



# Overweight and obesity in children and adolescents: The South African problem

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Overweight and obesity in children and adolescents are on the increase worldwide. Overweight and obesity increase the risk for the development of non-communicable diseases during childhood and adolescence, and predispose the individual to the development of overweight, obesity, cardiovascular disease, and metabolic and other disorders in adulthood. In Africa the number of overweight or obese children has doubled since 1990. In South Africa, overweight and obesity in children and adolescents are on the increase, but the prevalence varies with age, gender and population group. These differences are important when intervention programmes and policies are considered. South Africa faces a double burden of disease where undernutrition and overweight or obesity are found in the same populations, in the same households and even in the same children. Malnutrition is a major contributor to the double burden of disease in South African children and adolescents.

## Introduction

The terms overweight and obesity refer to abnormal or excessive fat accumulation to the extent that it may have adverse effects on the health and well-being of the individual.<sup>1</sup> Evaluating overweight and obesity in individuals or groups is based on an anthropometric indicator, a reference population and cut-off points for normal, overweight and obesity.<sup>2</sup> Various measures are used, ranging from clinical assessment, to skinfold thicknesses, weight-for-age, body mass index (BMI; kg/m<sup>2</sup>), waist-to-hip ratio and others. Although not a perfect anthropometric indicator, BMI is the most generally used index, or indicator, of weight status. Whereas adult BMI assessment is fairly straightforward, the BMIs of children differ at different ages. Overweight and obesity in children and adolescents are therefore usually expressed as BMI-for-age.<sup>2</sup> A number of internationally comparable reference sets for children and adolescents exist, such as those of the International Obesity Taskforce (IOTF), the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO).<sup>3,4</sup> However, these charts have thus far been compiled without adequate normative values for the African and Asian continents.

Once considered predicaments mainly of the affluent, overweight and obesity are now markedly on the increase in low-income and middle-income populations, particularly in urban areas. In 2010, it was estimated that, globally, about 43 million children under the age of 5 years were overweight, and 35 million of these were living in developing countries.<sup>5,6</sup> The fastest overweight and obesity growth rates are found in Africa – the number of overweight or obese children in 2010 was more than double that in 1990.<sup>5,6</sup> The two overriding causes of the increased prevalence of overweight and obesity in developing countries are said to be a decline in physical activity and diets rich in refined fats, oils and carbohydrates.<sup>7,8</sup> Whereas undernutrition and communicable diseases were once the overriding health threat in developing countries, it is now estimated that non-communicable diseases, such as obesity-associated disorders, could be the cause of 7 out of every 10 deaths by 2020.<sup>7</sup>

## The impact of overweight and obesity in childhood and adolescence

Overweight and obesity during childhood and adolescence have negative impacts, on both physical and psychological well-being. From a physical point of view, obesity is associated with a higher risk for the development of insulin resistance, type 2 diabetes mellitus, and a number of cardiovascular abnormalities during childhood and adolescence.<sup>9</sup> Although the end points for cardiovascular risks are not necessarily seen in childhood or adolescence, most of the major risk factors are, including high systolic and diastolic blood pressure, dyslipidaemia (increased low-density lipoprotein cholesterol, raised triglycerides and low levels of high-density lipoprotein cholesterol), abnormal vascular endothelial function, abnormal left ventricular function, abnormalities in left ventricular mass and atherosclerotic lesions.<sup>9,10,11,12,13</sup> While most



cases of childhood diabetes mellitus were once type 1, there has, over the last couple of decades, been a rapid increase in the development of obesity-associated type 2 diabetes mellitus.<sup>12</sup> Symptoms of the insulin resistance syndrome, including hyperinsulinaemia, dyslipidaemia and hypertension, are not uncommon in obese children.<sup>9</sup> Other conditions found in association with overweight and obesity in childhood and adolescence include the risk of developing asthma, or an increase in the severity of existing asthma, low-grade systemic inflammation, obstructive sleep apnoea, early onset of puberty, foot and other skeletal abnormalities, and fatty liver disease.<sup>11,13,14</sup>

Overweight and obesity during childhood and adolescence not only influence well-being during this period, but can persist into adulthood. Excess body fat in children and adolescents increases the risk for the development of several medical conditions during adulthood, including insulin resistance, adult-onset type 2 diabetes mellitus and cardiovascular problems such as hypertension, ischaemic heart disease and stroke.<sup>9,14</sup> Overweight and obesity are also said to increase the risk for different cancers, skeletal problems, non-alcoholic fatty liver disease, polycystic ovarian syndrome, and a variety of inflammatory conditions.<sup>11,14,15,16</sup> A recent systematic review of the literature showed that overweight and obesity in childhood and adolescence increase adulthood risk for disability pension, premature mortality and morbidity.<sup>14</sup>

From a psychological point of view, low self-esteem seems to be the overriding concern of overweight and obesity during childhood and adolescence.<sup>17</sup> Overweight and obesity during childhood and adolescence can give rise to a lack of confidence, negative self-perception and depression.<sup>18,19,20</sup> From a psychosocial perspective, stereotyping, discrimination and social rejection may occur.<sup>19</sup> These, in turn, may lead to withdrawal from physical activities with further aggravation of the weight problem. In a local study on urban school children living in Potchefstroom (South Africa), it was shown that overweight and obesity can significantly influence scholastic and athletic competency, physical self-concept and social acceptance.<sup>17</sup> As with the physical effects of overweight and obesity, the psychological impact may extend into adulthood.

