-to-hip ratio, which can be a concern for the financial health of a SIB. The issue of cost became also apparent when analyzing the method of DXA. Despite its superior accuracy in measuring obesity, the DXA method is not a viable outcome metric due to its high cost and potential risks to the child's health. Furthermore, it is the only covered outcome metric that is exposed to external influence, as countries, like for example, Germany have prohibited the use of the procedure on children due to potential health implications related to the radiation exposure (Rönnecke 2020).

The most suitable outcome metric appears to be BMI, despite its weakness of not analyzing body composition. Its key advantages, such as comparability due to global data as reference points and its status as a recommended tool of measurement by the WHO, outweigh the challenges it poses. Additionally, it provides relevant reference values for specific interventions as it has previously been utilized in projects such as JOGG and MUN-SI. The costs of measuring the BMI are low, and the process of measurement is straightforward and consistent, meeting the criteria for a reliable and suitable outcome metric. Moreover, the BMI is resistant to external influences and offers increased transparency, shielding from potential results manipulation.

In terms of suitable intermediary outcomes, educational measures are not appropriate as they pose challenges in measurement and making it difficult to link them directly to governmental savings. Instead, it is advisable to focus on specific metrics that can track progress resulting from increased health awareness, leading to behavioral changes. Behavioral outcome measures are reliable, cost-effective, and aligned with the goals of the SIB contract to reduce childhood obesity in the long-term. Suitable outcome metrics referenced in projects such as JOGG include the increase in the percentage of children who consume vegetables at least once per day, the percentage of children who consume sugary drinks, or the percentage children doing at least 60min or moderate to vigorous intensity physical activity daily (World Health Organization 2012). This specific target is based on the WHO's recommendation of 5 to 17 year old's to participate in at least accumulated 60 minutes of "moderate- to vigorous-intensity physical activity each day" (World Health Organization 2012).

As most of the costs resulting from obesity stem from health costs, see chapter 4.4., the suitable outcome pricing should be linked to a specific metric of decrease of BMI as primary outcome metric. For instance, the reduction of average BMI within the intervention period is linked to a previously agreed upon payout. To ensure the transparency and measurement accuracy of the results, constant measurement intervals should be included and performed by professionals.

Assesment Criteria	**BMI**	**Waist circumference**	**WHR/ WHtR**	**Skinfold thickness**	**BIA**	**DXA**
Aligned with objectives	⋆⋆	⋆⋆	⋆	⋆	⋆⋆	⋆⋆⋆
Financially achievable	⋆⋆⋆	⋆⋆⋆	⋆⋆⋆	⋆⋆⋆	⋆⋆	⋆
Guarded against perverse incentives	⋆⋆⋆	⋆⋆	⋆	⋆	⋆	⋆⋆⋆
Not exposed to external factors	⋆⋆⋆	⋆⋆⋆	⋆⋆⋆	⋆⋆⋆	⋆⋆⋆	⋆⋆
Total	92%	83%	67%	67%	67%	75%

Table 3: Suitability of the covered outcome measure as a primary outcome metric

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

As outlined in chapter 6.4, 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).

