

BEST PRACTICES REPORT

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EXECUTIVE SUMMARY

The growing burden of obesity

The aim of this best practices report is to establish where and how national obesity strategies have been successfully implemented, with the emphasis on key success factors that can be applied to the South African context. It makes use of scoping review methodology and draws on examples and lessons emerging from both South Africa and other countries around the world. This report has been prepared by the review team tasked by South Africa's National Department of Health (NDoH) with reviewing the 2015-2020 National Strategy for the Prevention and Control of Obesity in South Africa and is the first step in the development of the next National Obesity Strategy for South Africa 2021/2022-2026/2027.

The first part of this report introduces the concept of obesity as an abnormal or excess amount of fat in the body measured by the Body Mass Index (BMI). It then establishes the links between obesity and a wide range of health conditions, most notably non-communicable diseases (NCDs) like cardiovascular diseases, diabetes mellitus and cancer, which account for more than 70% of all mortality worldwide. Obesity can also affect the severity and prognosis of infectious diseases, as evidenced during the COVID-19 pandemic.

The links between obesity and NCDs follow a linear pattern, with rising death rates and incidence of comorbidities reported as BMI increases. Conversely, prospective studies have confirmed the increased survival and improved quality of life seen in individuals after metabolic weight loss. While obesity is a growing problem in South Africa and globally, it can be effectively reduced through a combination of the right locally informed interventions and adequate implementation and monitoring arrangements. South Africa has much to gain from reducing obesity in its population and is therefore developing a National Obesity Strategy that builds on the successes, gaps and lessons from the previous strategy (2015-2020) and on the evidence emerging from obesity strategies implemented worldwide.

Specific factors affecting obesity interventions in South Africa

South Africa faces a growing burden of both obesity and NCDs. In 2016, 31% of adult males, 67% of adult females, and 13% of under-5 children in South Africa were overweight or obese. Obesity is particularly challenging as health care systems are faced with increasing numbers of individuals where obesity co-exists with malnutrition, commonly referred to as the overfed but undernourished paradox. While the causes for this increased burden are not different to those faced by other nations of similar levels of economic development, there are some specific factors that make the management of obesity and NCDs particularly challenging in the South African context.

Urbanisation, the nutrition transition and sedentarism. Since the 1990s dietary intakes have shifted from traditional locally available and home-grown food toward increased reliance upon ultra-processed foods and eating away from home, especially in areas experiencing rapid urbanisation. This transition has been associated with higher intakes of salt, fats and oils, protein, and sugar-sweetened beverages and foods. At the same time physical activity decreased and sedentary time increased. The lack of facilities for physical activities together with crime and insecurity in South Africa is a barrier to engaging in physical exercise.

Cultural perceptions and obesity normalisation. In a qualitative study in Soweto (a setting which has undergone rapid urbanisation and nutrition transition), both men and women reported that they preferred bigger bodies; males linked bigger bodies to wealth and affluence while females associated bigger bodies to beauty, happiness and confidence. Another South African study found that the highest prevalence of obesity among South African adults, stratified by sex and race, was in black African women, and yet this group had a significantly lower self-perception of overweight or obesity

than white women, who have a lower prevalence of obesity. Individuals might not seek a solution (weight control) if they do not recognise that a problem (overweight) exists.

Food insecurity and nutrition education. If basic nutrition knowledge and time, cooking space, ingredients, and cooking fuel are lacking, it results in consumption of easily accessible and cheap foods that do not require cooking, such as fast food or sliced bread. In lower- to middle-income and predominantly Black communities, fast food outlets are typically more available than they are in high-income and white communities in urban areas. A study in poorly resourced schools in South Africa found that 22% of learners skipped breakfast, 24% brought a lunch box (mostly with bread) and 57% of learners brought money to school, but tuckshops and vendors in the school environment sold mostly unhealthy foods. Poverty and high food prices were perceived as major challenges for healthy eating. Limited health literacy, defined as the knowledge, skills, and confidence to adopt personal lifestyle changes, was also reported.

Lack of data. Lack of data is a universal challenge for setting targets and monitoring health promotion strategies, and obesity is no exception. BMI is the most common indicator for obesity, but it is resource-intensive to measure, and thus not collected regularly or thoroughly enough to detect geographical and social variations or emerging trends at the local level. Without data it is difficult to evaluate the effectiveness of national obesity strategies, which explains why outcomes of several initiatives are often questioned. Limited data relevant to outcome measures for obesity prevention and management could be found in the SADHS, SANHANES-1, NIDS and the Healthy Active Kids South Africa (HAKSA) Report Card on Physical Activity for Children and Youth. The annual General Household Survey (GHS) has been identified as a future target survey for monitoring certain obesity-related indicators.

Lack of research funding. The South African Medical Research Council and the National Research Foundation are the biggest research funders in South Africa, yet only one research study on obesity could be found in their latest annual reports.

Approaches and interventions to address obesity

The main report includes a review and discussion of different approaches used in a range of settings to address obesity or nutrition-related challenges. Broadly speaking, most obesity-related interventions fall into three main categories:

- **Agentic interventions:** These aim to increase individual knowledge or skills to make healthier choices, leaving the environment unchanged. 'Nudge' strategies focus on positive reinforcement and indirect suggestions as ways to influence the behaviour and decision-making of groups or individuals. An example of an agentic intervention is front-of-package labelling of unhealthy foods to help consumers make better choices.
- **Structural interventions:** These change the environmental context within which individual behaviours occur, thereby diminishing individual choice. Examples include banning sale of unhealthy foods and sugar-sweetened beverages (SSBs) in schools, or product reformulation to improve the nutrient content of ultra-processed foods.
- **Agento-structural interventions:** These are situated between the two, as they address structural aspects of environments while requiring a level of individual choice for behavioural change. There are many examples, including infrastructure design to encourage physical activity, fiscal regulations to disincentivise purchase of unhealthy products through increased taxes, or conversely to make healthier products more attractive by subsidising their cost.

All obesity strategies covered in this report emphasize the importance of tailoring interventions according to the local context and culture, as the same interventions have been known to achieve different results across countries. If all practical aspects of implementation are not thoroughly considered, interventions may even have unintended negative consequences for certain population groups, such as a shift from one form of unhealthy consumption to another where a healthy alternative is less easily available, culturally unaccepted, or more expensive.

Examples of specific interventions that have been used as part of obesity programmes around the world are discussed in detail in the report, and include front-of-package labelling of foods, restrictions on marketing unhealthy products to children, improvement in school food standards and options, taxation on unhealthy foods and SSBs, reformulation of ultra-processed foods to improve nutrient contents, retail environment changes such as menu labelling, corporate voluntary efforts and social investment, utilising digital technology for weight awareness and management, and programmes for increased physical activity and reduced sedentary behaviour.

Obesity strategies in South Africa and around the world

Reviewers investigated a sample of national obesity strategies and associated reports from several countries in the Asia-Pacific, Latin American, and European regions. The main components and lessons from each of those national strategies are described in the main report. Briefly, the main conclusions emerging from reading across the strategies are as follows:

Common interventions. A range of interventions are utilised in different countries to prevent or reduce adult or childhood obesity. The most common measures include the implementation of population-level interventions, fiscal and commercial policies, and system changes to make it easier and more affordable/attractive for individuals to make healthier lifestyle choices and to decrease access to, or demand for, unhealthy food options. Examples include restrictions on unhealthy food advertising and adding tax on SSBs. Food product reformulation and the addition of easily understood front-of-package labels are often accompanied by reductions of the salt, fat and sugar content of processed foods.

Challenges and barriers. National obesity strategy reports from several countries identified barriers to the implementation of specific interventions relating mostly to regulating food products and applying fiscal measures, including pressure and lobbying from the food industry. Likewise, opposition from certain public institutions was reported due to their concerns about the economic and social effects of policies to restrict or fiscally penalise unhealthy foods. However, the most frequently reported challenges and barriers involved the limited ability/competence by governments or their agencies to implement and enforce public policy. Several reports also referred to the weak or limited support received from civil society to specific commercial or fiscal measures that was often attributed to their lack of awareness about the risks of obesity or their limited understanding of the reasons justifying the adopted measures.

Limited evidence on strategy performance and outcomes in South Africa. Apart from a few noteworthy research reports, we found limited published evidence about the effectiveness of measures adopted in South Africa to reduce obesity. Interventions that focus on individual behaviour and education rather than utilising a broader population-based approach were less likely to be successful. Promising interventions in South Africa include the implementation of a tax on SSBs, which was followed by a reduction in mean sugar intake, reduced sales of taxed beverages, and increased selection of healthier beverages.

However, it was the lack of data linked to the implementation of the 2015-2020 National Obesity Strategy that is worth noting as part of this review. Our reading of the strategy document and the absence of strategy review information would point to a lack of a systematic, verifiable, costed monitoring and evaluation (M&E) plan combined with the absence of obesity surveillance data, poorly defined M&E responsibilities of the designated departments implementing the strategy, and a lack of funding/budget to support M&E activities.

Lessons for developing the next South Africa Obesity strategy

The most comprehensive review of national obesity strategies identified by the authors of this Best Practices report is the Theis and White (2021) review of 14 UK government strategies either wholly or partially dedicated to tackling obesity, stretching from 1992 to 2020. Their main finding was that most of the least successful policies relied on individuals to make behaviour changes rather than shaping external influences. A second important finding was that policies were largely proposed in a way that would be unlikely to lead to implementation. The following implementation viability criteria were used by the authors:

- Setting a target population
- Stating a theory of change
- Evidence to support the policy proposals
- Details about cost/allocated budget
- Suggesting a responsible agent
- Including a monitoring or evaluation plan
- Setting a time frame for achieving the policy objectives of the strategy

These criteria can be used and adapted to shape the next National Obesity Strategy for South Africa, as follows:

- Strategy development should involve all stakeholders, allowing for continuous inter-sectoral engagement and speaking with a unified voice.
- Practical and cost-effective actions (based on cost-benefit) need to be identified and prioritised, with responsibilities and financial/human resources for their implementation and regular monitoring clearly allocated.
- Implementation should be based on clear time frames, well-defined goals, and regular reviews of progress (in the form of agreed actions, committed resources and results).
- No strategy can claim success or failure unless it is closely monitored, with results recorded and swiftly communicated to all stakeholders (from national to local levels) and the public. Only this approach was found to generate both public accountability and the desired momentum in strategy implementation.

LIST OF ACRONYMS

BF	Breastfeeding
BMI	Body mass index
DALY	Disability-adjusted life years
EMRF	Electronic medical records file
FOPL	Front of package labelling
GBD	Global Burden of Disease
GDA	Guideline Dietary Intakes
GDP	Gross domestic product
GHS	General Household Survey
HAKSA	Healthy Active Kids South Africa
INFORMAS	International Network for Food and Obesity/NCDs Research, Monitoring and Action Support
LMICs	Low- and middle-income countries
METs	Metabolic equivalents
M&E	Monitoring and evaluation
MTL	Multiple Traffic Light
NBD	National Burden of Disease
NCD	Non-communicable disease
NDoH	National Department of Health
NIDS	National Income Dynamic Study
NRF	National Research Foundation
NSNP	National School Nutrition Programme
OECD	Organisation for Economic Co-operation and Development
PA	Physical activity
PAHO	Pan American Health Organization
SADHS	South African Demographic and Health Survey
SAMRC	South African Medical Research Council
SANHANES-1	South African Health and Nutrition Examination Survey
SBCC	Social and behavioural change communication
SEMDSA	Society for Endocrinology, Metabolism and Diabetes of South Africa
SISAN	Brazilian National Food and Nutritional Security System
SSB	Sugar-sweetened beverages
SUS	Brazilian National Health System
T2DM	Type 2 Diabetes Mellitus
TAF	Therapeutic algorithm files
TFA	Trans-fatty acids
UK	United Kingdom
USA	United States of America
WHO	World Health Organization
WHtR	Waist-to-height ratio

1. BACKGROUND

The aim of this best practices report is to establish where and how national obesity strategies have been successfully implemented, with the emphasis on key success factors that can be applied to the South African context. It makes use of scoping review methodology to summarise the health effects of obesity and highlight current trends in obesity and its associated comorbidities, both globally and in South Africa. The document reviews interventions that are utilised in national obesity strategies, factors that contribute to successful national strategy implementation, and challenges to obesity prevention and strategy implementation.

1.1 Introduction to obesity

Obesity is defined as an abnormal or excessive amount of fat in the body that presents a risk to health, and is based on the body mass index (BMI) classifications (World Health Organization, 2000). BMI is calculated from both weight (in kilograms) and height (in meters) as $BMI = \text{kg/m}^2$. A BMI below 18.5 is classified as underweight, BMI of 18.5-24.9 as normal weight, BMI of 25-29.9 as overweight, BMI of 30-34.9 as class I obesity, BMI of 35-39.9 as class II obesity, and a BMI of 40+ as class III obesity (also called severe or extreme obesity). BMI is the most widely recorded measure of obesity, but it does not provide information about fat distribution, which is an important risk factor for non-communicable diseases. Waist circumference and the waist-to-height ratio (WHtR) are useful indicators of abdominal obesity with a WHtR cut-off value of 0.5 highly correlated with cardiometabolic diseases in both sexes and most age groups (Ashwell and Gibson, 2016). Furthermore, BMI alone does not consider muscle mass, and thus can incorrectly classify very muscular individuals as overweight or obese, and so a combination of indicators is preferred to give the most accurate measure of obesity.

1.1.1. Mortality and morbidity

Not counting the impact of the current COVID-19 pandemic, non-communicable diseases (NCDs), including cardiovascular diseases, diabetes mellitus and cancer, are the leading cause of deaths worldwide, accounting for more than 70% of all mortality (Riley et al., 2017). Epidemiological studies from around the globe have confirmed that increased weight is associated with increased risk of death from all causes, most notably NCDs (Freedman et al., 2006; Gu et al., 2006; Pischon et al., 2008). The increase in mortality associated with obesity follows a linear pattern, with a rising death rate as BMI reaches above 25 kg/m^2 (Prospective Studies Collaboration et al., 2009). Prospective studies on the effects of metabolic (weight loss) surgery have confirmed the increased survival seen in individuals after weight loss, most notably due to decreased deaths from cardiovascular disease and cancer (Sjöström, 2013).

In South Africa, diabetes is the most common cause of death in adult females, followed by cardiovascular disease and hypertension, while tuberculosis is the most common cause of death in males (STATS South Africa, 2017). From 2015 to 2017, for both sexes, the most significant decline was seen in the proportion of deaths due to tuberculosis, while steady increases were observed in the proportion of deaths due to diabetes mellitus, hypertension, and ischaemic heart disease. The South African National Burden of Disease (NBD) team, together with local and international experts, revised the 2000 NBD list to reflect local cause of death patterns, which differs from the Global Burden of Disease (GBD) list (Pillay-van Wyk et al., 2016). All obesity-associated comorbidities (cerebrovascular disease, ischaemic heart disease, hypertension, and diabetes) remained in the top 10 causes of mortality. Globally, in 2015 the number of deaths from diabetes exceeded the combined mortality from HIV/AIDS, tuberculosis, and malaria.