## The South African problem

The occurrence of overweight and obesity in South African children at present is said to be at least comparable to that found in developed countries more than a decade ago.<sup>20,21</sup> It has even been said to be on par with that of many industrialised nations and amongst the highest in Africa.<sup>22</sup> These statistics are rather alarming as the WHO reported that the fastest growing rates in overweight and obesity are in Africa, with the number of overweight or obese children in 2010 more than double that in 1990.<sup>6</sup> In general, there appears to be an increase in the prevalence of overweight or obesity in childhood and adolescence in South Africa. Armstrong et al.<sup>23</sup>, in a comparison between rates from The South African

Primary Schools' Anthropometric Survey and The Health of the Nation Study, estimated an increase in overweight from 1.2% to 13% and in obesity from 0.2% to 3.3% over the period from 1994 to 2004. The results of major studies on the prevalence of overweight and obesity in South African children and adolescents are summarised in Table 1. Results from studies before 1999 showed low overweight and obesity rates, whilst more recent studies showed a mean prevalence of just over 15% for overweight and obesity combined. However, this prevalence does not give a true reflection of the problem as overweight and obesity differ markedly between age groups, between boys and girls, between ethnic groups and between geographical areas.

There appear to be strong age-dependent trends from early childhood to late adolescence in the prevalence of obesity and overweight, especially in previously disadvantaged populations. Some of the highest rates for overweight and obesity have been reported for early childhood. In rural communities from the Limpopo, Eastern Cape and KwaZulu-Natal Provinces, high overweight and obesity rates were observed with up to 50% of the under-one-year-olds being either overweight or obese.<sup>29,31</sup> Mamabolo et al.<sup>31</sup> suggest this high prevalence of overweight and obesity is related to cultural beliefs and practices where fat infants are seen as healthy and mothers therefore indulge in overfeeding – often with energy-rich foods. This high prevalence of infant overweight and obesity may not be representative of the whole of the previously disadvantaged South African population as a recent large study on a population in a Mpumalanga district found moderate levels of overweight and obesity in early childhood.<sup>26</sup> It is, however, important to note that the latter study did not include individuals under one year of age – an age for which a very high prevalence was reported elsewhere.<sup>29,31</sup> From cross-survey comparisons, the prevalence of overweight and obesity seems to decrease from early to late childhood, after which it once again increases to reach values of over 20% in girls in late adolescence.<sup>23,29</sup> This increase from late childhood to adolescence appears to be gender, and perhaps ethnicity, dependent.

In the majority of studies on children and adolescents in South Africa (Table 1), a higher prevalence of overweight or obesity was found in girls than in boys.<sup>20,21,22,32,33,36,38</sup> In most of these studies, there was an increase in the prevalence of overweight or obesity with age, where development of overweight or obesity in girls was linked to the time of menarche.<sup>30,33,36</sup> These findings are supported by the results of a recent study (2010) on 3511 children and adolescents from rural villages in a former Gazankulu homeland in Mpumalanga.<sup>26</sup> This study showed a relatively low overweight or obesity prevalence in boys and a higher prevalence, reaching 20% – 25% in late adolescence, in girls.<sup>26</sup> Factors suggested to play a role in this gender disparity include possible differences in the energy needs between boys and girls, in the levels of physical activity, in behavioural or cultural phenomena and in the timing of sexual maturation.<sup>26</sup> The association between puberty and overweight in girls may be a double-edged sword: on the