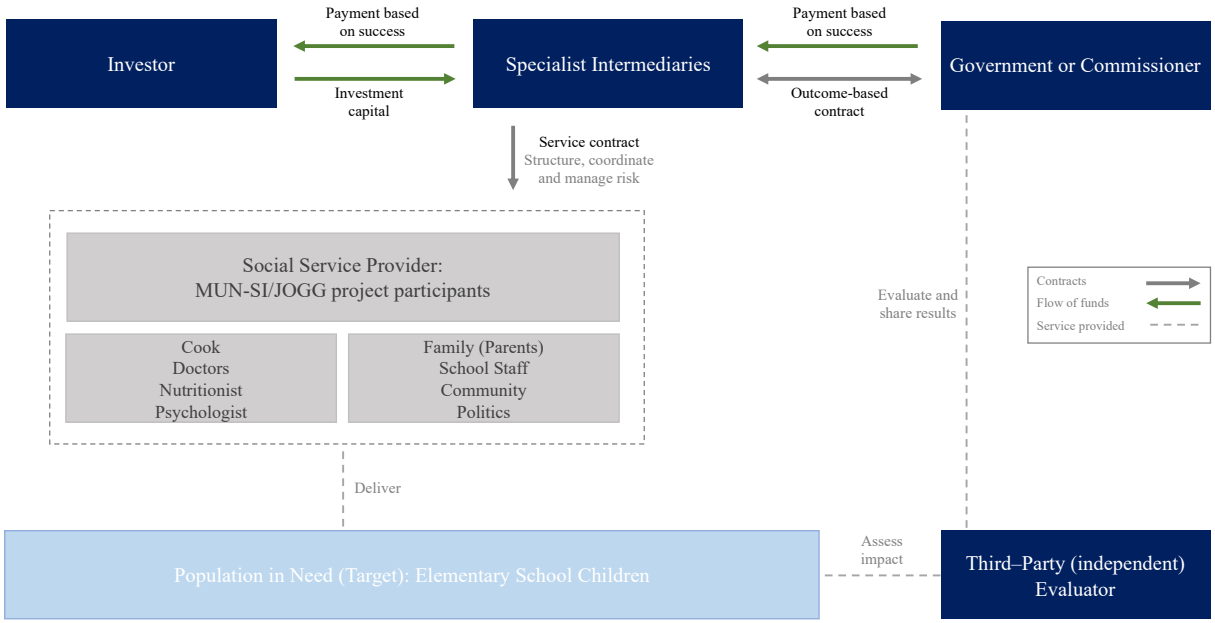

Figure 4: JOGG/MUN-SI Social Impact Bond Structure

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 8.1 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 4.1, 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 %P (see chapter 8.5.), 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 8.5., 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 8.5, the modelled 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 chapters 4 and 5, 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 4.1.: environmental and behavioral factors. To target the first cause, four pillars, also called intervention areas, were established:

(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) *Neighbourhood.* 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 4.7, 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 5: 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 8.1. "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,

"neighbourhood" 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 14). 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, as discussed in chapter 6 of this thesis. 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 %[1] of the total

[1] 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.

savings per child over their remaining lifetime of 73 years, provided that the child reduces their 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.

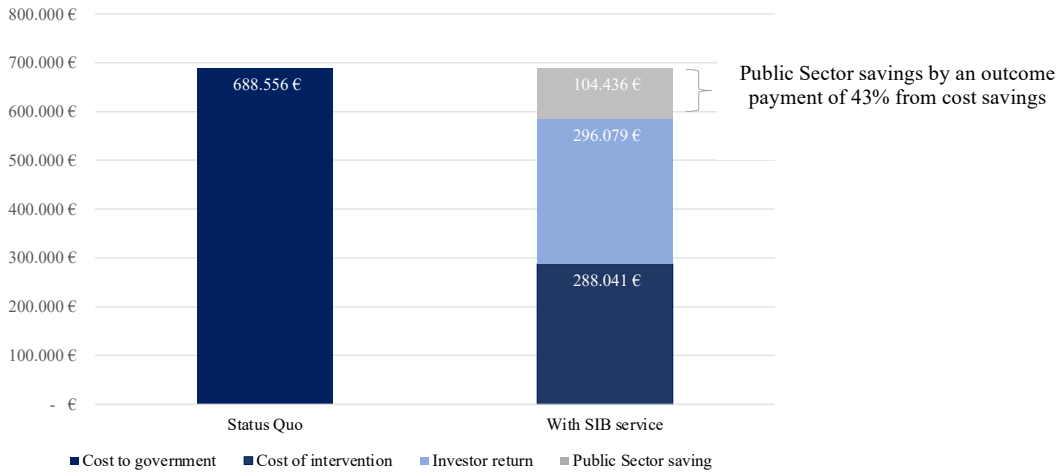

Figure 6: Public Sector Value Structure

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 9.1. 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 7: 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 8: 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 7: 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 4, 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, chapter 4 already discusses its limitations, which should be considered in further research and limit this project's ability to interpret the results. 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 4.2.2.).

