



# Cost of inaction on sugar-sweetened beverage consumption: implications for obesity in South Africa

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## Abstract

**Objective:** To estimate the effect of increased sugar-sweetened beverage (SSB) consumption on future adult obesity prevalence in South Africa in the absence of preventive measures.

**Design:** A model was constructed to simulate the effect of a 2.4% annual increase in SSB consumption on obesity prevalence. The model computed the change in energy intake assuming a compounding increase in SSB consumption. The population distribution of BMI by age and sex was modelled by fitting measured data from the 2012 South African National Income Dynamics Survey to the log-normal distribution and shifting the mean values.

**Setting:** Over the past decade the prevalence of obesity and related non-communicable diseases has increased in South Africa, as have the sales and availability of SSB. Soft drink sales in South Africa are projected to grow between 2012 and 2017 at an annual compounded growth rate of 2.4% in the absence of preventive measures to curb consumption.

**Results:** A 2.4% annual growth in SSB sales alongside population growth and ageing will result in an additional 1 287 000 obese adults in South Africa by 2017, 22% of which will be due to increased SSB consumption.

**Conclusions:** In order to meet the South African target of reducing the number of people who are obese and/or overweight by 10% by 2020, the country cannot afford to delay implementing effective population-wide interventions. In the face of plans to increase growth of SSB, the country will soon face even greater challenges in overcoming obesity and related non-communicable diseases.

## Keywords

Cost  
Sugar-sweetened beverages  
Obesity  
Modelling  
South Africa

South Africa has the highest prevalence of obesity in sub-Saharan Africa. In the past decade (2003–2012) this has increased among men by 2% from 9 to 11% and among women by 12% from 27 to 39%<sup>(1,2)</sup>. Simultaneously, the sales and availability of sugar-sweetened beverages (SSB) have increased alongside all categories of packaged and fast foods<sup>(3)</sup>. Excess sugar consumption is associated with weight gain and an increased risk for non-communicable diseases (NCD) including CVD, type 2 diabetes and cancer, which account for 27% of all deaths in the country<sup>(4–7)</sup>. NCD place significant financial strain on families and on the country. Moderate obesity (BMI = 30–35 kg/m<sup>2</sup>) is associated with an 11% increase in health-care costs and severe obesity (BMI > 35 kg/m<sup>2</sup>) with a 23% increase<sup>(8)</sup>. Obesity and its associated diseases

and ailments also negatively impact the workplace by increasing turnover, absenteeism and worker compensation claims, and decreasing productivity<sup>(9)</sup>.

While all foods high in sugar have a harmful effect on the body, liquid sugar in the form of SSB is rich in energy, but poor in other nutritional content, and has a negligible impact on satiety<sup>(10)</sup>. Although consumption of SSB is not the only cause of obesity, it is strongly linked to increased energy intake<sup>(11)</sup> and weight gain in both adults and children due to the high sugar content in these drinks. A 330 ml can of carbonated soft drink in South Africa contains an average of 40 g of sugar and the same size of sweetened fruit juice approximately 45 g of sugar. Drinking a single SSB daily increases the likelihood of being overweight by 27% for adults and 55% for children<sup>(12,13)</sup>.

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Consuming one or two SSB daily increases the risk of developing type 2 diabetes by 25%<sup>(14)</sup>.

As part of the nutrition transition in South Africa it is increasingly difficult to make healthy choices, as energy-dense foods have become more affordable and widely available. This has seen the increase in availability of and access to SSB in lower income groups and the commensurate growth of this segment of consumers. Those in living standard measure (LSM) 1–4 (the four lowest socio-economic status (SES) groups) comprise almost 7 million adults who earn less than R3500 (\$US 333) per month<sup>(15)</sup>. Access to unhealthy but affordable foods and beverages in this demographic group has increased over the last few years due to expansion of supermarkets into informal urban settlements and rural areas. This has resulted in a simultaneous double burden of malnutrition characterised by both overnutrition (overweight, obesity) and undernutrition (underweight, wasting, stunting). Furthermore, while approximately 40% of South Africans now consume the recommended daily amount of energy, the food sources for this energy are significantly low in nutrients, resulting in individuals who are often overweight from consumption of high amounts of energy but also undernourished from low levels of nutrients<sup>(2)</sup>.