In addition to mortality, the morbidity associated with obesity has been studied extensively, with metabolic and cardiovascular risks most well defined. The association between obesity and the development of Type 2 Diabetes Mellitus (T2DM) is the most significant and universally recognised. The British National Health System confirmed a 100-fold increase in the risk of development of T2DM over a 14-year period in women who had a baseline BMI $> 35 \text{ kg/m}^2$ (Colditz et al., 1995; Nguyen et al., 2011). The Society for Endocrinology, Metabolism

and Diabetes of South Africa (SEMDSA) estimates that the number of people living with diabetes in Africa will increase by 140% by the year 2040, with obesity driving this diabetes epidemic (Amod, 2017). In 2019, 463 million people had diabetes worldwide, with 80% from low- and middle-income countries (Chan et al., 2021). While heavy drinking is related to weight gain, it is the development of non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis in many obese individuals that is of concern (Traversy and Chaput, 2015). This weight associated liver damage is worsened by even moderate amounts of alcohol consumption. There is an unfortunate dearth of data on the burden and spectrum of NAFLD in African populations, however, globally the prevalence is estimated to increase by 15-56% from 2016-2030, while liver mortality and advanced liver disease will more than double during this period (Estes et al., 2018; Paruk et al., 2019).

Obese individuals are also at increased risk for cancer; current estimations are that more than 20% of cancers are caused by obesity (Kyrgiou et al., 2017; Wolin et al., 2010). In 2016 the International Association for Research on Cancer declared excessive body fat to lead to the development of cancers of the oesophagus, stomach, colorectum, biliary tract, pancreas, kidney, endometrium, ovary, breast, and thyroid (Lauby-Secretan et al., 2016). There is, however, no organ in the human body that is not adversely affected by the presence of excessive body fat, often in more ways than one. Evidence for the effects of obesity on the musculoskeletal, gastrointestinal, gynaecological, and urological systems are most robust (Bonfrate et al., 2014; Carbone et al., 2018; Oliveira et al., 2020; Perumpail et al., 2017).

Morbidity due to obesity was defined for the South African population based on a comparative risk assessment analysis of the 1998 South African Demographic and Health Survey (SADHS) data. This analysis revealed that 87% of T2DM, 68% of hypertension, 61% of endometrial cancer, 45% of ischemic stroke, 38% of ischemic heart disease, 31% of kidney cancer, 24% of osteoarthritis, 17% of colorectal cancer, and 13% of postmenopausal breast cancer were attributable to a raised BMI (Joubert et al., 2007).

The current COVID-19 pandemic has demonstrated that obesity is not only a risk for NCDs but can also be a risk factor for infectious diseases. Overweight and obese individuals have increased risk of developing severe COVID-19, including hospitalisation, intensive care support, and death (Parker et al., 2020; Popkin et al., 2020; Zhou et al., 2021). Increased COVID-19 mortality among individuals with obesity, diabetes, and hypertension highlight the importance of strengthening intersectoral public health policies.

1.1.2. Major risk factors for obesity

There is debate as to whether the causes of obesity, and thus the responsibility to address the increase in prevalence, lies with regulatory bodies (governments), providers (food industry), or the community (consumers). Researchers have shown that obesity is largely driven by environmental effects that undermine the self-regulatory capacity people have to make responsible decisions about personal diet and physical activity (Roberto et al., 2015).

Social determinants of health (the non-medical factors that influence health outcomes)¹ play a major role in influencing people's health including body weight. These include biological and behavioural factors, socio-cultural factors, living and working conditions, and structural factors. Social determinants such as poor housing, inadequate water and sanitation, a sub-optimal food environment, high levels of alcohol and substance abuse, low levels of social cohesion, and inadequate health-system response are some of the main drivers of ill health in South Africa (Scott et al., 2017). **Commercial determinants** of health are defined as factors that influence health and which stem from the profit motive used by the private sector to promote products and choices that are detrimental. The commercial determinants of health cover three areas. First,

¹ The conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems. (World Health Organization)

they relate to unhealthy commodities that are contributing to ill-health. Secondly, they include business, market and political practices that are harmful to health and are used to sell these commodities and secure a favourable policy environment. Finally, they include the global drivers of ill-health, such as market-driven economies and globalisation, that have facilitated the use of such harmful practices (Mialon, 2020).

The rise in obesity is fuelled by a change in **diet** to low-cost, easily available, calorie-dense, and nutrient-deficient foods, allowing for little nutritional variety in what is ingested by the general population (Popkin, 2017). This creates a situation where health care systems are faced with increasing numbers of individuals where obesity co-exists with undernutrition, commonly referred to as the overfed but undernourished paradox. The ongoing increased intake of ultra-processed foods is well documented and largely driven by food systems and political economic factors (Baker et al., 2020; Laster and Frame, 2019). Poor nutrition literacy, lack of transparent nutritional value of purchased foods and lack of knowledge of the nutritional value of consumed foods contribute to poor food choices and obesity (Kalkan, 2019; Michou et al., 2018). The **food environment** is a critical determinant of food preferences and food choices. An obesogenic environment with high availability and intense marketing of unhealthy foods and drinks is a strong predictor of unhealthy food consumption, causing increases in obesity worldwide (Institute of Medicine, 2006; Smith et al., 2019; Swinburn et al., 2013). Recently, the Lancet used the term “syndemic” to associate climate change (a disease of nature) with the obesity epidemic (a human disease) (Willett et al., 2019). The most deleterious negative effect of climate change concerns the decreased biodiversity of both animal and plant species. Low biodiversity limits food choices and consequently affect the intake of nutrients, antioxidants, and other protective substances (Binns et al., 2021).

Sedentary behaviour and a lack of physical activity is another risk factor for obesity, as energy is expended at extremely low levels. Sedentary activities occur in a variety of different settings, including work, school, travel, and leisure time (Saunders and Vallance, 2017). Sedentary behaviour can be defined as “any waking behaviour characterized by an energy expenditure less than 1.5 (≤ 1.5) metabolic equivalents (METs), while in a sitting, reclining or lying posture” (Tremblay et al., 2017). The most common sedentary activities include watching television, using computers, playing video games, other activities which consume screen time, reclining, socialising while sitting, desk-based work or schoolwork and non-active transport (Pate et al., 2011; Tremblay et al., 2017). A study of children aged 10 years old from 12 different countries found that the children spent an average of 8.6 hours per day engaging in sedentary activities and that 54% of the participants did not adhere to the recommended screen time guidelines (LeBlanc et al., 2012). **The built environment** provides opportunities or barriers for physical activity. Neighbourhood safety, traffic volume, walkability, population density, and the availability of green spaces, sport venues, and school playgrounds have been associated with physical activity levels (Terrón-Pérez et al., 2021). In addition, the effects of urbanisation and air-pollution on rising obesity prevalence has been well-documented (Lam et al., 2021; Parasin et al., 2021).

The **COVID-19 pandemic** has brought to the fore additional risk factors for obesity. Recent evidence regarding the effect of lockdowns and social distancing measures reveal increased exposure to obesogenic environments and disrupted participation in health promoting behaviour (Browne et al., 2021). Conversely, lessons learned from dealing with the COVID-19 pandemic could be used in public health systems to deal with the problem of obesity effectively and equitably (Chung et al., 2021).

1.2 Obesity trends and statistics

Globally, obesity trends have been best defined by the NCD Risk Factor Collaboration (NCD Risk Factor Collaboration (NCD-RisC), 2017a). This study of 128.9 million children, adolescents and adults revealed the worldwide number of adult women with obesity increased from 69 million in 1975 to 390 million in 2016 and the number of men with obesity increased from 31 million in 1975 to 281 million in 2016. An additional 213 million children and adolescents and 1.30 billion adults were in the overweight range, but below the threshold for obesity. Most alarming is the increase in BMI in the youth, with the number of girls with obesity increasing

from 0.9% (5 million) in 1975 to 7.8% (50 million) in 2016 while the number of boys with obesity increased from 0.7% (6 million) in 1975 to 5.6% (74 million) in 2016. Notably, more than 55% of the global rise in mean BMI from 1985 to 2017 - and more than 80% in some low- and middle-income countries (LMICs) - was due to increases in BMI in rural areas (NCD Risk Factor Collaboration (NCD-RisC), 2019).

The Global Burden of Disease obesity collaborators analysed data from 68.5 million participants around the world (GBD 2015 Obesity Collaborators et al., 2017). From 1980-2015, a steady increase in obesity prevalence was seen in all countries, with prevalence doubling in more than 70 countries and rates of increase in childhood obesity greater than the rate of increase in adult obesity. The largest jump in global obesity prevalence was observed in men between the ages of 25-29 years living in countries with a low-middle socio-demographic index.

The Organisation for Economic Co-operation and Development (OECD) estimates that in the population of their 37 member countries², one in five adults is obese and one in six children is overweight (OECD Obesity Update, 2017).

Global reports warn of rising trends in BMI, adolescent obesity, diabetes, and hypertension prevalence, with a disproportionate increase in LMICs when compared to high-income countries (NCD Risk Factor Collaboration (NCD-RisC), 2017a, 2017b, 2016). Of particular concern in LMICs is that this increase is most notable in rural areas (NCD Risk Factor Collaboration (NCD-RisC), 2019).

Obesity data for South Africa is found in the South African Demographic and Health Survey (SADHS) performed in 1998 and repeated in 2016 (National Department of Health (NDoH), Statistics South Africa (Stats SA), South African Medical Research Council (SAMRC), and ICF., 2018). Results from the 2016 SADHS provide information about individuals' health status and behaviours that can be compared with 1998 data (to determine past trend) or future data (to monitor effects of strategy implementation). In 2016, 31% of adult males, 67% of adult females, and 13% of under-5 children in South Africa were overweight or obese. Among women aged 15-24 years, overweight and obesity increased from 29.6% in 1998 to 39.8% in 2016, while in women aged 45-54 years it increased from 72% in 1998 to 81.9% in 2016. The prevalence of overweight or obesity among men was 29% in 1998 and 31% in 2016. Increases in average BMI occurred across all provinces. Furthermore, 46% of women and 44% of men aged 15 years and older in South Africa have hypertension. The prevalence of hypertension has nearly doubled since 1998, from 25% to 46% among women and from 23% to 44% among men. Most alarming are numbers for South Africans meeting criteria for pre-diabetes³: 64% of women and 66% of men are pre-diabetic, with an additional 13% of women and 8% of men confirmed to have diabetes. Furthermore, obesity primarily affects age categories that should contribute to the workforce.

The 2012 South African Health and Nutrition Examination Survey (SANHANES-1) provides further data for the South African population. SANHANES-1 aimed to assess aspects of the health and nutritional status of South Africans by means of questionnaire-based data (interviews) in combination with health measurements and laboratory tests, making use of a stratified cluster sampling approach (Shisana et al., 2014). The prevalence of overweight and obesity respectively was 24.8% and 39.2% in females, 20.1% and 10.6% in males, 16.5% and 7.1% in girls (aged 2-14 years), and 11.5% and 4.7% in boys (aged 2-14 years). The prevalence of hypertension was 31.8% and almost one out of four participants aged 15 years and older had an abnormally high serum total-cholesterol (23.9%) or LDL-cholesterol (24.6%). 18.4% of participants had impaired glucose homeostasis. Although no follow-up survey has been performed yet, parameters such as fitness, dietary salt, fat, sugar, fruit

² Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

³ Adjusted HbA1c level of 5.7%-6.4%

and vegetable intake, and sugar-sweetened beverages (SSB) consumption can be used in future to assess trends and effectiveness of strategy implementation.

The high prevalence of obesity in South Africa has been illustrated in the National Income Dynamic Study (NIDS) in sample sizes of 8,000 men and more than 10,000 women. NIDS is a longitudinal study of important socio-economic issues in South Africa and surveys and measurements are conducted in waves. The prevalence of overweight and obesity has steadily increased in the review period from 2009 to 2012 (wave 1 – wave 2) with the overall obesity rate in the NIDS sample rising between waves from 6.4% to 8.7% for men and from 27.6% to 32% for women (Ardington et al., 2012). For women, levels of obesity are highest in urban areas, but changes are significantly lower in urban areas, suggesting that the gap between urban and rural areas is closing over time. Both the levels and the changes in obesity between waves are highest for African females followed by coloured females, then Asian/Indian females, and then white females.

The significant increase in overweight and obesity prevalence in adults, and the increased prevalence of metabolic syndrome and cardiometabolic risk in South Africa, has been confirmed in numerous cohort studies (Kruger et al., 2021, 2017; Nienaber-Rousseau et al., 2017). For South African youth, recent data is harder to come by in published literature. The South African Youth Risk Behaviour Survey, performed by the Human Sciences Research Council, found that the overweight and obesity prevalence in adolescents increased between 2002 and 2011 from 16.9% to 23.1% (overweight) and 4% to 6.9% (obesity) (Reddy et al., 2013, 2010, 2009). Even though no follow up studies are available, regional publications for the period from 2012 to 2020 continue to report increasing trends in both overweight and obesity for South African youth (Kimani-Murage et al., 2011; Monyeki et al., 2012; Negash et al., 2017; Pisa et al., 2015).

The continued increased overweight and obesity prevalence in South Africa are alarming, given clarion calls of meeting the sustainable development goals (SDGs) to reduce obesity by the year 2030 (World Health Organization, 2016).

1.3 The cost of obesity

Loss of life due to obesity is not the only price to pay. The increased cost of treating associated comorbid diseases (such as acute myocardial infarction and cerebrovascular disease) presents a challenge to both private and public health care systems. In addition to individual cost implications due to decreased productivity and subsequent lower household income, both private and public health care costs for treating obesity-related diseases have become an enormous economic burden (Daviglius et al., 2004; Finkelstein et al., 2008; Narbro et al., 2002; Quesenberry et al., 1998).

Most data on the cost of obesity to health care systems is derived from the USA and UK, where the combined medical costs associated with treatment of preventable obesity-related diseases are estimated to increase by 48-66 billion US dollars per year in the USA, and by 2 billion British pounds per year in the UK, by 2030 (Wang et al., 2011). In 2007, the direct cost of obesity to the UK National Health Service was £3.2 billion (R41.7 billion) and the cost of being overweight (but not obese) was £2.2 billion (R34.4 billion) (Allender and Rayner, 2007). Furthermore, as overweight and obese children tend to remain in the same BMI category throughout their adult life, modelling of the German population estimated the excess lifetime cost per obese child to be 3.15 times and 4.52 times higher for boys and girls respectively when compared to normal weight individuals (Sonntag et al., 2016).