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

1. Appendix – Intervention Model JOGG/MUN-SI

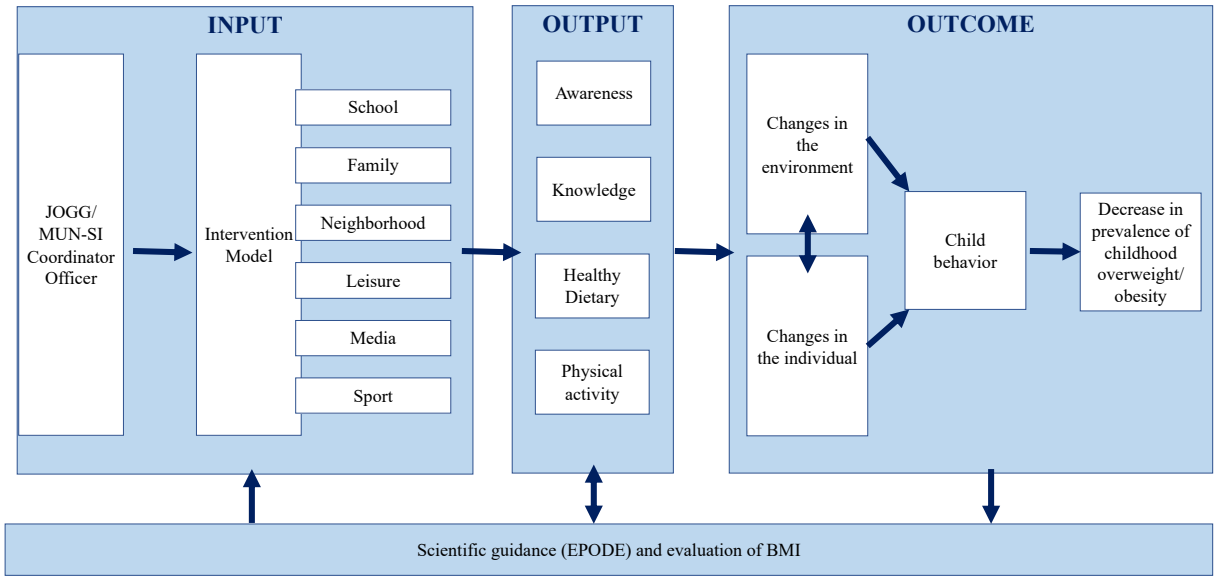

Figure 132: Illustration of the JOGG/MUN-SI Project for an elementary school on the Azores

2. 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

Table 18: Overview average cost per child per year

3. 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

AFHK. 2020. “2018-2019 Annual Report Card.” Action For Healthy Kids. https://www.actionforhealthykids.org/wp-content/uploads/2020/10/AFHK-2018-2019-Annual-Report-Card_FINAL.pdf.

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.

Borga, Magnus, Janne West, Jimmy D Bell, Nicholas C Harvey, Thobias Romu, Steven B Heymsfield, and Olof Dahlqvist Leinhard. 2018. “Advanced Body Composition Assessment: From Body Mass Index to Body Composition Profiling.” *Journal of Investigative Medicine* 66 (5): 1–9. https://doi.org/10.1136/jim-2018-000722.

Borys, J.-M., Y. Le Bodo, S. A. Jebb, J. C. Seidell, C. Summerbell, D. Richard, S. De Henauw, et al. 2012. “EPODE Approach for Childhood Obesity Prevention: Methods, Progress and International Development.” *Obesity Reviews* 13 (4): 299–315. https://doi.org/10.1111/j.1467-789X.2011.00950.x.

CDC. n.d. “About Child & Teen BMI.” Centers for Disease Control and Prevention. https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html#calculated.

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

Darbandi, Mitra, Yahya Pasdar, Shima Moradi, Hamid Jan Jan Mohamed, Behrooz Hamzeh, and Yahya Salimi. 2020. “Discriminatory Capacity of Anthropometric Indices for Cardiovascular Disease in Adults: A Systematic Review and Meta-Analysis.” *Preventing Chronic Disease* 17 (October): 200112. https://doi.org/10.5888/pcd17.200112.

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.

Deloitte. n.d. “Paying for Outcomes Solving Complex Societal Issues through Social Impact Bonds.” https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/gx-deloitte-wef-paying-outcomes-.pdf.

European Investment Advisory Hub. 2021. “SOCIAL OUTCOMES CONTRACTING IN EUROPE. An Introductory Guide to Social Outcomes Contracting in European Union Member States.” https://advisory.eib.org/publications/attachments/social-outcomes-contracting-in-Europe-10052021.pdf.

Flynn, JT, DC Kaelber, and CM Baker Smith,. 2017. “SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children

and Adolescents. *Pediatrics* . 2017; 140(3):E20171904." *Pediatrics* 140 (6): e20173035. https://doi.org/10.1542/peds.2017-3035.