Significant resources are invested into marketing energy-dense products partially because they are cheap to produce and highly palatable<sup>(16)</sup>. New technologies have enabled companies to gather data on consumer preferences, which in turn are used to market products aggressively based on demographics. Products are often placed strategically in formal and informal convenience stores ('spaza' shops) to ensure the most profitable ones are at eye level and easily accessible<sup>(16)</sup>.

A single beverage company accounts for approximately 60% of the off-trade (excludes hotels, restaurants and registered bars) soft drinks market in South Africa and was rated as the overall favourite brand in the country in 2013<sup>(17)</sup>. In 2012 South Africans consumed an average of 285 Coca-Cola products per person, a 56% increase from 2002, placing the country tenth in the world for consumption of these products<sup>(18,19)</sup>. This has been accomplished through the use of local advertising campaigns linking the brand to South Africans' aspirations and passions as well as the increase in product availability<sup>(20)</sup>. It has been shown that preference for food products is often shaped not only by taste but largely by brand image<sup>(16)</sup>.

The UN high-level NCD summit held in 2011 recommended that the 'best buys' for addressing obesity-related NCD included large-scale prevention interventions outside the health-care infrastructure<sup>(21)</sup>. The South African National Department of Health's National Strategic Plan for the Prevention and Control of Non-Communicable Disease 2013–2017 has listed fiscal policy as one cost-effective 'best buy' to prevent obesity and has set a target of reducing the number of people who are obese and/or overweight by 10% by 2020<sup>(6)</sup>. In line with these plans, the South African

Minister of Health recently called for regulations on foods high in sugar<sup>(22)</sup>.

Demands to implement fiscal measures to reduce SSB consumption are growing in several other countries, including India, Ireland, the UK and Australia<sup>(23,24)</sup>. In October 2013 Mexico passed a tax on SSB and junk food, followed by Chile in January 2015, and Hungary and France also have newly introduced SSB taxes<sup>(25–27)</sup>. Berkeley, California has recently become the first city in the USA to pass an SSB tax<sup>(28)</sup>. Since the implementation of the SSB tax in Mexico in January 2014, SSB sales in the first quarter of 2014 compared with those in the first quarter of 2013 dropped by 10% while bottled water sales increased by 13%<sup>(29)</sup>.

A South African modelling study estimated that a 20% SSB tax would reduce obesity by 3.8% in men and 2.4% in women. This would result in a reduction of the number of obese adults by over 220 000 (2.8%)<sup>(30)</sup>. This type of fiscal intervention, alongside other preventive measures, could alleviate the growing obesity and related NCD burden on the health system. However, without such interventions SSB consumption will continue to grow and the future impact of obesity will be difficult to curtail. According to Euromonitor International, a global market intelligence firm providing market data and analysis, sales of soft drinks in South Africa grew by 14.9% between 2007 and 2012, and are projected to grow by 12.8% over the five years between 2012 and 2017 at an annual compounded growth rate of 2.4%<sup>(31)</sup>. The aim of the present analysis was to determine the impact of increased SSB consumption on future obesity prevalence in South Africa in the absence of any preventive measures.