The only available estimate for the impact of obesity on the South African economy was performed by Discovery Health in their 2017 Discovery ObeCity Index (Discovery Obesity Index, 2017). This private health insurer evaluated BMI and waist circumference in six South African cities and compared their health care

spending. Results suggested that the economic impact of obesity in South Africa is R701 billion each year. This included obesity-related costs such as loss of productivity, medical spending, and absenteeism.

In a cost of illness study designed to estimate the direct cost of T2DM in the public sector in South Africa, the diagnosis and management of patients with diagnosed T2DM cost R2.7 billion in 2018 (Erzse et al., 2019). This amount increased to R21.8 billion if undiagnosed patients were considered. The 2030 cost of all T2DM cases is estimated to be R35.1 billion, with 51% of the cost attributable to the management of T2DM and 49% attributable to complications.

1.4 Specific challenges related to obesity in South Africa

1.4.1. Urbanisation and the nutrition transition

Urbanisation has been increasing steadily in sub-Saharan African countries since the 1970s and has been accompanied by growth of industry, including food manufacturing in urban areas (UNIDO, 2013). Since the 1990s dietary intakes in LMICs shifted from traditional locally available and home-grown food towards ultra-processed foods and eating away from home. This transition was associated with higher intakes of fats and oils, salt, protein, and SSBs. At the same time physical activity decreased and sedentary time increased. In South Africa, the lack of facilities for physical activities, together with crime and insecurity, is a barrier to engaging in physical exercise (Statistics South Africa, 2017).

The increase in overweight in South Africa is associated with increased gross domestic product (GDP) and available dietary energy, protein, fat, and sugar (Steyn and McHiza, 2014). In many urban areas in South Africa, ultra-processed food items are regarded as desirable status symbols and widely consumed. In a study of SSB advertisements in a demarcated area in Soweto, authors found the density of advertisements to be 3.6 per km² near schools, with 50% of schools having branded advertising of SSBs on their school property (Moodley et al., 2015).

A recent study in Malawi, Kenya, Ghana and South Africa investigated shifts in nutritional status in children and adults. Among these four countries, South Africa had the highest GDP and highest prevalence of obesity among preschool children and adults (Mbogori et al., 2020). The increasing prevalence of overweight and obesity was much greater than the declining rate of underweight and appears to be associated with economic development. These findings emphasise the importance of early public health interventions to prevent obesity associated with the nutrition transition. Despite the major health implications, few LMICs have public health programmes addressing the dietary and physical activity challenges associated with obesity and its comorbidities (Popkin et al., 2012).

The school food environment in South Africa was better defined in a recent report on food access and consumption amongst grade 7 learners in a LMI area in Cape Town (O'Halloran et al., 2021). Researchers made use of questionnaires, learner photography, school principal interview, a tuckshop inventory and observation of three-day tuckshop purchases. Processed meats and fizzy drinks were present in two thirds of the homes and sweets, chocolates, jam, biscuits and crisps were present in 44–54% of homes. Spaza shops, General Dealers and supermarkets were the food outlets most frequented by household members. An inventory of the tuckshop revealed that only unhealthy snack foods were available for sale and, according to our purchase observation, the most popular snack items bought were sweets, chocolates and biscuits. De Villiers and colleagues showed in a survey of 100 schools in urban and rural areas in the Western Cape, that the most common items sold by street vendors were sweets, crisps, ice lollies, doughnuts, hot dogs/burgers and fat cakes (fried dough balls) (de Villiers et al., 2012).

1.4.2. Cultural perceptions and obesity normalisation

A nationally representative survey of anthropometric factors based on the 1998 SADHS found that the highest prevalence of obesity among South African adults, when stratified by sex and race, is found in black South African women, and yet the self-perception of overweight or obesity is much higher in white women compared to black women (Puoane et al., 2002). The researchers speculated that traditional and cultural perceptions concerning body size play a role in national obesity patterns. As obesity becomes more prevalent, people may also underestimate their weight (Robinson, 2017). In a qualitative study using focus group discussions in Soweto, Johannesburg (a setting which has undergone rapid urbanisation and nutrition transition), both men and women reported that they preferred bigger bodies; males linked bigger bodies to wealth and affluence while females associated bigger bodies to beauty, happiness and confidence (Bosire et al., 2020). Being 'fat' or 'overweight' were perceived to be 'normal' when compared with obesity which was seen to be a debilitating or disabling condition. This illustrates that most people were aware of obesity but perceived it more in terms of morbid obesity or extremes of fatness. These findings indicate that regular visual exposure to bigger bodies (partly due to unchanging socio-cultural factors that reinforce the acceptability of bigger bodies) plays a role in the poor detection and consequent underestimation of body weight. South Africans on average tend to underestimate their BMI (Mchiza et al., 2020). Individuals might not seek a solution (weight control) if they do not recognise that a problem (overweight) exists.

1.4.3. Food insecurity and nutrition education

A small study of food-insecure residents (as framed by the Food Aid Organization definition of food security⁴) within a peri-urban area of South Africa found that participants lacked economic access to food at the end of the month, they were unable to consume foods they preferred, and they felt that their diets were neither nutritious nor enabled an active and healthy life (Hunter-Adams et al., 2019). Time, cooking space, ingredients, and fuel to cook with all represent different aspects of food security. If these basics are lacking it results in consumption of easily accessible and cheap foods that do not require cooking, such as fast food or sliced bread. Furthermore, the current COVID-19 pandemic has exacerbated food insecurity. There is a need for policies that address all forms of malnutrition by making healthy foods accessible and affordable, while restricting unhealthy foods through fiscal and regulatory restrictions (NCD Risk Factor Collaboration (NCD-RisC), 2021).

A study in 90 purposively selected poorly resourced schools in South Africa showed that 22% of learners skipped breakfast, 24% brought a lunch box mostly filled with bread, and vegetables were served in only 41% of schools on the day of the survey (Faber et al., 2014). Poverty (74%) and high food prices (68%) were major challenges for healthy eating. Only 15% of teachers had received training in nutrition although 81% of educators taught nutrition as part of school subjects. The school food environment in SA has large scope for improvement towards the promotion of healthy eating and regulating foods sold in tuckshops and by food vendors.

1.4.4. The South African food industry and marketing

The South Africa fast food market size was valued at \$2.7 billion in 2018 and is expected to reach \$4.9 billion by 2026, driven by an increase in consumption of convenience food due to a rise in availability of vendors (Allied Market Research, 2019). Although the food and beverage sector has been hard hit by Covid-19 lockdown prohibition, takeaway and fast food sectors are showing signs of recovery much faster than restaurants and bars (Statistics South Africa, 2021). A large part of the South-African population purchase street food and fast food, with Black Africans being the most frequent consumers of street food and whites of fast food (Steyn et al., 2011; Steyn and Labadarios, 2011). In lower- to middle-income communities, fast food outlets are typically more available than they are in high-income communities in urban areas (Michimi and Wimberly, 2015). In a study of schools in South-Africa, 57% of learners brought money to school in lieu of a

⁴ Physical and economic access to sufficient safe and nutritious food that meets dietary needs and food preferences for an active and healthy life

lunch box, but tuckshops and vendors in the school environment sold mostly unhealthy foods (Faber et al., 2014).

The Access To Nutrition Foundation (ATNF) monitors the policies and practices of international food & beverage manufacturers, including the dominant companies in South Africa. Their 2021 Access To Nutrition Index Report took into consideration 22 leading food manufacturing companies (Access to Nutrition Foundation, 2021). Similar to 2018, Nestlé leads the 2021 rankings, Unilever comes second, with Arla showing the largest improvement due to a new labelling policy, responsible marketing policies, and an improvement in healthiness of its product portfolio. However, the average score remained the same, and overall, the results show that companies need to enhance their efforts to encourage healthier diets for all.

Television is a powerful medium for marketing food and beverages. In a recent study investigating the extent and nature of advertising of unhealthy versus healthy food and beverages to South African children watching television, unhealthy food and beverage advertising was recorded at a significantly higher rate during the time frame when children were likely to be watching (Yamoah et al., 2021). Persuasive power strategies, such as using cartoon characters and celebrated individuals, were used more in unhealthy versus healthy food advertisements. The findings are in breach of the South African Marketing to Children pledge and suggest a failure of the industry self-regulation system (South African Government, 2011).

1.4.5. Lack of data

Lack of data is a universal challenge encountered in health promotion strategies, and obesity is no exception. Historically, BMI has been used to indicate effectiveness of strategic intervention, and although useful as a broad indicator, it is not a perfect indicator of metabolic health and relatively resource-intensive to gather.

Timely, easily understood, concise, and locally relevant data is needed to inform policy development to prevent obesity. Relevant data should be drawn from multiple sectors, and cross-sector collaboration is therefore essential. Indicators for implemented strategies should be developed and included in current data collection tools to ensure that monitoring and evaluation (M&E) is effective (Erzse et al., 2021).

The South Africa General Household Survey (GHS) collects annual household data on education, household income, availability of energy and drinking water, means of transport and access to food (Statistics South Africa, 2018). Since 2009, the survey measures food access by asking about modifications made in household diet or eating patterns during the previous month because of limited resources to obtain food. This single question used in 2009 was expanded in 2010; a question was added related to decreases in the variety of foods consumed. Due to the demonstrated flexibility to incorporate new questions about diet, the GHS has been identified as a potential target for future monitoring of obesity-related data over time.

1.4.6. Lack of research funding

The South African Medical Research Council (SAMRC) and the National Research Foundation (NRF) are the biggest research funders in South Africa. Only one obesity research study could be found in the latest SAMRC annual report: a landmark international study to improve understanding of, and address the mechanisms, underlying child obesity (SAMRC Annual Report, 2020). The NRF, housed in the NDoH, did not have any mention of obesity in its annual report or website search.

1.5 Strategy for the prevention and control of obesity in South Africa (2015-2020)

Due to the increasing prevalence of overweight and obesity and associated non-communicable diseases (NCDs), coupled with increases in the cost of treating NCDs, the NDoH in line with National Development Plan vision 2030 put into place strategic measures and guidance to reduce obesity in the population of South Africa. The 2015-2020 National Strategy for the Prevention and Control of Obesity in South Africa is a population-

focused approach concentrated on policy, context, and environmental change. The 2015-2020 obesity strategy was put together by the NDoH in consultation with researchers from numerous universities and other stakeholders.

The strategy aimed to address obesity through modifying the obesogenic environments and reducing the drivers of obesity, while providing opportunities for increased physical activity and healthy food options in every possible setting (including health care facilities, early development centres, schools, workplaces, and the community at large). The strategy identified numerous multi-sectoral, multidisciplinary approaches that are essential to combat the growing obesity epidemic. In addition, the strategy provided a framework for implementation of key actions including an objective to strengthen research, surveillance and monitoring and evaluation.

No interim evaluation reports on the Strategy for the Prevention and Control of Obesity in South Africa (2015-2020) could be found on the NDoH website or elsewhere.

2. AVAILABLE GUIDANCE ON OBESITY INTERVENTIONS

The **NOURISH framework** was developed by the World Cancer Research Fund International and is based on the premise that to change consumer behaviour towards the consumption of healthy food, there should be an increase in availability, accessibility and affordability of healthy food options and a decrease in the availability, accessibility and affordability of unhealthy food options. The framework provides a food policy package for healthy diets for the prevention of obesity and diet related NCDs. It comprises three broad domains of policy actions which should be considered in responding to unhealthy diets in the communities: the food environment, food system and behavioural change communication (Hawkes et al., 2013).

The **Bellagio Conference on Program and Policy Options for Preventing Obesity in the Low- and Middle-Income Countries** in 2013 compiled a guide for LMICs to assist with obesity prevention (Popkin et al., 2013). Several critical barriers to implementation were identified, the most significant being food industry pushback, limited ability by governments to protect public policy development, and weak civil society support. An additional finding was that the following programmes and policies would benefit from more research to better evaluate their impacts: front of package labelling (FOPL), restrictions on marketing of unhealthy foods, improvement in school food standards and options, food taxes and subsidies, price incentive schemes, retail environment changes, and corporate voluntary efforts.

The International Network for Food and Obesity/NCDs Research, Monitoring and Action Support (INFORMAS) is a global network of public-interest organisations and researchers that monitor, benchmark and support public and private sector actions to improve and create food environments that reduce obesity, NCDs and their related inequalities (Swinburn et al., 2013). The **INFORMAS framework** focuses on monitoring the key aspects pertaining to food environments in countries over time, with the purpose of strengthening the accountability of governments and the private sector in issues pertaining to the impact of their policies and actions on food environments, obesity and NCDs. The proposed monitoring framework includes contextual factors, population risk factors, and characteristics of food environments (such as the nutrient composition of available foods, the availability of foods in communities, prices and affordability of foods, and the risks to food environments within trade and investment agreements). Data collection activities should occur on a regular basis to enable assessment of trends and update benchmarks of good practice.

In 2014 the WHO established the **Commission on Ending Childhood Obesity** to provide policy recommendations to governments to prevent infants, children, and adolescents from developing obesity, and to identify and treat pre-existing obesity in children and adolescents (World Health Organization, 2017). Their Ending Childhood Obesity implementation plan guides member states to focus on six key areas, with further details provided in the full report:

1. Implement comprehensive programmes that promote the intake of healthy foods and reduce the intake of unhealthy foods and SSBs by children and adolescents.
2. Implement comprehensive programmes that promote physical activity and reduce sedentary behaviours in children and adolescents.
3. Integrate and strengthen guidance for NCD prevention with current guidance for preconception and antenatal care, to reduce the risk of childhood obesity.
4. Provide guidance on, and support for, healthy diet, sleep, and physical activity in early childhood to ensure children grow appropriately and develop healthy habits.
5. Implement comprehensive programmes that promote healthy school environments, health and nutrition literacy and physical activity among school-age children and adolescents.
6. Provide family-based, multicomponent, lifestyle weight management services for children and young people who are obese.

The commission recommend that emphasis should be on taking ownership, providing leadership, and engaging political commitment to tackle childhood obesity over the long term. All relevant stakeholders should be engaged including the private sector and all government sectors and institutions responsible for policies, including education, food and agriculture, commerce and industry, development, finance and revenue, sport and recreation, communication, environmental and urban planning, transport and social affairs, and trade. Data collection on BMI by age should help set national (local) time-bound targets for childhood obesity.