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.

Freedman, David S., Cynthia L. Ogden, and Brian K. Kit. 2015. "Interrelationships between BMI, Skinfold Thicknesses, Percent Body Fat, and Cardiovascular Disease Risk Factors among U.S. Children and Adolescents." *BMC Pediatrics* 15 (1): 188. https://doi.org/10.1186/s12887-015-0493-6.

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

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.

Guglielmi, Giuseppe, Federico Ponti, Margherita Agostini, Michele Amadori, Giuseppe Battista, and Alberto Bazzocchi. 2016. "The Role of DXA in Sarcopenia." *Aging Clinical and Experimental Research* 28 (6): 1047–60. https://doi.org/10.1007/s40520-016-0589-3.

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

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

Hu, Frank, ed. 2008. "Measurements of Adiposity and Body Composition." In *Obesity Epidemiology*, 1st ed., 53–83. Oxford University PressNew York. https://doi.org/10.1093/acprof:oso/9780195312911.003.0005.

Jackson, Andrew S., and Michael L. Pollock. 1985. "Practical Assessment of Body Composition." *The Physician and Sportsmedicine* 13 (5): 76–90. https://doi.org/10.1080/00913847.1985.11708790.

JANPA. 2015. "JOINT ACTION ON NUTRITION AND PHYSICAL ACTIVITY - JANPA." https://www.hzjz.hr/wp-content/uploads/2013/11/JANPA-Newsletter-1.pdf#:~:text=JANPA%20is%20a%20joint%20action%20across%20Europe%20on,and%20physical%20activity%20policies%20targeting%20childhood%20and%20adolescence.

Jastreboff, Ania M., Louis J. Aronne, Nadia N. Ahmad, Sean Wharton, Lisa Connery, Breno Alves, Arihiro Kiyosue, et al. 2022. "Tirzepatide Once Weekly for the Treatment of Obesity." *New England Journal of Medicine* 387 (3): 205–16. https://doi.org/10.1056/NEJMoa2206038.

Join the Healthy Boat. n.d. "Ergebnisse Der Baden-Württemberg Studie - Grundschüler." https://www.gesundes-boot.de/programm/wissenschaft/information-in-english.

———. n.d. "Ergebnisse Der Baden-Württemberg Studie - Kindergartenkinder." https://www.gesundes-boot.de/programm/wissenschaft/information-in-english.

Kelly, Thomas L., Kevin E. Wilson, and Steven B. Heymsfield. 2009. "Dual Energy X-Ray Absorptiometry Body Composition Reference Values from NHANES." Edited by Adrian Vella. *PLoS ONE* 4 (9): e7038. https://doi.org/10.1371/journal.pone.0007038.

Kesztyüs, D, and Jm Steinacker. 2017. "Health and Economy – Why We Need to Promote Physical Activity in Children." *Deutsche Zeitschrift Für Sportmedizin* 2017 (04): 85–92. https://doi.org/10.5960/dzsm.2017.276.

Ko, Kwang-Pil, Dae-Kyu Oh, Haesook Min, Cheong-Sik Kim, Jae-Kyung Park, Yeonjung Kim, and Sung Soo Kim. 2012. "Prospective Study of Optimal Obesity Index Cutoffs for Predicting Development of Multiple Metabolic Risk Factors: The Korean Genome

and Epidemiology Study." *Journal of Epidemiology*. https://doi.org/10.2188/jea.JE20110164.

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.

Krause, Laura. 2014. "Übergewicht Und Adipositas Im Kindes- Und Jugendalter Ein Fokus Auf Sozialer Ungleichheit." Freie Universität Berlin. https://refubium.fu-berlin.de/bitstream/handle/fub188/12623/Doktorarbeit_Laura_Krause_Onlineversion_110515.pdf?sequence=1&isAllowed=y.

Kuczmarski, Robert J., Cynthia L. Ogden, Shumei S. Guo, Laurence M. Grummer-Strawn, Katherine M. Flegal, Zuguo Mei, Rong Wei, Lester R. Curtin, Alex F. Roche, and Clifford L. Johnson. 2002. "2000 CDC Growth Charts for the United States: Methods and Development." *Vital and Health Statistics. Series 11, Data from the National Health Survey*, no. 246 (May): 1–190.