## Methods

### Overview

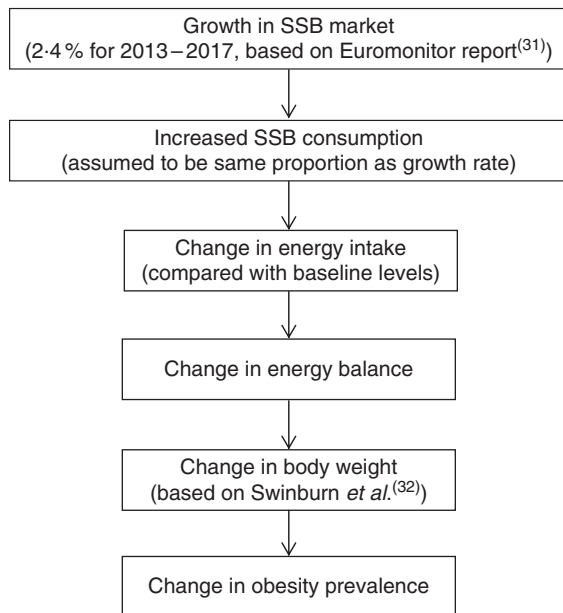
We constructed a mathematical simulation model to estimate the effect of an annual increase in SSB consumption on the prevalence of obesity based on the 2.4% industry growth rate projected by Euromonitor International for 2013–2017.

The model computes the counterfactual change in energy intake assuming a compounding increase in SSB consumption. Published equations linking energy intake to body weight were used to estimate changes in BMI and obesity<sup>(32)</sup>. The model was implemented in Microsoft® Excel (2010). The baseline year was 2012. Figure 1 presents the proposed conceptual framework for the effect of the growth in the SSB market.

### Data

#### Baseline consumption

An SSB was defined as a non-alcoholic drink with added sugar and comprised carbonated and non-carbonated



**Fig. 1** Conceptual framework of the effect of the projected growth in the SSB market in South Africa (SSB, sugar-sweetened beverages)

sweetened drinks, sweetened fruit juices and squash concentrates based on data available from the South African National Health and Nutrition Examination Survey (SANHANES-1). A broader definition of SSB includes, in addition to the above, sports and energy drinks, ready-to-drink tea and coffee, flavoured milks and non-sweetened fruit juices. These were not included in our definition because data were not available from SANHANES-1. Data from SANHANES-1 were used to estimate SSB consumption in adults aged 15 years and above<sup>(2)</sup>. The SANHANES-1 is a baseline cross-sectional survey of the SANHANES series. Multi-stage disproportionate, stratified cluster sampling was used to select the study population and all individuals residing at the selected households were eligible to participate. Questionnaire-based data were obtained through interviews in combination with some health measurements.

The participants were asked how frequently they consumed SSB in the last week with response options of 'none', 'every day', 'one to three times last week' and 'four to six times last week'. We assumed one serving to be 330 ml, the size of a can of carbonated soft drink, and that one serving was consumed each time. The average consumption for the category was considered the mid-point of each frequency of consumption category.

#### Rate of change of consumption

Based on the 2013 Euromonitor report, the soft drink market, including all categories of SSB, in South Africa is projected to increase by 2.4% per year up to 2017<sup>(31)</sup>. We assumed that SSB consumption would increase by 2.4% for males and females and across all age groups.

#### Prevalence of overweight and obesity in South Africa

Anonymised public release data sets of wave 3 version 1 of the National Income Dynamics Study (NIDS) provided data for BMI estimates<sup>(33)</sup>. NIDS is South Africa's first national panel study and was implemented by the Southern Africa Labour and Development Research Unit based at the University of Cape Town's School of Economics. A total of 28 255 individuals in 7305 households were recruited in the base wave in 2008<sup>(34)</sup>. Waves 2 and 3 were conducted in 2010/2011 and 2012, respectively<sup>(35,36)</sup>.

Our analysis included adult men and women aged 15 years and above with a valid height and weight measurement. We cleaned and coded the data in the statistical software package STATA version 12.1 (2011). Design effect was accounted for by using the STATA *svyset* command. BMI was computed as weight in kilograms divided by the square of height in metres. BMI values that were excluded from the analysis included those falling below and above the 1st and 99th percentiles, respectively. Data were fitted to the log-normal distribution in Microsoft Excel (2010) using the least-squares method. Polynomial functions were used to fit the means and standard deviations across age groups, separately for men and women. The fitting procedure and comparison of the log-normal distribution to the gamma distribution have been previously described<sup>(30)</sup>.

#### Population estimates

The 2012 to 2017 population estimates by sex and 5-year age groups were obtained from Statistics South Africa<sup>(37)</sup>.