3. EVIDENCE ON OBESITY PREVENTION AND CONTROL INTERVENTIONS

Obesity prevention and control strategies can be broadly organised into three groups by the degree to which an intervention involves individual agency versus structural change (Backholer et al., 2014). *Agentic interventions* aim to increase individual knowledge or skills to make healthier choices, leaving the environment unchanged. *Structural interventions*, by contrast, change the environmental context within which individual behaviours occur, thereby diminishing individual agency. *Agento-structural interventions* are situated between the two, as they address structural aspects of environments while requiring a level of individual agency for behavioural change.

In regard to agentic interventions, “nudge theory” uses positive reinforcement and indirect suggestions to influence the behaviour and decision-making of groups or individuals. A recent systematic review and meta-analysis confirmed the effectiveness of nudge strategies to change dietary choices to healthier ones (Arno and Thomas, 2016).

Policy-based approaches often have a wider reach and are more enduring compared with other types of interventions because they codify change and survive transitions in leadership (Cobiac et al., 2013; Magnusson, 2008). Compared with individually targeted interventions, population-level policy can offer larger and more sustained benefits for population health and at a lower cost to society. However, an equity-focused systematic review including 36 papers showed that the equity impact of most policies examined, be they agentic, agento-structural, or structural in nature, was neutral (Olstad et al., 2016). These results were broadly consistent when findings were stratified by participant population (children versus adults), level of implementation (microenvironment versus macroenvironment), and by anthropometric and behavioural outcomes. Characteristics of policies more or less likely to improve inequities could not be clearly ascertained. However, fiscal measures (including both taxes and subsidies) proved powerful, with free/subsidised school fruit/vegetable/healthy meal schemes having neutral impacts on inequities in several studies, while tax-related fiscal measures had consistently neutral or positive impacts. These findings were further underscored in a 2021 study from Mexico that compared the equitability of individual- and population-level interventions to reduce obesity (Vidaña-Pérez et al., 2021). Mathematical models determined that a 20% SSB tax produced the largest estimated increase (4.50%) in normal BMI prevalence, was the most cost effective, and had the largest and most equitable decrease in obesity across socioeconomic categories. Pharmacotherapy and metabolic

surgery produced sizable decreases in obesity prevalence (3.68% and 1.18%), whereas dietary advice had the lowest impact on normal and obese categories.

The following section will examine different interventions which can be included in national strategies for the prevention and control of obesity. Interventions can be organised according to targeted life-stages: ‘antenatal and infant’, ‘preschool (2–6 years) and school age (6–18 years)’ and ‘adolescence and adulthood’.

3.1 Antenatal and infant interventions

3.1.1. Antenatal interventions

Interventions during pregnancy show poor efficacy in reducing childhood obesity, however, positive effects can be found on maternal or neonatal conditions considered risk factors for childhood overweight/obesity such as maternal weight gain, gestational diabetes, small for gestational age and low birth weight infants. Balanced protein/energy supplementation and nutrition and exercise counselling were found to be useful in reducing these risk factors (Blake-Lamb et al., 2020). Dietary counselling reduced the risk of gestational diabetes by 46%, thus showing promise as it can act on a known overweight/obesity risk factors for the child (Grobler et al., 2019).

3.1.2. Promotion and support for breastfeeding

The effect of breastfeeding (BF) and breastfeeding promotion interventions on childhood obesity have been extensively studied, with mixed results. The vast majority suggest that longer-term exclusive BF (to at least 6 months of age, as recommended by the WHO) significantly reduces the risk for childhood obesity. Three meta-analyses, examining dozens of studies between them, concluded that the risk of childhood obesity is greatly reduced by BF in infancy (Arenz et al., 2004; Harder et al., 2005; Yan et al., 2014). Comparing exclusive to non-exclusive BF, the evidence is not conclusive regarding a greater protective effect against the risk of childhood obesity of the first vs. the second (Patro-Gof़ab et al., 2016a). The WHO recommends the use of a cup to feed infants with breastfeeding difficulties in low resource settings (World Health Organization, 2019). Cups are more easily sanitized than bottles and only require that the infant be able to swallow and breathe, demanding less energy and skill than the more complex suck-swallow-breathe mechanism needed for BF. It has been extensively studied as a measure in infants who need to be fed by an alternative oral feeding method, with no reports available regarding its effect on obesity.

Potential mechanisms by which exclusive BF reduces the risk of childhood obesity include differences in the macronutrient profiles and bioactive components of formula versus breast milk, differential effects on the gut microbiota, and that babies who feed directly from the breast are less likely to be overfed (Azad et al., 2018). Breastfeeding babies self-regulate (they stop sucking when they are full), whereas bottle-feeding often involves the parent or caregiver pushing the baby to finish the bottle. In this way, breastfed babies learn to eat only when hungry and to stop eating when full, which is a valuable skill for maintaining healthy weight.

The ability for mothers to BF involves more than just awareness of its benefits; BF promotion and support programmes need to be informed by locally relevant challenges that mothers face in South Africa, such as lack of family or social support, inappropriate advice from health workers, or returning to work/school (Jama et al., 2017).

3.1.3. Formula milk

Studies on the characteristics of formula milk in the first year of life in relation to the risk of overweight or obesity focus mainly on the protein content. Lower protein formulas are associated with lower weight and weight z-scores between 6 and 12 months, with lower BMI between 12 months and 6 years of age and with a lower risk of obesity at 6 years in the absence of conclusive data on body composition (Patro-Gof़ab et al., 2016b).

3.1.4. Complementary feeding

Timing and protein intake are the two most studied aspects in relation to complementary feeding. Available evidence regarding the timing of introduction of complementary feeds is conflicting, with some reports supporting introduction no earlier than 4-6 months, with others stating that ‘the appropriate age range depends on the individual’s characteristics and development, even more so if the infant was born preterm’ (EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA) et al., 2019; Fewtrell et al., 2017). Exclusive on demand BF and introduction of complementary feeds no earlier than 6 months of age remain the current WHO recommendation (World Health Organization, 2021). Regarding protein intake, the ESPGHAN (European Society for Paediatric Gastroenterology, Hepatology, and Nutrition) suggests not exceeding 15% of the total energy intake at the time of complementary feeding as a protective measure against subsequent overweight/obesity (ESPGHAN, 2017).

3.2 Preschool (2-6 years) and school age (6-18 years) interventions

The 2018 HAKSA Report Card on Physical Activity for Children and Youth provides data regarding physical activity (PA) of South African school-aged children (Draper et al., 2018). A study that objectively measured PA (ISCOLE, 9-11 years old, across income settings), and one study using self-report, indicated that between 48-51.7% of children are meeting the recommended one-hour of moderate- to vigorous-intensity PA per day (Roman-Viñas et al., 2016; Sampasa-Kanyinga et al., 2017). Children spend an average of 3.3 hours per day using screens, with only 34% of children meeting the screen time guideline of <2 hours per day. The proportion of children participating in school physical education in South Africa was only 32% (Silva et al., 2018). Compliance with the Sport and Recreation South Africa national school sport programme (a core deliverable in the 2016-2017 strategic plan) appeared poor, and there is a lack of documented evidence of policy implementation and evaluation (Draper et al., 2018).

3.2.1. School based interventions

Bleich et al. completed a robust review of randomised controlled trials conducted in preschool (6 studies) and school (24 studies) settings (Bleich et al., 2018). Most of the programmes with completely positive or mixed effects combined diet and physical activity interventions and most programmes with positive outcomes included the home environment as a secondary site of intervention. Seventeen studies had favourable and statistically significant effects for at least one adiposity outcome, with most of these based at schools rather than preschools. In an evaluation of the efficacy of childhood obesity interventions, the following components were most effective in changing obesity-related health outcomes in children 2–5 years of age: engaging caregivers in praise/encouragement for positive health-related behaviour, providing education about the importance of screen time reduction to caregivers, and engaging paediatricians and health care providers (Scott-Sheldon et al., 2020). School based gardening activities, although costly and time-consuming, lead to increased intake of healthier foods (notably vegetables), with a modest but positive impact on BMI measurements (Davis et al., 2021; Landry et al., 2019; Rochira et al., 2020). Engaging teachers to implement nutrition curricula support sustainable obesity prevention efforts in the school environment and nutrition literacy programs lead to higher consumption of fruits and vegetables, while the consumption of energy-dense food and SSBs decrease (Hawkins et al., 2021; Vieira and Carvalho, 2021).

3.2.2. Regulation of marketing of unhealthy products to children

Children are exposed to various forms of food marketing, the majority of which comprise ultra-processed foods and drinks. Sweetened breakfast cereals, salty or sugary snacks, sweets, SSBs, and fast food are high in fats, sugar and salt which increase desirability of these products in the target audience (Adams et al., 2012; Correa et al., 2020; Harris et al., 2009; Kelly et al., 2010; Wicks et al., 2016). A strong link exists between food advertisements on TV, preference requests, and consumption of unhealthy food and beverages among

children (Boyland and Whalen, 2015; Smith et al., 2019). Several international organisations recommend restriction of marketing and advertising of unhealthy foods to children as a strategy to prevent obesity (Global Food Research Program, 2021).

Transnational companies create obesogenic environments that are flooded with persuasive advertisements and marketing of ultra-processed foods and drinks. They spend billions of dollars per annum designing sophisticated marketing strategies that are aimed at increasing exposure and acceptability of unhealthy foods and drinks among children and adolescents (Igumbor et al., 2012; Institute of Medicine, 2006; Moodie et al., 2013; Story and French, 2004). Children fall prey to these adverts as they lack nutrition knowledge and are unable to separate fact from fallacy when exposed to advertisements, resulting in excessive energy consumption (Institute of Medicine, 2006). This young age group is profitable to industry in that children and adolescents independently make their own purchasing decisions, hold power to influence household purchases, may develop brand loyalty from a younger age and are future consumers (Story and French, 2004). TV advertisements remain the main vehicle for promotion of unhealthy food; other platforms include magazines, newspapers, billboards, social media, websites, video games and promotion on public buildings such as schools, clinics and sports grounds (Montgomery and Chester, 2009; Story and French, 2004). Product packaging is another powerful medium that industry uses to market products, often using cartoon characters, celebrities, sports figures, characters in movies and TV, and attractive colours and shapes on product packages to increase product appeal among youth (Elliott and Truman, 2020; Huang et al., 2016).

At least sixteen countries have implemented statutory regulations on food marketing to children, the most common approach being prohibition of advertising on children's TV channels or during children's TV programmes (Taillie et al., 2019). In South Korea for example, marketing to children is prohibited between 5pm-7pm and at any time during children's programmes; in Mexico, TV advertisements for restricted foods are banned between 2.30pm-7.30pm weekdays and 7am-7.30pm weekends when the audience is >35% children, and in Chile the ban extends from 6am-10pm (Anselmi, 2018). Chile's National Law of Advertising and Marketing aims to restrict marketing and advertising of unhealthy foods and beverages high in energy, fats, sugar and/or sodium to children below the age of 14 years, and to ban these foods in school kiosks and feeding programmes (Corvalán et al., 2019, 2013). Results from Chile revealed that adolescents' exposure to TV advertising decreased after the 2016 implementation of the law, while no dietary changes could be demonstrated (Jensen et al., 2021). The marketing restrictions in Chile extend beyond TV advertising to other media platforms including radio, magazines, social media, billboards, pamphlets, and websites. Marketing of unhealthy products is also prohibited in public places commonly used by children and adolescents such as day care centres, cinemas, parks, gymnasiums, swimming pools, community centres, as well as in public and private transport, and at public events with children or adolescent participation such as sports, cultural or fan events. Other marketing strategies that appeal to children such as cartoon characters, animation, children's music, child actors, free toys, or interactive games that could attract children's attention are also prohibited. A study conducted to evaluate the impact of a ban on sales of unhealthy food within school premises in Chile revealed that unhealthy food sales decreased from 90.4% in 2014 to 15.0% in 2016 (Massri et al., 2019).

One challenge that follows restricted TV marketing is that companies may increase the use of other avenues to market their products. After implementation of new regulations in Slovenia, TV adverts increased in the time slots outside of the restricted times, resulting in little or no difference in the amount of viewing (Lavriša et al., 2020). In South Korea, a significant decrease in TV advertisements was accompanied by increased online, mobile, and social media adverts (Lee et al., 2017).

The WHO has released a set of recommendations to provide a framework for its member states when implementing restrictions on marketing to children (World Health Organization, 2006). The policy aims to regulate responsible marketing by industry and to reduce the impact of marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt on children.

3.2.3. Nutritional standards for school meals

The South African National School Nutrition Programme (NSNP) aims to provide a daily nutritious meal with at least 30% of the recommended dietary allowance for children over the age of 4 years to learners from socio-economic quintiles 1 to 3 (Hazell, 2016). The NSNP provides one daily meal to 9 million children during school terms, supplemented by an additional breakfast to 40,000 children in the poorest schools. The prescribed daily meal of the NSNP consists of a starchy food, a protein dish and vegetables or fruit.

Two schools in the Eastern Cape province that initiated NSNP meals for the first time were followed up for 6 months, during which time the prevalence of overweight and obesity among learners decreased from 26% to 19% (Graham et al., 2018). This suggests that a nutritious daily meal may have protective effects against overweight and obesity among primary school aged children.

A meta-analysis of interventions in the school food environment from all over the world showed that almost all interventions focussed on the availability of different foods in the school environment, 60% involved the direct provision of food, and 31% addressed the regulation of vending machines, kiosks, and food stores, or the introduction of cafes, snack bars, or fruit and vegetable buffets. Only 12% of internal school food environment interventions were effective and 3% had a partial effect in the reduction of BMI. The authors concluded that policy actions are necessary to improve school food environments to sustain healthy dietary intake and prevent obesity, but that the effect may not be sustainable if an unhealthy food environment around schools competes with a healthy in-school environment (Pineda et al., 2021). The food environment around schools includes the location and concentration of food retailers such as convenience stores, take-aways, and fast food outlets within a 5km radius of the school (Williams et al., 2014).

3.2.4. Cultural tailoring

A scoping review of childhood obesity prevention studies conducted between 2005 and 2019 in the USA found that cultural tailoring was a component in a substantial proportion of interventions (Kumanyika, 2020). Cultural tailoring is creating a health message which recognises and reinforces a group's cultural values, beliefs, and behaviours and builds upon those to provide context and meaning to the message. The approach applied in this project can support implementation research to answer questions about what it takes for an intervention to be well designed and delivered for effectiveness in diverse settings.

3.3 Interventions targeting adolescence and adulthood

3.3.1. Communication and technology

Mass media and emerging technology (smartphone applications, fitness trackers, and online social networks) may be an effective way to educate individuals and help overcome obesity, in part through online interaction with health care providers and health-conscious peers (Awofeso et al., 2019). Previous reviews and meta-analyses have shown that digital health technologies can be an effective vehicle to promote a healthy lifestyle, most notably by increasing healthy eating habits and physical activity (Lentferink et al., 2017; Matthews et al., 2016; Schembre et al., 2018). As the field of behavioural medicine continues to leverage digital tools to improve the reach and effectiveness of interventions, academic-industry partnerships should be explored (Arigo et al., 2019).