Kyle, U. 2004. "Bioelectrical Impedance Analysis?Part I: Review of Principles and Methods." *Clinical Nutrition* 23 (5): 1226–43. https://doi.org/10.1016/j.clnu.2004.06.004.

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.

Louer, Amy L., Denise N. Simon, Karen M. Switkowski, Sheryl L. Rifas-Shiman, Matthew W. Gillman, and Emily Oken. 2017. "Assessment of Child Anthropometry in a Large Epidemiologic Study." *Journal of Visualized Experiments*, no. 120 (February): 54895. https://doi.org/10.3791/54895.

M., Van Koperen. 2014. "Young People at a Healthy Weight ´JOGG´ Netherlands." http://chrodis.eu/wp-content/uploads/2017/03/young-people-at-a-healthy-weight-jogg.pdf.

Maastricht UMC+. n.d. "Skinfold Measurements." Dietetics department of the academic hospital of Maastricht (Maastricht UMC+). https://nutritionalassessment.mumc.nl/en.

Marra, Maurizio, Rosa Sammarco, Antonino De Lorenzo, Ferdinando Iellamo, Mario Siervo, Angelo Pietrobelli, Lorenzo Maria Donini, et al. 2019. "Assessment of Body Composition in Health and Disease Using Bioelectrical Impedance Analysis (BIA) and Dual Energy X-Ray Absorptiometry (DXA): A Critical Overview." *Contrast Media & Molecular Imaging* 2019 (May): 1–9. https://doi.org/10.1155/2019/3548284.

McGee, Steven R. 2018. *Evidence-Based Physical Diagnosis*. 4th edition. Philadelphia, PA: Elsevier.

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.

NIH. n.d. "Obesity and Cancer." National Cancer Institute. https://www.cancer.gov/about-cancer/causes-prevention/risk/obesity/obesity-fact-sheet.

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.

———. n.d. "7. Young People at a Healthy Weight." Accessed March 12, 2023. https://www.oecd-ilibrary.org/sites/de158cb6-en/index.html?itemId=/content/component/de158cb6-en#tablegrp-d1e33904.

———. n.d. “Young People at a Healthy Weight.” OECD Library. https://www.oecd-ilibrary.org/sites/de158cb6-en/index.html?itemId=/content/component/de158cb6-en#section-d1e36729.

Orsso, Camila E., Maria Cristina Gonzalez, Michael Johannes Maisch, Andrea M. Haqq, and Carla M. Prado. 2022. “Using Bioelectrical Impedance Analysis in Children and Adolescents: Pressing Issues.” *European Journal of Clinical Nutrition* 76 (5): 659–65. https://doi.org/10.1038/s41430-021-01018-w.

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.

Radiologienetz. n.d. “Dual-Röntgen-Absorptiometrie (DXA/DEXA).” https://www.radiologie.de/dual-rontgen-absorptiometrie-dxa-dexa/.

Rito, Ana, Joana Baleia e Sofia Mendes, and Délfia Lopes. 2020. “Impacto de Uma Década de Um Programa de Base Comunitária Em Meio Escolar, Na Obesidade Infantil Em Portugal: MUN-SI 2008-2018.” *Acta Portuguesa de Nutrição* 21 (June). https://doi.org/10.21011/apn.2020.2111.

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.

Rönnecke, Elisa. 2020. “Körperfettmessung Bei Kindern Und Jugendlichen - Alters- Und Geschlechtsbezogene Perzentilen von Hautfaltendicke, Taillen- Und Hüftumfang Sowie Taille-Hüft-Index Und Taille-Größe-Index: Ergebnisse Einer Pädiatrischen Kohorte in Deutschland (LIFE Child).” https://ul.qucosa.de/api/qucosa%3A72166/attachment/ATT-0/.

Ross, Robert, Ian J. Neeland, Shizuya Yamashita, Iris Shai, Jaap Seidell, Paolo Magni, Raul D. Santos, et al. 2020. “Waist Circumference as a Vital Sign in Clinical Practice: A Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity.” *Nature Reviews Endocrinology* 16 (3): 177–89. https://doi.org/10.1038/s41574-019-0310-7.

Savva, Sc, M Tornaritis, Me Savva, Y Kourides, A Panagi, N Silikiotou, C Georgiou, and A Kafatos. 2000. “Waist Circumference and Waist-to-Height Ratio Are Better Predictors of Cardiovascular Disease Risk Factors in Children than Body Mass Index.” *International Journal of Obesity* 24 (11): 1453–58. https://doi.org/10.1038/sj.ijo.0801401.