#### Modelling

Following the steps presented in Fig. 1, we implemented the modelling as follows.

#### Change in sugar-sweetened beverage consumption

Using the Euromonitor 2.4% projected annual increase in SSB sales, the model was run twice for each year: (i) assuming 2.4% consumption growth; and (ii) assuming 0% consumption growth. Both scenarios accounted for population growth as forecast by Statistics South Africa.

#### Change in energy intake

The percentage change in energy intake from SSB was assumed to be the same as the percentage change in volume of SSB consumed. We used an average energy density estimate of 1800 kJ/litre (average of Coca-Cola SSB) to convert the change in volume consumed to change in energy intake. We used Coca-Cola because it accounts for approximately 60% of the off-trade soft drinks market in South Africa according to the SABMiller Quarterly Divisional Seminar Series, South Africa<sup>(18)</sup>. In addition, personal communicator, Dr Celeste Naude, at the Centre for Evidence-based Health Care, Stellenbosch University, calculated the mean energy density for an SSB

to be 188 (sd 40) kJ/100 ml using energy density values of a sample of ninety carbonated drinks, sports drinks, concentrates, iced teas and sweetened fruit juices obtained from the South African Medical Research Council Food Data System<sup>(38)</sup> and nutrition information provided on beverage labels. In our model energy intake from other types of drinks other than the SSB defined above was not accounted for.

#### Change in BMI

We estimated the change in body mass using equations published by Swinburn *et al.*, which state that an increase in daily energy intake of 94 (95 % CI 88.2, 99.8) kJ/d is associated with a change in body weight of 1 kg in equilibrium for adults<sup>(32)</sup>. The change in average body mass was converted to change in average BMI by applying average height estimates from NIDS wave 3<sup>(33)</sup> for each age group.

#### Change in obesity prevalence

Rose and Day's theorem that the mean predicts the number of deviant individuals was used to estimate the prevalence of overweight and obesity from the mean BMI for each age group and sex<sup>(39)</sup>. The difference in obesity prevalence between the model which assumed 2.4% consumption growth and that assuming 0% consumption growth was taken to be the increase in obesity due only to the projected increased SSB consumption.

#### Confidence intervals

Confidence intervals were obtained through Monte Carlo simulation using the Ersatz program (JJ Barendregt, Brisbane, 2007), varying the conversion factor between energy consumption change and weight change<sup>(32)</sup> and the SSB consumption estimates by age and sex.

#### Sensitivity analysis

In the model energy intake from other types of drinks other than SSB included in our definition was not taken into account. However, an increase in consumption of SSB may be offset by people drinking less of other beverages. This possibility is considered in the sensitivity analysis by assuming that change in other kinds of drinks consumed would be similar to those due to a price reduction of SSB. Deterministic one-way sensitivity analysis was performed to account for the effect of substitution of other beverages. Using previously published price elasticities<sup>(40)</sup>, we calculated the rate of change in BMI resulting from people consuming less milk, diet drinks and unsweetened fruit juice. The number of obese people and change in BMI were computed.

## Results

### Change in sugar-sweetened beverage consumption and energy intake

At baseline, South African adults consumed a daily average of 184 (95 % CI 166, 205) ml SSB, with the 15–24 years age group drinking the highest amount and those aged 65 years and above drinking the least. The results show that by 2017, South African adults will be consuming approximately 200 ml SSB/person per d. Because some age groups already have higher baseline consumption they are projected to consume even more than 200 ml SSB/person per d by 2017 due to the projected 2.4% growth. The trends in change in energy intake over the years closely mirror those of the change in volume consumed.

Table 1 presents the change in SSB consumption and energy intake over the years accounting for the compounded industry growth. By 2017, the group aged 15–24 years will potentially be drinking an additional 25 ml SSB/person per d compared with 2012.