Regarding the management of obesity, the use of social media has had mixed results. An analysis of 12 studies evaluating the effect of interventions using social networking services revealed a modest but significant reduction in BMI from baseline (Ashrafian et al., 2014). Effectiveness regarding obesity prevention by encouraging overall healthier lifestyles is more promising. A recent meta-analysis revealed that eHealth interventions significantly promoted physical activity and healthy diet although not contributing to a healthy weight status (Duan et al., 2021). Furthermore, in a mixed methods study involving healthy young adults using

a social networking mobile application for 6 months, participants in the underweight-normal BMI group significantly increased their daily step count over the study duration, while participants in the overweight-obese group did not sustain a short-term decrease in their BMI and mentioned negative emotions from app use (Laranjo et al., 2020). Most participants mentioned a desire for a more personalised intervention.

The social and behavioural change communication (SBCC) team for NCD prevention in South Africa aims to support the design, implementation and evaluation of practical and strategic communication activities (Better Health Project South Africa, 2021). The team has identified global and local examples of successful mass media campaigns to promote a healthy diet and exercise, as well as solutions to barriers such as limited resources, community participation, and governmental intersectoral action. In a recent analysis of the 2020 National Nutrition and Obesity Week campaign, strengths included the ability to engage multiple stakeholders while weaknesses included limited attention to a costed workplan, a theory of change and a monitoring and evaluation plan (Better Health Project South Africa, 2021).

3.3.2. Household food production and community gardens

There is evidence to support home gardening as a means to increase fruit and vegetable consumption, with gardeners less likely to be obese (Kegler et al., 2020). In a recent scoping review on the impact of community gardening in Kenya and South Africa, researchers found that reports were mostly cross-sectional in design, with limited results on health impact, unable therefore to properly investigate causal relationships (Hutton et al., 2021). However, the evidence collated in this review supports the argument that community food production programmes and initiatives benefit health, economic and social wellbeing and support sustainability within the environment.

3.3.3. Tax on sugar sweetened beverages (SSBs)

Price increase in the form of tax is one of the most common fiscal interventions to curb consumption of unhealthy foods and beverages by making the unhealthy options less economically attractive (Andreyeva et al., 2010; Sassi et al., 2018). The premise for food or beverage taxation is decreased affordability of unhealthy products resulting in consumers shifting to more affordable products (Andreyeva et al., 2010; World Cancer Research Fund, 2021). Consumers from low socio-economic backgrounds are sensitive to price increases and there is evidence of altered purchasing behaviour following the implementation of these taxes (Sassi et al., 2018).

SSBs include soft drinks, fruit drinks, milk drinks, iced tea, and energy and vitamin water sweetened with added sugars. A strong relationship exists between consumption of SSBs and obesity (Malik et al., 2010; Te Morenga et al., 2014). In addition, SSBs also independently relate to the development of NCDs such as diabetes, some cancers, and cardiovascular diseases (de Koning et al., 2012; Drouin-Chartier et al., 2019; Singh, 2016). These products are energy dense, easy to consume in large quantities without reducing the total amount of food consumed, and they contribute to increases in both childhood and adult obesity worldwide (DiMeglio and Mattes, 2000; Mourao et al., 2007; Sánchez-Pimienta et al., 2016). While SSBs are considered unhealthy and taxed by governments, 100% fruit juices are not considered under the category of SSBs and have largely been untouched by policy. Additionally, no evidence regarding mandatory warnings accompanying 100% fruit juices could be found, despite the high sugar content (Coelho, 2017). However, researchers recently identified which fruit juice sugar information labels would be best understood by the consumer, which provides easy to implement actions for policymakers (Sah et al., 2021).

Globally more than 40 countries, including South Africa, have implemented tax on SSBs (Global Food Research Program, 2021). Evaluation studies in the USA, UK, and Mexico showed that SSB taxes reduced purchasing and consumption of SSBs, increased consumption of healthier alternatives such as water or zero-sugar drinks, and incentivised industry to reduce sugar content through reformulation (Bandy et al., 2020; Colchero et al., 2017;

Falbe et al., 2020; Pell et al., 2021; Powell and Leider, 2020; Scarborough et al., 2020). In Mexico, the greatest reduction was achieved among low income groups and those with greatest consumption (Colchero et al., 2017). A recent publication in South Africa revealed a reduction in mean sugar intake, reduction of taxed beverage sales and increase in selection of untaxed beverages (milk, bottled water, 100% fruit juice, and alcohol) (Stacey et al., 2021). Similar to Mexico, and underscoring results from a recent meta-analysis, these changes were more pronounced in lower income groups, suggesting that a reduction in consumption of SSBs is an equitable intervention associated with health benefits for socio-economic disadvantage communities (Backholer et al., 2016).

In a synthesis of findings on the 2016 South African government proposed SSB tax of 20%, followed until April 2021, authors provided valuable insight into its implementation in South Africa (Hofman et al., 2021). Protracted consultations with beverage manufacturers and the sugar industry resulted in a lower SSB tax, the Health Promotion Levy, of approximately 10% coming into effect in April 2018. Despite the lower-than-planned rate, purchases of SSBs and sugar intake from SSBs fell. There were greater reductions in SSB purchases among lower socioeconomic groups and in subpopulations with higher SSB consumption. These groups bear larger burdens from obesity and related diseases, again suggesting that this policy improves health equity.

3.3.4. Easy to understand schemes of food labelling

Front of package food labelling (FOPL) that summarises the more detailed nutritional information usually located at the back or sides of the pack is a quick and easy method to communicate nutrition information to consumers (Cecchini and Warin, 2016; Hawley et al., 2013; World Health Organization, 2020). Consumers tend to find the more detailed nutrition facts panel difficult to interpret due to the numbers and terminology used, inconvenient due to its location at the back, and time consuming (Centurión et al., 2019; Ducrot et al., 2016; Taillie et al., 2017). Adoption of simple, easy to understand FOPL is recommended to assist consumers of all social levels to easily identify unhealthy products at a glance.

Front of package food labelling systems differ according to the type and number of nutrients presented on the label, amount of nutrition information presented, label design, reference values and whether the label provides any interpretive guidance to the consumers (EUFIC, 2018; World Health Organization, 2020). Labels that interpret the nutritional quality (interpretive) rather than state the nutrient levels (reductive) are more effective in assisting consumers identify unhealthy products (Cecchini and Warin, 2016; Taillie et al., 2017). Interpretive FOPL include Multiple Traffic Light (MTL) and nutrient warning labels, and reductive FOPL include Guideline Dietary Intakes (GDA) (Hamlin et al., 2015).

Interpretive FOPLs use aids such as colour, pictorial images or icons, shapes and text associated with warning or danger to make the labels easier to understand (Hammond, 2011; Wogalter et al., 2002). The use of icons or pictorial images (shapes such as the triangle, octagon, and circles) and colours such as red and black increases the understandability of the labels especially for the less literate, children and the elderly (Fleyeh, 2004; Houts et al., 2006; Wogalter et al., 2002). These designs furthermore increased risk perception linked to overconsumption of the labelled product (Kelly et al., 2009). Multiple Traffic Light labelling is a preferred FOPL format due to its common and attractive colours (red, amber and green), however consumers can find it difficult to interpret when the label contains two or all three colours simultaneously (Kees et al., 2014; Machín et al., 2018b).

A review of studies revealed that nutrient warning labels tend to better assist consumers to identify unhealthy products than either the GDA or the MTL (Taillie et al., 2020). Nutrient warning labels highlight nutrients and other food components, such as artificial sweeteners, that are in excess in a food product. They are mandatory in countries such as Chile, Israel, Uruguay, Peru, and Mexico (Chile Ministry of Health, 2015; Israel Ministry of Health, 2017; Ministerio de Salud Pública Uruguay, 2018; Ministry of Health Peru, 2018; Secretaría de

Economía, 2020). Studies have demonstrated that consumers, including children, are better able to identify unhealthy products, understand excess nutrient content, and are more inclined to limit purchases of SSBs and other ultra-processed foods when they are confronted by warning labels as compared to other label types (Arrúa et al., 2017; Khandpur et al., 2018; Machín et al., 2018a).

3.3.5. Reformulation of processed foods with reduced salt, fat, and sugar content

International organisations recommend product reformulation by industry as one strategy to reduce the salt, saturated fats, trans-fats, energy and sugar content in foods (World Cancer Research Fund, 2021; World Health Organization, 2018). To limit salt and trans-fats consumption, the South African NDoH introduced measures which have led to reduction of sodium and fat content of bread and other processed food (Ndanuko et al., 2020; South African Government, 2013, 2011; Tekle et al., 2020).

Implementation of restrictive food policies (food taxes, FOPL and marketing restrictions) is an added incentive for product reformulation in some countries, including South Africa. The display of a warning label, for example, may create a negative perception of the product and may lead to product reformulation by companies to avoid displaying the label (World Cancer Research Fund, 2021). One year following the mandatory implementation of the Law of Food Labelling and Advertising in Chile, the proportion of products high in nutrients of concern dropped from 51% to 44% (Reyes et al., 2020). There is currently still limited evidence regarding the effects on obesity of taxing sugar-added foods, but initial reports are promising while robust studies are awaited (Pfänder et al., 2020). In contrast, and has been mentioned earlier in this report, product reformulation by the SSB industry, as evidenced in the replacement of sugar with artificial sweeteners, has intensified as more countries have begun to implement sugar reduction targets and SSB taxes (Borges et al., 2017; Dunford et al., 2018).

Since the introduction of the Health Promotion Levy in South Africa, there has been growing evidence of product reformulation, with many brands reducing sugar content (Stacey et al., 2021). Data from a meta-analysis suggest that replacing sugar with non-nutritive sweeteners leads to weight reduction, particularly in participants with overweight/obesity following an unrestricted diet, and that this information could be utilised for evidence-based public policy decisions (Laviada-Molina et al., 2020). A scoping review of 372 studies showed no conclusive evidence for beneficial or harmful effects of non-nutritive sweeteners on appetite and short-term food intake, risk of cancer, risk of diabetes, risk of dental caries, weight gain or risk of obesity (Lohner et al., 2017). As few studies investigated numerous other health outcomes (headaches, depression, behavioural and cognitive effects, neurological effects, risk of preterm delivery, cardiovascular effects, chronic kidney disease), conclusive evidence is lacking regarding risk/benefit, and further research is needed. In contrast, animal studies show that the consumption of non-nutritive sweeteners alter the gut microbiome and may induce glucose intolerance, increased food consumption and weight gain (Green and Syn, 2019). Other possible effects include inhibition of protective intestinal enzymes and increased appetite, but evidence from clinical studies is controversial. Therefore, further research in humans is needed to evaluate the relationship between non-nutritive sweeteners consumption and the gut microbiome.

The most common obesity prevention interventions are via taxation and subsidisation. A review of previously employed strategies provides valuable insights to guide the effective and efficient design and implementation of tax or subsidy instruments (Pfänder et al., 2020; World Bank, 2019). First, the targeting of the tax is important (tax objects, subjects and setting), because taxes will induce behavioural adjustments (substitution) in consumption and production. Second, the size of the tax rate is important; nutritional challenges to be addressed with taxes may call for rather substantial price changes, but conversely the revenue effects will be bigger the larger the tax rate. Third, the administrative aspects of a tax, for industry and government (enforcement and compliance monitoring), should be taken into consideration. And fourth, the involvement,

suggestions and challenges of relevant stakeholders and experts in the preparation of a tax should be considered to optimise the political viability of the scheme.

3.3.6. Menu labelling laws

Several locations in the USA and Australia have passed laws requiring restaurant chains to label the energy content of items on menus. Controversies include who should be included (supermarkets, convenience stores, pizza chains), how energy content should be presented (calories, salt and sugar content), and how such laws would be implemented and enforced in the informal market (Wellard et al., 2015). The evidence regarding menu labelling is mixed, showing that labels may reduce the energy content of food purchased in some contexts but have little effect in other contexts (Alexander et al., 2021; Ding et al., 2020; Swartz et al., 2011). The strongest data evaluating purchases at typical fast food restaurants like McDonald's and Burger King suggests labels do not alter consumer purchases (VanEpps et al., 2016). However, there is evidence that labels do encourage lower energy purchases in other settings such as coffee chains or full-service restaurants (VanEpps et al., 2016).

3.3.7. Corporate voluntary efforts and incentive driven programmes

It would be imperative for governments to encourage and support corporate voluntary efforts to limit increasing obesity numbers. Discovery Health, a South African private health insurer, was globally one of the first private companies to action, and publish results, on their incentive-based health promotion programme (Patel et al., 2010). Membership in the programme is voluntary and offered separately from the health plan because legislation in South Africa precludes differential insurance premiums based on health status. Activities include subsidised gym memberships, and smoking cessation and weight reduction programmes. Highly engaged participants in the programme have lower costs per patient, shorter stays in hospital, and fewer admissions compared with non-registered and low-engagement participants. Admission rates were also 7.4% lower for cardiovascular disease, 13.2% lower for cancers, and 20.7% lower for endocrine and metabolic diseases in highly engaged participants.

3.3.8. The treatment of obesity

Healthy eating and physical activity are the most important factors in the prevention of obesity; however, it does not address the 30% of men, 70% of women and 13% of under-5 children already suffering from overweight and obesity in South Africa. Changes in brain chemistry, metabolism, and hunger and satiety hormones which occur during attempts to lose weight, make it notoriously difficult to definitively lose weight (Rosenbaum and Leibel, 2010). There is good evidence that the body's natural response to weight loss is to increase appetite (and thus maintain weight) and that lifestyle changes such as diet and physical activity alone are often unable to bring about significant levels of weight loss with only 5% of individuals maintaining weight loss (Greenway, 2015). Although pharmacotherapy (medication) can increase this number to 8-10% while treatment is continued, it is currently not available in the public sector in South Africa (Kushner, 2018).

Metabolic surgery is the only treatment modality to have good long-term outcomes with 60% excess weight loss sustained at 10 years after operation (Golzarand et al., 2017; O'Brien et al., 2019). More significant is the associated resolution of comorbidities and decrease in mortality (Carlsson et al., 2020; Sjöström et al., 2007). It is currently the only curative treatment option for T2DM and the first line preferred treatment modality for individuals with a BMI ≥ 35 kg/m² and individuals with a BMI ≥ 30 kg/m² and poor glycaemic control (Cummings and Rubino, 2018; Rubino et al., 2016). There are multiple available reports on its cost-effectiveness when compared to conventional treatment options (Ademi et al., 2018; Borisenko et al., 2018; Boyers et al., 2021; Galvain et al., 2021; Harrison et al., 2021; Lester et al., 2021; Noparatayaporn et al., 2021).