Schienkiewitz, Anja, Stefan Damerow, and Angelika Schaffrath Rosario. 2019. “Alles nur Methodeneffekte? Prävalenz von Untergewicht, Übergewicht und Adipositas bei Kindern und Jugendlichen in Abhängigkeit von Gewichtungsfaktoren und Referenzsystem.” *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 62 (10): 1235–41. https://doi.org/10.1007/s00103-019-03011-y.

Schienkiewitz, Dr. Anja, Angelika Schaffrath Rosario, Reinhard Dortschy, Dr. Bärbel-Maria Kurth, and PD Dr. Hannelore Neuhauser. 2013. “Referenzperzentile Für Anthropometrische Maßzahlen Und Blutdruck Aus Der Studie Zur Gesundheit von Kindern Und Jugendlichen in Deutschland (KiGGS).” Edited by Robert Koch-Institut. https://www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsB/KiGGS_Referenzperzentile.pdf?__blob=publicationFile.

Silveira, Erika Aparecida, Larissa Silva Barbosa, Ana Paula Santos Rodrigues, Matias Noll, and Cesar De Oliveira. 2020. "Body Fat Percentage Assessment by Skinfold Equation, Bioimpedance and Densitometry in Older Adults." *Archives of Public Health* 78 (1): 65. https://doi.org/10.1186/s13690-020-00449-4.

Socha-Dietrich, Karolina, and Peter Zweifel. 2014. "Creaming and Dumping: Who on Whom." https://www.researchgate.net/publication/267338064_Creaming_and_Dumping_Who_on_Whom.

Social Finance. 2013. "A TECHNICAL GUIDE TO DEVELOPING SOCIAL IMPACT BONDS." https://www.socialfinance.org.uk/assets/documents/technical-guide-to-developing-social-impact-bonds.pdf.

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

Social Finance Ltd. 2013. "A Technical Guide to Developing Social Impact Bonds." Socialfinance.Org.Uk. 2013. https://www.socialfinance.org.uk/assets/documents/technical-guide-to-developing-social-impact-bonds.pdf.

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.

The American Journal of Clinical Nutrition. 1998. "Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: Executive Summary , –." *The American Journal of Clinical Nutrition* 68 (4): 899–917. https://doi.org/10.1093/ajcn/68.4.899.

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.

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.

Walter-Kroker, Anja, Axel Kroker, Muriel Mattiucci-Guehlke, and Thomas Glaab. 2011. "A Practical Guide to Bioelectrical Impedance Analysis Using the Example of Chronic Obstructive Pulmonary Disease." *Nutrition Journal* 10 (1): 35. https://doi.org/10.1186/1475-2891-10-35.

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: World Health Organization, Regional Office for Europe.

Wilms, Britta, and Sebastian M. Schmid. 2021. "Adipositas bei Erwachsenen – Prävalenz, Bedeutung und Implikationen für die Prävention und Gesundheitsförderung." In *Prävention und Gesundheitsförderung*, edited by Michael Tiemann and Melvin Mohokum, 855–65. Springer Reference Pflege – Therapie – Gesundheit. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-62426-5_56.

World Health Organization. 2011. "Waist Circumference and Waist-Hip Ratio : Report of a WHO Expert Consultation, Geneva, 8-11 December 2008." https://apps.who.int/iris/handle/10665/44583.

———. 2012. “Population-Based Approaches to CHILDHOOD OBESITY PREVENTION.” https://apps.who.int/iris/bitstream/handle/10665/80149/9789241504782_eng.pdf.
———. n.d. “Child Growth Standards: Triceps Skinfold-for-Age.” https://www.who.int/tools/child-growth-standards/standards/triceps-skinfold-for-age.
Young, Grace. n.d. “Setting and Measuring Outcomes.” https://golab.bsg.ox.ac.uk/toolkit/technical-guidance/setting-measuring-outcomes/.
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.
Zinn, Carmen. 2022. “Bestimmung Der Körperzusammensetzung Bei Gesunden Kindern Und Jugendlichen Sowie Patienten Mit Kraniopharyngeom Mittels Bioelektrischer Impedanzmessung Und Anthropometrie.” https://d-nb.info/969700059/34.