**Table 1** Change in SSB consumption and energy intake among South African adults aged 15 years and above, by age group, accounting for the compounded industry growth 2013–2017, compared with 2012

Age group	Change in SSB consumption (litres/d)					Change in energy intake (kJ/d)				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
15–19 years	0.0050	0.0101	0.0154	0.0208	0.0263	9.01	17.57	27.78	38.00	47.24
20–24 years	0.0050	0.0101	0.0154	0.0208	0.0263	9.01	17.57	27.78	38.00	47.24
25–29 years	0.0048	0.0097	0.0147	0.0198	0.0250	8.59	17.70	26.65	35.20	44.86
30–34 years	0.0048	0.0097	0.0147	0.0198	0.0250	8.59	16.47	26.00	34.72	44.41
35–39 years	0.0043	0.0088	0.0133	0.0180	0.0227	7.80	16.03	23.04	32.00	39.73
40–44 years	0.0043	0.0088	0.0133	0.0180	0.0227	7.80	14.46	24.12	32.52	41.34
45–49 years	0.0041	0.0083	0.0126	0.0170	0.0215	7.37	14.57	22.65	31.00	38.51
50–54 years	0.0041	0.0083	0.0126	0.0170	0.0215	7.37	15.02	23.46	30.04	38.08
55–59 years	0.0036	0.0072	0.0110	0.0148	0.0187	6.42	12.47	21.60	25.76	33.09
60–64 years	0.0036	0.0072	0.0110	0.0148	0.0187	6.42	12.88	18.93	26.20	34.19
65–69 years	0.0029	0.0058	0.0089	0.0119	0.0151	5.19	11.49	15.42	20.00	27.93
70–74 years	0.0029	0.0058	0.0089	0.0119	0.0151	5.19	10.45	15.81	20.72	26.88
75–79 years	0.0029	0.0058	0.0089	0.0119	0.0151	5.19	10.39	15.92	21.80	26.98
≥80 years	0.0029	0.0058	0.0089	0.0119	0.0151	5.19	10.68	16.53	20.75	27.18

SSB, sugar-sweetened beverages.



### Change in BMI

Figure 2 shows the change in BMI units compared with baseline due to the projected SSB industry growth. The results show that by 2017 there is a 0.15 BMI unit increase for males and a 0.17 BMI unit increase for females due to increased SSB consumption.

### Change in obesity

In Table 2, the proportion of obese men and women with the projected SSB industry growth and accounting for population growth is compared with the proportion of obese men and women when only population growth is considered. The results demonstrate that the proportion of obese men and women increases even without the effect of SSB consumption. There is, however, a greater increase in the proportion of obese adults due to the projected SSB industry growth. The proportion of obese females is higher than males in both scenarios.

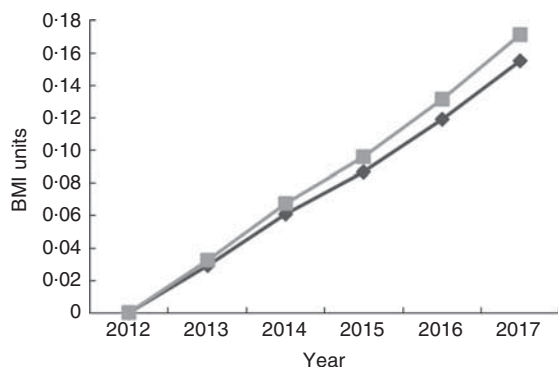
Figure 3 presents the additional number of obese people resulting from the 2.4% industry growth alone and not accounting for the effects of population growth on obesity in each year. There are consistently more obese women added than men in all the years. We predict that by 2017 there will be 280 000 additional obese adults due to increased SSB consumption. We also predict the 2.4% SSB

industry growth will result in approximately 21 000 additional obese men and about 35 000 additional obese women year on year. Figure 3 shows that although the additional number of obese adults in the first two modelled years is relatively modest, at approximately 48 000 in 2013 and 100 000 in 2014, the numbers increase exponentially by 2017 due to the compounding effect.