In South Africa, metabolic surgery has been available exclusively to privately funded patients since 2010 (Van der Merwe et al., 2015). It was only in 2017 that Obesity and Metabolic Surgery programmes were initiated at two public hospitals (Stellenbosch University and Sefako Makgatho Health Sciences University). These programmes for the first time provided access to obesity treatment for obese individuals in the public sector, as well as skill development and education surrounding obesity prevention and treatment to health care workers and the public. The programs have efficacy and safety results comparable to reports from international centres and serve as an example of strategic thinking as they not only address obesity but at the same time serve to treat and cure the most common NCDs, most notably T2DM (Lubbe et al., 2019).

3.4 The importance of obesity surveillance, monitoring and evaluation

Population health surveillance is the ongoing systematic collection, analysis, interpretation, and dissemination of the data to decision makers responsible for policy and programmes (Hardy and Mahrshahi, 2020). Surveillance therefore refers to data collection from populations over two or more points in time and can happen at National, Provincial and Regional levels of a country project (Hoelscher et al., 2017). Surveillance data can indicate the need for interventions and monitor the effect of previously implemented strategies. Active surveillance requires trained field teams to collect data, while passive surveillance is based on clinic records and national surveys, and therefore provides limited data that may have variability in quality. Although questionnaires on self-reported behaviours have limitations, they remain the most feasible method of collecting population surveillance data. Effective surveillance systems are essential for preventing and addressing the public health problem of obesity (Hardy and Mahrshahi, 2020).

Body mass index (BMI) is used in obesity surveillance systems to monitor trends in populations (Hoelscher et al., 2017). It is a convenient and cost-effective measure in both adults and children due to its ease of collection, analysis, and interpretation by scientists and the public, and can be viewed as a democratic measure of health, as it allows individuals to assess their health independent of medical authorities (Gutin, 2018; Must and Anderson, 2006; Romero-Corral et al., 2008). Challenges noted in the literature regarding BMI as an obesity indicator include concerns about interpretation, privacy, stigmatization, and the possibility of dysfunctional behavioural responses such as eating disorders, especially at school-level (Massachusetts Department of Public Health, 2014; Nihiser et al., 2009). Concerns regarding misclassification and lack of standardised BMI values for the South African population are also noted (Blundell et al., 2014; Gómez-Ambrosi et al., 2012; Kruger et al., 2017; Moeng-Mahlangu et al., 2020). Recent reports recommend the use of bioelectrical impedance analysis (BIA) which is relatively simple method suitable for large epidemiological studies of changes in body composition (Devakumar et al., 2015). Combining two or more different anthropometric measures, such as waist-to-hip ratio and waist circumference-to-height ratio may be more sensitive to the accumulation of abdominal fat, however, these measurements are more invasive and require additional privacy (Gómez-Ambrosi et al., 2012; Hoelscher et al., 2017).

Monitoring of the prevalence of obesity alone is insufficient information for policy makers to determine the effectiveness of obesity interventions. Because obesity is a complex and multifactorial issue, measures of environmental determinants, such as the food and built environments should be included as part of surveillance data. Obesity surveillance data should be recorded in such a way to calculate outcomes benchmarked against internationally accepted recommendations for weight-related behaviours, for example the total time per day spent sedentary or doing moderate or vigorous physical activity. Food intake can be monitored by measuring consumption frequency of key “healthy” and “unhealthy” foods, as well measuring certain dietary behaviours. Obesity surveillance data in relation to the density of supermarkets, fast food outlets and transport data can lead to targeted policy decisions to address obesogenic factors in communities. In 2019 the Lancet Commission on Obesity suggested a framework, inclusive of LMICs, which identifies relevant interventions and indicators by which urban design, land use, and the built environment can address obesity (Devarajan et al., 2020). These include factors such as pedestrian priority and dignity, wide pavements

with tree canopies, water fountains with potable water, benches for the elderly at regular intervals, access to open-green spaces within 0.5-km radius and playgrounds in schools.

3.5 Prioritising obesity interventions based on economic evidence

Given resource constraints facing many countries, implementing all available effective interventions aimed at addressing obesity is unlikely to be feasible. Cost-effectiveness analyses that compare the cost and benefits or competing courses of action can be useful for informing the prioritisation of effective obesity strategies and policies as well as in defining a package of interventions that represent good value for money. While a growing body of evidence has emerged on the health benefits of obesity prevention strategies, at least in terms of intermediate health outcomes such as BMI reductions, there is comparatively limited evidence on the costs and cost-effectiveness of these strategies (Ananthapavan et al., 2014; Anderson and World Health Organization, 2009; Brown et al., 2019; Sonntag et al., 2016). Existing cost-effectiveness studies have focused on assessing single interventions using variable methodologies, thus limiting the comparability of findings across studies. While single intervention evaluations may be useful when policy makers are faced with one policy alternative, they are limited for the identification of a package of interventions aimed at holistically tackling obesity prevalence.

Furthermore, the majority of existing cost-effectiveness interventions focus largely on assessing the value for money of clinical interventions for obesity such as bariatric surgery and pharmaceutical management of obesity (Ananthapavan et al., 2014; Sharifi et al., 2017). However, a growing recognition of the importance of environmental factors that promote obesity has led to a shift from the evaluation of so-called ‘upstream’ policy interventions to ‘downstream’ interventions that target behavioural changes such as regulatory and fiscal policies and community-level obesity prevention programmes.

Compared to downstream interventions, upstream interventions have been shown to be both more effective in improving obesity-related health outcomes and cost-saving. For example, in a review of economic evidence of obesity prevention and treatment strategies in Australia, the majority of primary prevention strategies were either cost-saving due to a reduction in future health care expenditure or cost-effective, with incremental cost per disability-adjusted life-years (DALYs) averted lower than the Australian cost-effectiveness threshold of \$50,000/DALY (Table 1) (Ananthapavan et al., 2014).

Table 1. Cost-effectiveness of Obesity Prevention Strategies

Cost-effectiveness	Obesity Prevention Strategies
Cost-saving	School (curriculum)-based education programme to reduce television viewing
	Multi-faceted school (curriculum)-based programme including nutrition and physical activity
	School-based education programme to reduce SSB consumption
	Reduction of advertising of unhealthy food and beverages to children
	Front-of-package nutrition labelling
	Unhealthy food and beverage tax (10%)
Cost-effective (ICER \leq \$50,000/DALY)	Multi-faceted school (curriculum)-based programme without an active physical activity
Not cost-effective (ICER $>$ \$50,000/DALY)	Active transport interventions designed to increase the number of children walking to school and to provide a safer traffic environment around schools
	Active after-school communities programme
	Healthy diet and lifestyle weight-loss programmes for adults

Adapted from Ananthapavan et al. (Ananthapavan et al., 2014)

In a more recent study, the cost-effectiveness of 16 obesity prevention strategies in Australia was assessed including regulatory interventions and programmes targeting unhealthy food and drink consumption and the promotion of physical activities among children and adults (Ananthapavan et al., 2020). Using a modelling approach, the authors predicted that all 16 interventions were cost-effective and would result in significant health gains ranging from approximately 7500 healthy-adjusted life-years (HALYs) for work-place intervention to reduce sedentary behaviour to approximately 472,000 HALYs for alcohol price increases. The following interventions were assessed as net cost-saving over the lifetime of the population: taxation on alcohol and SSBs, restrictions on TV advertising of unhealthy foods, package size cap on SSBs, supermarket shelf tags on healthier products, menu nutrient labelling on fast food, school-based interventions to reduce sedentary behaviour and increase physical activity, restrictions on price promotion of SSBs, reformulation to reduce sugar in SSBs, and a national mass media campaign to encourage reduced consumption of SSBs. Regulatory and fiscal policies resulted in the largest cost savings.

Similar findings have been reported in a US population using a microsimulation model to demonstrate that regulatory and fiscal policies targeting exposure to and consumption of unhealthy foods and drinks in children would be cost-saving in the long term (Gortmaker et al., 2015b). These actions include SSB excise tax, the removal of tax subsidy for advertising unhealthy food to children and setting nutrition standards for food and beverages sold in schools outside of school meals. Other studies have also reported significantly higher net savings for regulatory and fiscal policies (Lehnert et al., 2012).

The favourable economic profile of regulatory and fiscal policies compared to other preventative programmatic interventions is largely due to the low implementation costs and potentially higher coverage across a wider population resulting in lower cost per person. However, the strength of evidence of the effectiveness of these interventions is comparatively lower (Ananthapavan et al., 2020; Gortmaker et al., 2015a).

3.5.1. Are cost-effectiveness analysis results transferable across settings?

Differences between setting in terms of model parameters such as unit costs, intervention coverage, and epidemiology of obesity and related diseases and risk factors may limit the transferability of findings from other settings to South Africa. There is a dearth of evidence on the cost-effectiveness of obesity prevention interventions within the South Africa context. In one study assessing the cost-effectiveness of seven obesity prevention strategies in seven countries including South Africa, fiscal measures affecting the prices of healthy (reduced price) and unhealthy (increased price) foods were cost-saving in South Africa (Cecchini et al., 2010).

Overall, studies report consistent findings across settings (in terms of the cost-effectiveness profile of regulatory vs community-level programmatic interventions) and provide useful insight into potential obesity prevention strategies that can be prioritised for implementation in South Africa. Furthermore, these studies suggest that a package of interventions is likely to have higher health gains and economic profiles compared to individual interventions with regulatory/fiscal policies not only yielding highest net savings within the health system but also potentially generating additional government revenue (Cecchini et al., 2010; Gortmaker et al., 2015a; Long et al., 2015).

Beyond gains described here, other considerations such as the strength of evidence on intervention effectiveness, equity, acceptability, feasibility of implementation and sustainability are important and should be taken into account when designing obesity prevention strategies aimed at reducing the burden of obesity and obesity-related diseases in South Africa (Ananthapavan et al., 2020; Gortmaker et al., 2015a).

4. EXAMPLES OF NATIONAL OBESITY STRATEGIES FROM AROUND THE WORLD

Although effective national strategies need to be tailored to the local context, by analysing examples of successful policies and interventions from other countries, we can learn lessons and generate new ideas that are applicable to South Africa.

4.1 Asia Pacific examples

4.1.1. Tonga: taxation and monitoring

The Tonga Department of Health conducted an end-of-term review of their national strategy to control NCDs, to inform the design of the new strategy (Tonga End of Term Review, 2015).

For healthier diets, key steps that were implemented included changes on import duty of healthy and unhealthy foods (taxation), partnerships to increase the use of vegetable gardens, a school food policy development programme, and aid to duck and poultry hatcheries. While the food tax policy covers many food products, the study team focused on just a few key products consumed by most Tongans. Import duties on tinned fish was reduced to 0%, fish (frozen or chilled) to 0%, onions and potatoes to 15%, and import duty on fatty foods (mutton flaps, turkey tails, and chicken leg quarters), sugary foods (ice cream), and instant noodles were increased to 15%. Prices increased following the imposition of import duty across all products, and import volumes decreased. It is important to note that despite lower import volumes, tax revenues from import duty and excise tax have increased consistently. The two products most responsive to price change were ice cream and mutton flaps. Outcomes for this strategy implementation were measured by the longitudinal survey; most people reduced their consumption of taxed food, while 16% opted for alternative products. Vegetable consumption increased from 7.8% to 26.9%, and there was some improvement in overweight trends, with marginal improvement in obesity trends. For increased physical activity, key steps included sports and PA programmes/competitions supported by the health promotion unit, addition of PA to curricula, granting of sports and cycling equipment, extension/improvement of footpaths in urban areas, and marking of distance on electrical poles in villages to encourage walking. It is less clear how outcomes for PA were measured with few outdated surveys available, but in the follow-up survey, there did seem to be some improvement in physical activity levels (female engagement in recreational PA increased from 40% to 44%).

After key informant interviews, the following strengths were identified to build on in the next phase of the strategy: targeting youth (>14 years old), building on existing partnerships between sectors, and re-engaging with community organisations for supporting key health messages, policies, and activities at the community level.

Key lessons learned regarding strategy implementation included:

- **Coordination** - Lack of resources to support coordination and implementation was identified as an important challenge to success. Coordination is a central component of implementation of nationwide programmes and clear roles and responsibilities should be allocated to all governing and administrative bodies. Policy changes and actions should be linked, requiring coordination between policy makers and implementers.
- **Communication and engagement** - Stakeholders and partners should be engaged early and be involved in decision making in their area from the outset. It is important to engage political, social, and community leaders to support social and behavioural change, as well as engaging the private sector in an ethical manner. Communication between stakeholders and partners should be ongoing and consistent, with regular engagement between those involved directly and those who are influential but external (respectful partnering).

- **Resources** - Activities were often curtailed by a lack of funds to invest in resources and or materials required to undertake the activity or sustain the programme. Due to funding barriers momentum was lost for some activities. Initiatives should be part of the 'core business' of partners and budgeted for early. Start where the programme is currently and make sure to complement the 'core business' of the partner. Adequate funding should thus be allocated to activities.
- **Monitoring** - Either a lack of management and execution or overly complex (disjointed) systems for reporting on activities and undertaking monitoring were identified as challenges. M&E systems should be simplified.
- **Prioritisation** - The comprehensiveness of the first plan did not prioritise actions within areas or between risk factors. Fewer issues should be focused on with prioritisation of issues/goals/activities.

Included in the Tonga strategy were taxation laws on tobacco, alcohol, and unhealthy foods (World Bank, 2019). One valuable lesson learned is that without complementary measures, tax increases may merely result in a switch from one form of unhealthy consumption to another. For example, taxation on imported tobacco led to a shift in use to more affordable and widely available local tobacco which is just as harmful to health. Tax on cigarettes had a greater effect on low-income smokers, and price increases tended to be financed disproportionately by high-income households, highlighting the equity impact of price policies. Price, rather than health, was the main reason among those who decided to change behaviours.

Increased alcohol taxation led to decreases in the frequency and amount of alcohol products consumed; however, a shift to substitutes (kava, marijuana, glue/petrol sniffing, and crystal methamphetamine) was observed. Import tax on turkey tails, mutton flaps, and ice cream helped reduce consumption, though rather than choosing healthier foods instead, individuals tended to shift to local cheaper brands. This demonstrates the importance of imposing unified tax rates for both imported and locally manufactured unhealthy products if increased taxation is used in a strategy.

It seems that policy interventions should rather be focused on the affordability and accessibility of healthy food; however, in Tonga the removal of the 15% tax on imported fruits resulted in neither lower retail prices nor higher consumption of these products. Imported fruit prices remained the same and the benefits from the tax exemption went to traders rather than consumers.

In summary, the Tonga example shows that consumer response to price change depends on the characteristics of the product and the available alternatives. Products where price changes are most likely to influence consumption are products with a high price per unit, products whose unit price occupies a noticeable proportion of household expenditure, and products not considered a daily staple but rather a luxury.

Recommendations regarding taxation as a strategy in national health policies were as follows:

- To avoid dilution, product taxation should be applied consistently (at the same level) for both local and imported products.
- The choice of which foods to tax should be based on scientifically supported criteria across all food groups, including the use of nutrient profiling that indicates an unhealthy threshold (e.g., levels of fat, salt, and sugar).
- Improved monitoring of the prices of tax-exempt healthy food should ensure that tax exemption achieves the goal of price reduction, and in turn higher consumption of healthy food products.
- Annual tax increases should well-exceed increases in consumer prices and incomes. Small, incremental increases in tax alone do not work. What drives behaviour change is the "price shock" that comes after a large tax increase. After the large tax increase, small incremental increases can be

used to sustain impact. Monitor tax interventions continuously to ensure that impact is clear and known.

- Revenues acquired from increased taxation should be communicated to the public and used to support and promote healthy lifestyles among the population, as well as to improve health care services.

4.1.2. Australia: stakeholder engagement and monitoring

In 2018 the Australian Health Council committed to developing a national obesity strategy (Australian Department of Health, 2019). A consultation process to inform the strategy was undertaken in 2019 and 2020 to increase community and organisation input into what the national obesity strategy should cover. A total of 81 proposed sub-strategies (informed by evidence and stakeholder consultations) were presented in a paper for public comment, which took the format of surveys.

Main findings from participant responses included:

- Population-level interventions and system changes, in particular food systems, should be prioritised in the strategy. Suggestions included making healthier food and drinks an easier and more convenient option by subsidising healthy food and using price to make unhealthy options less attractive, reducing advertising of unhealthy food and drinks, and focussing efforts on settings where people live, work and spend time.
- Suggestions regarding infrastructure and urban planning included better walking and cycling infrastructure with provision of shade, planning for production of fresh food in urban settings and closer to where people live, and ready access to drinking water in urban and remote settings.
- Whole-of-government, sustained action and a commitment at all levels is needed to ensure a strategy will be resourced, implemented, reported on, and evaluated. Participants suggested governments need to work with all sectors, not just health.
- Targeted measures are needed to address overweight and obesity amongst priority population groups, with particular focus on equity to ensure that the delivery of any strategy does not further exacerbate inequities for priority populations. Negative impacts on people are to be avoided and strategies should be designed with the input of consumers.

An excellent example of monitoring of effectiveness is the New South Wales Schools Physical Activity and Nutrition Survey (Hardy and Mihrshahi, 2020). This survey was conducted in 2004, 2010 and 2015 in a representative sample of schools to estimate the prevalence and trends in children's weight status and weight-related behaviours to inform state health plans. Trained field teams measured children's height, weight, and waist circumference, measures of fitness and movement skills, as well as health behaviours and the school nutrition and physical activity environment. The data collected through this survey made a substantial contribution to the evidence base for policy and the development of programmes. For example, children's low consumption of fruit and vegetables was addressed by implementation of fruit and vegetable breaks in primary schools. The finding that children who purchased food regularly from the school canteen were more likely to be overweight or obese led to a more rigorous implementation of a Healthy School Canteen Strategy.

4.2 Latin American examples

4.2.1. Mexico: evidence-based policy, a unified voice and monitoring

In 2014 Mexico approved taxation of SSBs and nonessential energy-dense food which made producers legally responsible for calculating, reporting, and paying these taxes (Pérez-Escamilla et al., 2017). The following key factors played a part in successful implementation:

- Research was key in influencing taxation and included obesity trends and associated health and economic consequences, as well as data on excessive intake of SSBs and high energy density diets of Mexican children. Later reports included proof of the elasticity of demand for SSBs in the Mexican population (10% increase in price associated with a 11.6% reduction in the demand), that the principal substitutes for SSBs were healthy (water and milk), and modelled weight and T2DM projections under different tax scenarios. These relevant reports, along with existing evidence on the impact of SSB taxes to disincentivise intake, consumer shifts associated with healthier diets, and the revenue generated to support obesity prevention efforts, were disseminated widely.
- To create a strong unified voice in communicating with the public and policymakers, 27 non-governmental organisations formed a coalition and partnered with academic and international organisations to lobby congress and conduct a mass-media campaign.
- The National Institute of Public Health monitored and evaluated the effect of the taxes on prices, consumption, and the use of fiscal revenues for obesity-related programmes. They found that SSB prices increased in urban (but not rural) areas. In urban areas they found a decrease in the consumption of SSBs (9%) and nonessential energy-dense foods (5%). These results were pivotal in defeating an attempt by the SSB industry to repeal the tax measure a year after implementation.

4.2.2. Ecuador: food package labelling

In 2013 Ecuador became the first country in Latin America to mandate food package labelling in the form of a traffic light (Pérez-Escamilla et al., 2017). The regulation was motivated by obesity prevalence and data for excessive levels of added sugars, sodium, and saturated fats in Ecuador diets. The draft decree stipulated that the label had to be placed on the front of the package, however, the final decree failed to carry this stipulation due to strong lobbying from the food industry. The Pan American Health Organisation (PAHO) provided political support and widespread media attention. Ecuador's labelling decree was developed and implemented with very little civil society engagement, and leadership was entirely provided by the Ministry of Health and academia with support from PAHO. Thus, in Ecuador the policy ended up being enacted as a Ministry of Health regulation and not as a federal law as in the case of Chile. Evaluation to assess impact is ongoing.

4.2.3. Argentina: evidence-based policy

Legislative strategies to ban trans-fatty acids (TFA) from foods have been more successful than labelling or education as shown in Scandinavian and American countries (Downs et al., 2017, 2013). Importantly, it has been identified by the WHO as a 'best-buy' public health intervention for LMICs (Cecchini et al., 2010). In Latin America, policies that require removing industrial TFAs and replacing them with polyunsaturated fats exist in Argentina, Chile, Brazil, Costa Rica, India, and Mexico. The introduction of the TFA ban in Argentina is an excellent example of evidence-based policy change (Pérez-Escamilla et al., 2017).

The first evidence generated was an analysis of lipid composition of commonly consumed foods, where almost all the processed foods analysed that were sweet or salty, such as cookies and crackers, contained high levels of TFAs (even apparently healthy choices, such as cereal bars, contained partially hydrogenated vegetable oil). As oils and fats are produced by a handful of large companies in Argentina, the government initiated early policy dialogue with key industry stakeholders, and in 2004 a voluntary food product reformulation programme was introduced by the food industry.

In the second phase, in 2008 the government of Argentina initiated mandatory regulations that specified percentage limits on TFAs as compared to total fats in foods, and in 2014 full compliance was mandated. After the regulation was fully developed, a modelling study estimated its health and economic impact, with results indicating that the regulation may be able to prevent around 300 to 1,500 deaths per year in Argentina (Rubinstein et al., 2015).

4.2.4. Colombia: physical activity

Ciclovías ('Open Streets' programmes) temporarily close streets to motorised traffic to transform them into a safe, people-oriented pleasant space for physical activities and socialising. Ciclovías were first introduced in two Colombian cities, and because of the documented success of the programme, the initiative has since spread to 461 cities in Latin America. Evidence suggests that users of the programme are more likely to meet physical activity guidelines, and a cost-benefit study estimated that each dollar invested in a Ciclovía saves \$3 USD per person in health care costs, amounting to \$13 million USD per year (Montes et al., 2012; Pratt et al., 2016).

The successful spread of Ciclovías is due to their popularity among the public by improving people's quality of life, resulting in strong political support from city mayors. Ciclovías are an excellent example of advances in understanding the relationship between urban planning and public health. Their introduction has been met with some resistance from businesses and transportation enterprises that were affected by the road closures, but this was overcome with strong support from civil society, highlighting new economic development opportunities for small businesses, and by having a strong evidence base for deploying Ciclovías (Zieff et al., 2013).

4.2.5. Chile: combined actions

In a paper describing a new regulation implemented to tackle obesity in Chile in 2012, authors highlighted the main challenges encountered over the last 10 years with the implementation of FOPL, advertising regulations, and school food restrictions (Rodríguez Osias et al., 2017). All three of these components have proven cost effective (Cecchini et al., 2010). The law mandates that foods that exceed certain levels of energy, sugars, sodium, or saturated fatty acids (defined by the Ministry of Health after review of available scientific evidence by a committee of academic experts) must carry a symbol that warns about its content. Foods labelled as such are forbidden to be sold in schools and their advertising is strongly restricted.

Scientific input was key, as academic institutions were asked to review evidence regarding nutrient profiling and recommend a definition of 'unhealthy' foods based on Chilean dietary patterns. A decision was made to base the definition of unhealthy foods based on the UK's traffic light based FOPL technical guidance. Regulated foods were defined based on specially developed nutrient profiling, which considered natural foods as gold standard. For liquid foods, amounts of energy, sugars, saturated fats, and sodium in 100 mL of cow's milk were used as cut-offs. For solid foods, values within the 90th-99th percentile range for energy and critical nutrients were selected as cut-off within a list of natural foods.

Before institution of this law, every member state of the World Trade Organisation was notified, and wide public consultation took place. One of the main arguments against the regulation was its potential negative effects on business, particularly for small and medium enterprises. Objections to the law included that it violated freedom of expression, was paternalistic, and was naive as it ignored the complexities involved with food advertising. Criticism from the food industry included interference with intellectual property rights (by restricting industry brands and logos), creating trade barriers, and eliminating the possibility of comparing products (since 'all food would be marked as unhealthy'). The industry focused particularly on the expected increase in production costs due to the changed composition of their products, as well as required

modifications in labelling and packaging. It was suggested that the law be introduced gradually, to give the food industry time to develop the technology needed to reduce the content of critical nutrients in their products. It took two International Health and Nutrition Summits (2008 and 2011) for the Ministry of Health to convince the food industry.

Besides pressure from the food industry, the regulation also faced important opposition from other public institutions, especially the Ministry of Economy, the Ministry of Agriculture, and the Ministry of Foreign Affairs concerned about the effects the law could have on the economy and international relations. The message that reducing obesity in Chile was a national endeavour and that this law was necessary to improve the country's health—particularly children's health—was key to sealing the alliances with other government ministries. The support of key political and civil society stakeholders was of great importance. To finally pass the law, some difficult compromises involving elements of the original bill had to be accommodated, including those pertaining to using a 'traffic light' food labelling system, banning of infant formula advertising, and the prohibition of selling unhealthy foods in universities.

A stop sign stating "High in X" was chosen as the warning label for packaged regulated foods. The legal process was completed in 2015, but implementation only began in July 2016, giving the food industry time to alter the formulation of their products to meet the cut-off points if they wished. This law was not introduced in isolation but was accompanied by the introduction and strengthening of public programmes to promote healthy lifestyles and increased taxation on SSB. A new taxation system for solid food, based on its sugar content, is being explored for future implementation.

Prior to implementation, the authorities from the Nutrition Department defined the standards and indicators to monitor and enforce the law, and this duty was carried out by a designated regional department of the Ministry of Health. Designated departments oversee monitoring and implementation (according to standard procedures) at the local level, as well as carrying out periodic health and food surveillance. No follow-up publications on measured outcomes could be found in our literature search, and outcomes indicating local impact will have to be determined (Pérez-Escamilla et al., 2017).

4.2.6. Brazil: inter-sectoral involvement

The Brazilian approach to obesity prevention and control involves two main approaches: firstly that of the Brazilian National Health System (SUS) run by the Ministry of Health, and secondly the approach from the National Food and Nutritional Security System (SISAN), responsible for orchestrating actions by three different ministries: the National Council on Food and Nutritional Security, the National Conferences, and the Inter-Ministerial Chamber for Food and Nutritional Security (Dias et al., 2017).

The SUS approach regards obesity mainly as a disease or risk factor, with emphasis on individual and social/environmental interventions aimed at changing eating habits and levels of physical activity. The SISAN approach defines obesity as a societal problem of food security, with emphasis on new modes of producing, marketing, and consuming foods to change eating practices in an integrated way for society. This approach involves various areas of the federal government and thus makes the policy process more complex by requiring greater linkage between sectors and expanding the potential points of conflict.

The SUS approach from 2006 to 2014 reinforced the individual and patient-care approach, and after 2014 evolved to develop a line of primary care for obesity, as well as health promotion measures. Since 2007, several rulings have been issued that define the organisation of care and set criteria for high complexity health care services for patients with overweight and obesity, including the guarantee of surgical treatment (SUS regards access to metabolic surgery as a right). This 'medicalisation' of obesity took place in the context of competing interests for public funds. The concept of obesity as a disease, treated only by the National Health

System and focused on the physical body and individualised care, has limited reach as it treats only those already affected. Certain health promotion proposals tended to be 'sector-based', since they focus mainly on eating habits and physical activity, and strategies that extend beyond the health sector's scope became necessary given the difficulties in an individual-focused approach. Adherence to individualised treatment tends to be low, to a major extent because individuals are still exposed to the same environmental pressures that compete unequally with personal motivation to modify eating habits and behaviours.

A turning point was the publication of the National Food and Nutritional Policy, which repositioned the food and nutrition issue on the agenda of the SUS and strengthened the debate on food and nutritional security, both inside and outside the health sector. Measures based on the social/environmental health approach, aimed at guaranteeing healthy environments and life settings, favoured proposals for inter-sector linkage such as guaranteed access to healthy eating in workplaces and schools. Progressive inter-sectoral proposals indicated new developments in addressing the problem, culminating in the Inter-Sector Strategy for the Prevention and Control of Obesity: Recommendations for States. The approach to obesity in the newly configured EIPCO establishes links with the processes of food production, supply, commercialisation, access, and consumption. By transcending the sphere of public health, obesity is now also acknowledged as a social problem, related to the prevailing food system, with repercussions on health and quality of life.

However, regulation of food advertising has still not made progress in Brazil since this runs counter to the interests of the processed and ultra-processed food products industry, a powerful lobby in policy decisions. The least contested measures are voluntary agreements to reduce levels of salt, saturated fats, and sugar in processed foods. A proposed 'partnership' with the food industry suggests that industry voluntarily refrain from advertising unhealthy foods, which is highly unlikely.