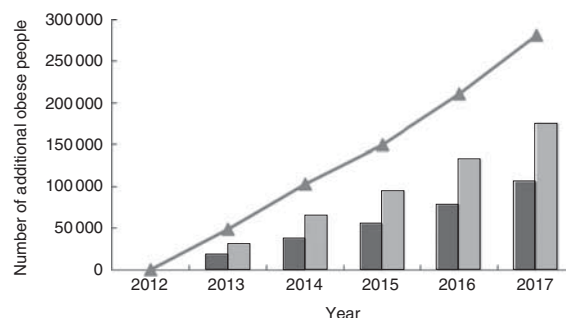
The NIDS data show that in 2012, the baseline year, there were 2.03 million obese men and 5.87 million obese women in South Africa. When both the 2.4% industry growth and population growth are accounted for, there may be an additional 1.29 million obese adults by 2017 (Table 3). Table 3 also shows that by 2017 there will be 5.2% additional obese men and 3.0% additional obese women due to the SSB industry growth alone.

### Sensitivity analysis

The model was run assuming substitution with other beverages based on previously described price elasticities (Table 4)<sup>(40)</sup>. The results of the sensitivity analysis show that if the assumption is included that people who drink more SSB will drink slightly lower quantities of other beverages, the increase in the number of obese adults from 2012 to 2017 is only marginally lower than when substitution is not accounted for.



**Fig. 2** Cumulative change in BMI in South African adults aged 15 years and above (—◆—, males; —■—, females) due only to the growth in the SSB industry, 2012–2017 (SSB, sugar-sweetened beverages)



**Fig. 3** Increase in number of obese South African adults aged 15 years and above (■, males; □, females; ▲, all) due only to the growth in the SSB industry, 2012–2017 (SSB, sugar-sweetened beverages)

**Table 2** Comparison of the proportion of obese South African adults aged 15 years and above, by sex, with and without SSB industry growth and accounting for population growth

Year	0% industry growth				2.4% industry growth			
	Males		Females		Males		Females	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
2012	13.47	13.45, 13.48	35.47	35.44, 35.49	13.47	13.45, 13.48	35.47	35.44, 35.49
2013	13.51	13.51, 13.51	35.51	35.51, 35.51	13.62	13.61, 13.62	35.69	35.67, 35.70
2014	13.56	13.29, 13.82	35.54	35.13, 35.94	13.80	13.54, 14.04	35.92	35.51, 36.32
2015	13.63	13.36, 13.91	35.62	35.18, 36.05	13.97	13.72, 14.22	36.15	35.75, 36.54
2016	13.70	13.44, 13.97	35.69	35.30, 36.12	14.17	13.92, 14.45	36.42	36.04, 36.82
2017	13.77	13.49, 14.02	35.77	35.33, 36.17	14.39	14.13, 14.62	36.72	36.33, 37.13

SSB, sugar-sweetened beverages.

**Table 3** Projected total numbers of obese South African adults aged 15 years and above, and proportion of additional obese adults each year, by sex and overall

Year	Males			Females			All		
	Number obese (millions)*	95 % CI	Proportion additional obese (%)†	Number obese (millions)*	95 % CI	Proportion additional obese (%)†	Number obese (millions)*	95 % CI	Proportion additional obese (%)†
2012	2.03		0	5.87		0	7.90		0
2013	2.11	2.11, 2.11	0.9	6.03	6.02, 6.03	0.5	8.13	8.13, 8.14	0.6
2014	2.19	2.15, 2.23	1.8	6.19	6.12, 6.26	1.1	8.38	8.27, 8.49	1.3
2015	2.27	2.23, 2.31	2.7	6.36	6.29, 6.43	1.6	8.63	8.52, 8.74	1.9
2016	2.36	2.32, 2.41	3.9	6.55	6.48, 6.62	2.2	8.90	8.80, 9.02	2.7
2017	2.45	2.41, 2.50	5.2	6.74	6.67, 6.82	3.0	9.19	9.07, 9.31	3.6

SSB, sugar-sweetened beverages.

\*Due to population growth and SSB industry growth.

†Due to SSB industry growth relative to baseline (2012).