4.2.7. Regional lessons on preventing childhood obesity

To understand the design and implementation of evidence-based healthy lifestyle policies to prevent childhood obesity in Latin America, Pérez-Escamilla et al. investigated 4 country examples according to key elements of successful deployment (Paina and Peters, 2012; Pérez-Escamilla et al., 2017). Scientific evidence and continued monitoring played an important role, not only in achieving tipping points for policy launch, but also in sustaining effective implementation.

The following key elements for successful and sustainable policy interventions were identified:

- Anticipating, and early addressing of **feedback loops**. Examples of positive feedback loops include research and evidence, informed advocates, public outreach, and a broad range of supporters. Negative feedback loops include outside interest groups, misunderstood definitions, and negative perceptions.
- Utilising **scale free networks** by change in one aspect leading to change in many areas. Strong evidence used in marketing campaigns (along with a plan for overcoming expected challenges) had a large impact on the support the policies ultimately received.
- Opting for **phased transitions**. Most countries went through a phased transition when definable events and processes led to a tipping point that allowed for policy approval or expansion of implementation. This process might be rapid or prolonged, but always seems to be phased. Multisectoral coalitions, strong advocacy, and persuasive evidence of the feasibility of policy implementation all play important roles in accelerating the process. It is imperative to gather evidence and identify and involve coalition groups early in policy development.

- Understanding **path dependence** by explaining what characteristics influence divergent outcomes. Anticipating the factors that will support or divert policy adoption presents advocates with the opportunity to gather evidence and present solutions in advance.
- Optimising **emergent behaviour** when smaller entities spontaneously come together as a collective. Successful examples of policy implementation were marked by multiple consultations with members of academia, government, advocacy groups and civil society who eventually formed a coalition, with each stakeholder bringing a different skill set to help overcome major negative feedback loops mostly driven by the food industry.

4.3 European examples

4.3.1. United Kingdom: viability

To understand why 14 UK government strategies (either wholly or partially dedicated to tackling obesity), stretching from 1992 to 2020 and containing 689 wide-ranging policies, had not made an impact on rising obesity prevalence, a mixed-methods review was completed in 2021 (Theis and White, 2021). The authors attempted to identify weaknesses in policy design and failures of implementation and evaluation leading to a lack of effectiveness.

The main finding was that UK governments have tended to prioritise the provision of information and capacity building in their obesity strategies rather than directly shaping the choices available to individuals through population-level fiscal and regulatory measures (except for the recent Soft Drinks Industry Levy). Most policies were not interventionist in nature and made high demands on individual agency, relying on individuals to make behaviour changes rather than shaping external influences. Until 2004, the governments' regulatory policies had no indication of regulatory escalation, meaning that the policies were largely proposed without detailing what might happen in the case of insufficient action or change. Since 2004, more deterrence measures have been proposed, such as legislation on nutrition labelling for pre-packaged foods, a restriction of television advertising of unhealthy products, and a levy on SSBs. When the deterrence policies were escalated, they did not suggest incapacitation measures but merely suggested extension of deterrence measures, like expanding the Soft Drinks Industry Levy to more products.

A second important finding was that policies were largely proposed in a way that would be unlikely to lead to implementation. Policy implementation viability criteria that were evaluated for each strategy included:

- Setting a target population
- Stating a theory of change
- Evidence to support the policy proposals
- Details about cost and allocated budget
- Suggesting a responsible agent
- Including an M&E plan
- Setting a time frame

30% of the policies did not fulfil a single one of the above seven implementation viability criteria, compared to just 8% of policies that fulfilled all seven. Only 24% of the policies had any details of an M&E plan, 19% cited any evidence to support policy proposals, and 9% offered details about cost or included an allocated budget. Many of the proposed policies were similar to (or exactly the same) in multiple strategies over multiple years, often with no reference to their presence in a previous strategy.

The authors concluded that governments should prioritise policies that make minimal demands on individuals and have the potential for population-wide reach to maximise their potential for equitable impacts. Policies should furthermore be proposed in ways that readily lead to implementation and evaluation.

4.3.2. Greece: E-health programme

To address the increasing prevalence of overweight and obesity in children and adolescents in Greece, the 'National e-Health Programme for the Prevention and Management of Overweight and Obesity in Childhood and Adolescence', was developed to provide guidance to all primary health care physicians about the personalised management of children and adolescents with overweight or obesity (Tragomalou et al., 2020). The programme includes an electronic medical records file (EMRF) for the electronic documentation of medical history as well as clinical findings of all outpatients. Therapeutic algorithm files (TAF) provide detailed information and guidance to paediatricians and general practitioners about the management of each child. The electronic database automatically calculates BMI and informs the physician about the patient's BMI status, while the BMI growth chart appears on the screen. The database selects the most appropriate TAF according to the patient's age, sex, BMI and information on diet and exercise in the system. The TAF provides a comprehensive and personalised management plan for the prevention and/or management of overweight and obesity for the patient, including initial advice to the patient and the family, a follow-up date and management if there is adequate response to the therapeutic interventions. If there is no response despite adherence, laboratory investigations are recommended, or referral of the patient to a paediatric dietician or psychologist, a paediatric endocrinologist, or a specialist centre with expertise in the management of overweight and obesity.

After the first year of follow-up, the prevalence of obesity decreased by 32.1%, the prevalence of overweight decreased by 26.7%, and cardiometabolic risk factors improved significantly, indicating that a national e-health programme is effective at reducing the prevalence of overweight and obesity in children and adolescents.

4.3.3. The health action campaign review: local context and multiple approaches

In a comprehensive review of international childhood obesity prevention policies in 15 countries, the Health Action Campaign review highlights what has worked, and lessons learned in each country (Musuwo, 2019).

In general, reasons for poor outcomes of childhood obesity prevention policies may be that not enough action was taken (too few approaches) or that not enough time has passed for improved results to be achieved. A further reason could be that top-down policies from governments need to combine with bottom-up, community-based approaches, to facilitate 'whole systems' results. The most successful interventions are usually adapted to local contexts, taking account of existing social, environmental, and cultural factors. Engaging with and empowering local stakeholders and children/families within communities can help ensure sustainable, inclusive, and equitable lifestyle and behaviour change. Successful examples include local initiatives in parts of France, the Netherlands, the USA, Finland, and South Australia. Key features of these approaches include:

- Addressing the wider influences on children's diets and physical activity by incorporating initiatives throughout school, home, and community environments.
- Support for parents, families and early years professionals as children's food preferences and lifestyle choices are established in the early years.
- Engagement of influential stakeholders from central to local level, such as businesses, local government, schools, early years centres, communities, families, and parents.

- Empowering and enabling the capacity-building of local communities to help improve environments for children.

A challenge encountered by governments is how to empower or scale up local initiatives, a lesson that can be taken from the **French** example. The French government initiated their National Health and Nutrition Program in 2001. This included published guidelines on school meal nutrition standards, installation of fresh-water fountains in all schools, and banning of vending machines selling unhealthy food. In addition, a 1.5% tax was imposed on the advertising budgets of food companies not encouraging healthy eating, and TV and radio adverts for SSBs, added salt, artificial sweeteners and manufactured food products had to contain a health message. These policies, however, did not affect all population groups equally, and heightened health inequalities.

In 2004, ten French communities targeted children aged 0-12 with a whole-community approach (EPODE). The EPODE example from France has been a success and has now been adopted in several other countries. The design of EPODE was based on results from a 1992 study in two French towns, which found school-based interventions were ineffective on their own in significantly reducing childhood overweight and obesity, and that improvements were best achieved with community-based interventions (Romon et al., 2009). A range of stakeholders are involved in EPODE at two levels: bottom-up (local community stakeholders who determine the social, cultural, and physical adaption of actions in the local context) and top-down stakeholders (providing resources and support at a central level). The EPODE programme has been successful at reducing obesity rates, with a reduction of up to 25% in some communities (Borys et al., 2016). The programme has not only had the capacity to reduce childhood obesity but also to reduce health inequalities, as initiatives are adapted to socioeconomic groups, increasing community acceptance. A criticism of the programme is the partial funding from industry, but some argue this has contributed to the programme's success. More than 5 years after initial implementation, EPODE was still active in over 90% of the original pilot communities and active in over 500 communities globally.

Of all countries reviewed, only **Scotland** has seen a national reduction in children at risk of obesity (at least among boys, between 2012 and 2017), and this after years of sustained government action. Success is ascribed to the many policies in place in Scotland with potential to prevent an increase in obesity. Adopted policies included local town/community programmes based on the French EPODE blueprint, with a strong emphasis on social marketing and building partnerships and capacity. A 'Route Map' was launched by the Scottish government in 2010 where child healthy weight programmes were delivered through school-based interventions. Evaluation of outcomes revealed increased knowledge of healthy lifestyles, improved dietary choices, and increased physical activity levels, with the greatest improvement in BMI among children attending group-based compared to school-based interventions (Mackie and McCann, 2014).

The Route Map has now been overtaken by the latest national obesity strategy. The Scottish government has developed a M&E framework to report the plan's key measures of performance, with plans to publish regular progress reports. With over 60 actions, the plan takes a primary prevention approach, aiming to halve childhood obesity by 2030 and significantly reduce health inequalities. The plan focuses on tackling weight-related issues from an early stage, food environments supportive of healthier food choices, access to effective weight management services, leaders across all sectors promoting healthy weight and diet, and reduction of diet-related health inequalities.

Compulsory national policies on school-based health education can also support action on obesity prevention. In **Finland**, health education, nutrition and cooking lessons are mandatory in all schools. The city of Seinäjoki has been the only to show falling childhood obesity numbers. Key aspects of their programme included improvement in school playgrounds, implementation of more physical activity in schools, elimination of sugary snacks, provision of healthier lunches, and introducing annual health checks in schools. These changes were

accompanied by taxes on sweets and SSBs. The sweets tax raised the price of confectionary by about 10%, however, the consumption of taxed sweets remained the same following the price increase. The SSB tax has been successful in decreasing consumption by 4.2% in comparison to products not affected by the tax.

5. CONCLUSION

Common features of obesity interventions

A range of interventions are utilised in different countries to prevent or reduce adult or childhood obesity. The most common measures include the implementation of population-level interventions, fiscal and commercial policies, and system changes to make it easier and more affordable/attractive for individuals to make healthier lifestyle choices and to decrease access to or demand for unhealthy food options. Examples include restrictions on unhealthy food advertising and adding tax on sugar-sweetened beverages (SSBs). In South Africa, the implementation of tax on SSBs was followed by a reduction in mean sugar intake and taxed beverage sales.

Food product reformulation and the addition of simple, consumer-friendly front-of-package labels on food are often accompanied by reductions of the fat, sugar, and salt content of processed foods. Nutrition related strategies are often combined with improvements in school premises and public spaces for physical activity and with public campaigns for obesity awareness and healthier lifestyles. Several country examples emphasised the importance of adequate monitoring at the local level and effective oversight from government departments of fiscal and other measures adopted in relation to food products.

Challenges and barriers to obesity strategy implementation

National obesity strategy reports from several countries identified barriers to the implementation of specific interventions relating mostly to regulating food products and applying fiscal measures, including pressure and lobbying from the food industry. Likewise, opposition from certain public institutions was reported due to their concerns about the economic and social effects of policies to restrict or fiscally penalise unhealthy foods. However, the most frequently reported challenges and barriers involved the limited ability/competence by governments or their agencies to implement and enforce public policy. Several reports also referred to the weak or limited support received from civil society to specific commercial or fiscal measures that was often attributed to their lack of awareness about the risks of obesity or their limited understanding of the reasons justifying the adopted measures.

Apart from a few noteworthy research reports, we found limited published evidence about the effectiveness of measures adopted in South Africa to reduce obesity. Specific South African challenges such as the nutrition transition, fast food consumption, cultural acceptance of obesity and unsafe neighbourhoods were reported as challenges to obesity management. It was also reported that interventions that focus on individual behaviour and education rather than utilising a broader population-based approach were less likely to be successful. Limited health literacy, defined as the knowledge, skills, and confidence to adopt personal lifestyle changes aimed at obesity reduction was also reported. However, it was the lack of data linked to the implementation of the 2015-2020 National Obesity Strategy that is worth noting as part of this review. Stakeholder consultations to be undertaken shortly as part of the ongoing National Obesity Strategy review may shed light on the reasons for such paucity of data. Our reading of the strategy document and the absence of strategy review information would point to a lack of a systematic, verifiable, costed monitoring and evaluation (M&E) plan combined with the absence of obesity surveillance data, poorly defined M&E responsibilities of the designated departments implementing the strategy, and lack of funding/budget document to support M&E activities.

What makes a successful national obesity strategy?

The most comprehensive review of national obesity strategies that reviewers found is the Theis and White (2021) review of 14 UK government strategies either wholly or partially dedicated to tackling obesity, stretching from 1992 to 2020. The authors attempted to identify weaknesses in policy design and failures of implementation/evaluation leading to a lack of effectiveness.

Their main finding was that most of the least successful policies relied on individuals to make behaviour changes rather than shaping external influences. A second important finding was that policies were largely proposed in a way that would be unlikely to lead to implementation, as evidenced after applying policy implementation viability criteria where the least successful strategies obtained the lowest scores.

The authors then adopt a set of criteria for success which we propose to use in shaping the next National Obesity Strategy for South Africa:

- Setting a target population
- Stating a theory of change
- Evidence to support the policy proposals
- Details about cost/allocated budget
- Suggesting a responsible structure / agent
- Including a monitoring or evaluation plan
- Setting a time frame

Lessons for the next National Obesity Strategy for South Africa

This document has reported a number of specific interventions, success factors and barriers to guide the formulation, implementation, and monitoring of the next National Obesity Strategy for South Africa. Combinations of population-based, commercial, and fiscal and regulatory measures would appear most cost-effective. Where fiscal measures are considered, their effects on industry and on consumer behaviour should be not only anticipated and mitigated at the planning stage but closely monitored over time at the local level to confirm their efficacy. Data availability is a key consideration at design stage, not only for obesity surveillance and strategy monitoring but also to ensure future evidence-based decisions. Mass media and electronic platforms may help to increase awareness and educate individuals and communities about keeping a healthy body weight through the intake of healthier food, the adoption of healthier lifestyles, and the interaction with health care providers.

Strategy development should involve all stakeholders, allowing for coordinated, continuous inter-sectoral engagement and speaking with a unified voice. Practical actions need to be identified and prioritised, with leadership responsibilities and financial/human resources for their implementation and regular monitoring clearly allocated. If there is one lesson underpinning the more successful interventions and national obesity strategies, it is that implementation should be based on clear time frames, well-defined goals, and regular reviews of progress (in the form of agreed actions, committed resources and results). No strategy can claim success or failure unless it is closely monitored, with results recorded and swiftly communicated to all stakeholders (from national to local levels) and the public. Only this approach was found to generate both public accountability and the desired momentum in strategy implementation.

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