**Table 4** Sensitivity analysis on decreased consumption of milk, diet drinks and fruit juice based on price elasticities

Year	Number of additional obese adults (2.4 % growth only; thousands)	Number of obese males (millions)	Number of obese females (millions)
2012	0	2.09	6.00
2013	31	2.10	6.02
2014	64	2.17	6.17
2015	100	2.25	6.33
2016	128	2.33	6.49
2017	276	2.34	6.57

## Discussion

We estimate that by 2017 there will be a 16 % increase in the number of obese adults in South Africa due to both population growth and the SSB industry growth, putting the total at 9.2 million. Over a period of 5 years there will be an additional 1.29 million obese adults in South Africa, 280 000 of which will be due to increased SSB consumption. In other words, there will be 35 000 additional obese women and 21 000 additional obese men year on year due to increased SSB consumption alone. These findings demonstrate that more than a quarter of the projected increase in obesity by 2017 will be due to SSB consumption. These results are comparable to other studies which show that 20 % of the increase in BMI over the last three decades in the USA is attributable to SSB consumption<sup>(11)</sup>. Another study in India showed that overweight prevalence would increase by 11 % over 9 years when taking into account the curvilinear rise of marketing model projections for SSB consumption<sup>(41)</sup>.

By 2017 South African adults will potentially be consuming an average of 200 ml of SSB per person daily, the equivalent of 6 teaspoons of sugar. With this amount of sugar consumption from SSB alone there is little margin for the consumption of other products with added or hidden sugars and to simultaneously remain below the WHO recommended sugar limit of 10 % of daily energy<sup>(42)</sup>. These results show that if effective interventions are not

implemented SSB consumption will increase and South Africa's obesity burden will continue to grow.

The total increase in SSB consumption and obesity is not expected to occur evenly across LSM (SES) groups. Although we were unable to model the impact of increased consumption by LSM group, SSB consumption in South Africa is currently greater in higher-income groups<sup>(18)</sup>. According to SABMiller figures, per capita consumption of Coca-Cola in LSM 7–10 (the four highest SES groups) is estimated at 292 ml/d, compared with 188 ml/d in LSM 4–6 (medium SES groups) and 122 ml/d in LSM 1–3 (lowest SES groups)<sup>(18)</sup>. SANHANES data show an average SSB consumption of 186 ml/d in urban informal areas and an average of 161 ml/d in rural informal areas<sup>(2)</sup>. In the future, SSB consumption trends will probably change with consumption becoming higher in lower-income groups (as has occurred in other countries like Mexico and the USA)<sup>(18,43)</sup>. The largest soft drink franchise in the country has outlined its future growth strategy and has identified LSM 1–6 as its main market opportunity, with a specific focus on LSM 1–3<sup>(18)</sup>. This is the poorest sector, which currently has the lowest per capita consumption. It has been suggested by industry that lessons learned in Mexico, where soft drink consumption is highest globally, should be applied in South Africa<sup>(18)</sup>. The SABMiller growth strategy indicates that this will include improving service levels and increasing delivery frequency of products, growing the number of outlets to improve penetration while ensuring that existing outlets are serviced accordingly, and increasing the number of coolers (storage for SSB) per outlet, in addition to building stronger brand loyalty<sup>(18)</sup>. In 2011 this growth strategy was implemented in Tembisa, an informal settlement near Johannesburg comprising 1.3 million people. The result was a tripling of the number of outlets to eighteen per 10 000 people and a doubling of the number of coolers to sixteen per 10 000 people. This generated a 7.5 % volume growth in Coca-Cola products between 2011 and 2012<sup>(18)</sup>. The comparison in the growth strategy between South Africa and Mexico suggests an intention to increase per capita consumption of soft drinks in South



Africa by three times within LSM 1–3. The growth strategy as implemented in Tembisa will likely be extended and will occur alongside marketing and advertising strategies to further develop brand loyalty. This in turn will result in a significant increase in the number of obese people in these groups, putting them at greater risk for NCD and perpetuating the cycle of poverty and ill-health.

### **Study strengths and limitations**

The present study is the first in sub-Saharan Africa to assess the impact of increased SSB consumption on future obesity trends. The study has several strengths. First, we were able to use nationally representative data from South Africa to estimate baseline consumption of different drinks and the baseline prevalence of obesity. This increases the generalizability of our results to all South African adults and potentially to other populations in low- and middle-income countries similar to South Africa. In addition, the height and weight from the survey were measured, which should allow for a high degree of accuracy of the BMI estimates. A limitation, however, is that our projections of obesity do not account for the BMI trend in South Africa and may be an underestimate. In addition, BMI is an imperfect measure of obesity as it does not always accurately take into account body fat<sup>(44)</sup>. This can lead to either overestimations or underestimations of obesity. In our study, we would not have been able to measure obesity in the entire adult population without using BMI.

We used the SANHANES-1 to estimate baseline consumption levels of different drinks. However, comparison with soft drink sales suggests that these estimates may have been too low. Euromonitor data show 2012 soft drink sales totalling 4.75 million litres, an average of 254 ml/person per d, which is higher than the SANHANES estimate of 184 ml. This may be due to the fact that Euromonitor includes a broader category of soft drinks than those included as SSB by SANHANES, or it may be the result of recall or reporting bias. There is further evidence that SANHANES figures may be an underestimate when compared with SABMiller figures; the latter show annual per capita consumption of all Coca-Cola products at 67 litres in 2012<sup>(18)</sup>. These products account for about 60 % of the (off-trade) soft drinks market, so the average South African is potentially consuming approximately 315 ml of SSB daily. The SANHANES data are the only source that is subdivided by age group and was therefore used for our model, bearing in mind the likely underestimation. At the time of the modelling, figures from the most recent Euromonitor report were used to project increase in SSB consumption. However, this report has subsequently been updated and shows that soft drink sales are projected to grow by 3.9 % per year between 2004 and 2019<sup>(45)</sup>. Further, we used the total 2.4 % industry growth across all age groups to project future consumption and this may have resulted in an underestimate of projected consumption in some age groups and an overestimate in others.

### **Policy implications**

The South African nutrition policy context has developed from one focused solely on undernutrition to one that also seeks to address the growing NCD epidemic. The South African Strategic Plan for Prevention and Control of Non-Communicable Diseases 2013–2017<sup>(6)</sup> identifies several cost-effective interventions for addressing obesity, one of which is a tax on unhealthy products<sup>(6)</sup>. Although there is good evidence to suggest that an SSB tax is an effective intervention in reducing consumption, a package of population-level interventions is essential to ensure maximal impact. Other potential, concurrent measures include food advertising regulations, easy-to-understand food labelling, worksite interventions and school-based interventions<sup>(6)</sup>. Government could also subsidize healthy products. Ideally this should be accompanied by strong public campaigns about the health implications of sugar and of excessive SSB consumption. The Strategic Plan acknowledges the need for this type of multi-pronged response<sup>(6)</sup>; however, the progress in terms of implementation seems to be protracted as specific regulations are yet to be passed. This, despite the recognition in the Foreword to the Plan that ‘without strong and innovative interventions **now**, we will not only subvert government’s goal of a long and health life for all, but our health services could in the future become overwhelmed with patients requiring acute as well as long term health care’<sup>(6)</sup>. Indeed, some challenges may be difficult to overcome, especially those surrounding vested interests<sup>(46)</sup>, but in the absence of effective preventive measures SSB consumption will continue to grow. This will lead to a greater burden of obesity, as demonstrated by the results presented herein.

Currently, consumers are persuaded to make unhealthy choices through the use of tactical marketing techniques and strategic placement and availability of high-energy products<sup>(16)</sup>. It is the responsibility of the government to protect the health of its population by levelling the playing field through interventions that nudge people to make healthier and more sustainable choices. In the absence of immediate implementation of the cost-effective interventions identified in the Strategic Plan, the target of 10 % reduction in obesity by 2020 will likely be difficult to achieve and the health systems in South Africa will confront serious challenges in tackling obesity and related NCD.

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