**TABLE 1:** Summary of studies on the prevalence of overweight and obesity in children and adolescents in South Africa.

Authors	Demographics	Measuring tool	Prevalence
Truter et al. <sup>20</sup>	Number: 280 children Age: 9 to 13 years Gender: male 45.7%; female 54.3% Area: two primary schools in Potchefstroom, North West Province	BMI for age (Cole et al. <sup>3</sup> , IOTF)	<b>Overweight:</b> 15.5% total; 15.6% boys; 15.1% girls <b>Obese:</b> 6.5% total; 5.5% boys; 7.2% girls
Armstrong et al. <sup>21</sup>	Number: 10 195 children Age: 6 to 13 years Gender: 55% male; 45% female Race: 47.60% Black; 32.46% White; 17.80% Coloured Area: 5 provinces with children from diverse socio-economic backgrounds; rural and urban Date: 2001–2004	BMI for age (Cole et al. <sup>3</sup> , IOTF)	<b>Overweight:</b> 10.8% all boys 13% all girls 15.4% White boys 15.5% White girls 7.6% Black boys 12.3% Black girls 8.7% Coloured boys 10.7% Coloured girls <b>Obese:</b> 3.2% all boys 4.9% all girls 4.3% White boys 7.8% White girls 2.1% Black boys 4.7% Black girls 3% Coloured boys 4.8% Coloured girls
Reddy et al. <sup>22</sup>	Number: 9224 children Age: 13 to 19 years Gender: 47% male; 53% female Race: 75.8% Black; 15.4% Coloured; 8.8% White Area: national Date: 2002	BMI for age (Cole et al. <sup>3</sup> , IOTF)	<b>Overweight:</b> 16.9% total 6.9% all boys 24.5% all girls 20.2% White boys 26% White girls 5.2% Black boys 25.1% Black girls 8.5% Coloured boys 16.9% Coloured girls <b>Obese:</b> 4% total 2.2% all boys 5.3% all girls 2.2% White boys 7.7% White girls 1.9% Black boys 5.3% Black girls 2.8% Coloured boys 3.8% Coloured girls
Puckree et al. <sup>24</sup>	Number: 120 children Age: 10 to 12 years Gender: 40% male; 60% female Race: 76% Indian; 24% Black Area: urban, KwaZulu-Natal	BMI for age (WHO)	<b>Overweight:</b> 5.03% (total) <b>Overweight for age:</b> Age 10 – 1.7%; Age 11 – 0.8%; Age 12 – 2.5% <b>Obese:</b> 1 of 120 children
Kemp et al. <sup>25</sup>	Number: 816 children Age: mean 6.78 years Gender: 51.3% male; 48.7% female Race: 69% Black; 26.7% White; 0.02% Coloured; 0.01% Indian Area: North West Province	BMI for age (Cole et al. <sup>3</sup> , IOTF)	<b>Overweight:</b> 7.8% total 6.4% boys 9.3% girls <b>Obese:</b> 3.8% total 3.3% boys 2.8% girls
Kimani-Murage et al. <sup>26</sup>	Number: 3489 Age: 1 to 20 years Gender: 49.4% male; 50.6% female Race: Black (Tsonga) Area: Agincourt sub-district, Mpumalanga Date: 2007	BMI for age (Cole et al. <sup>3</sup> , IOTF)	<b>Overweight:</b> 6% all aged 1–20 years 7% aged 1–4 years 4% aged 5–9 years 6% aged 10–14 years 8% aged 15–20 years <b>Obese:</b> 2% all aged 1–20 years 1% aged 1–4 years 1% aged 5–9 years 2% aged 10–14 years 4% aged 15–20 years
Reddy et al. <sup>27</sup>	Number: 10 270 Age: Grades 8–11 (± 14 to 19 years) Gender: 48.5% male; 48.5% female Race: 78.1% Black; 14.2% Coloured; 5.7% White; 1.1% Indian Area: national	BMI for age (Cole et al. <sup>3</sup> , IOTF)	Total overweight: 19.7% Total obese: 5.3%
Labadarios et al. <sup>28</sup>	Age: 1 to 9 years Area: national Date: 2005	BMI for age	Total overweight: 10% Total obese: 4%
Smuts et al. <sup>29</sup>	Number: 4000 children Age: 0 to 71 months Area: two districts – OR Tambo; Alfred Nzo, Eastern Cape and Umkhanyakude; Zululand, KwaZulu-Natal Date: 2002	Height-for-age, weight-for-age and weight-for-height (WHO)	<b>Overweight:</b> (Eastern Cape) 18%, <12 months 12%, 12–24 months 5%, 24–60 months (KwaZulu-Natal) 16%, <12 months 11%, 12–24 months 5%, 24–60 months

BMI, body mass index; WHO, World Health Organization; IOTF, International Obesity Taskforce.

Table 1 continues on the next page →

**TABLE 1 (Continues...):** Summary of studies on the prevalence of overweight and obesity in children and adolescents in South Africa.

Authors	Demographics	Measuring tool	Prevalence
Kruger et al. <sup>30</sup>	Number: 1257 children Age: 10 to 15 years Gender: 48% male; 52% female Race: 73.1% Black; 15.2% White; 6.2% Coloured Area: 35.8% rural; 46.4% urban; 17.8% informal (North West Province)	BMI for age (Cole et al. <sup>3</sup> , IOTF) Sum of skinfolds	<b>Overweight:</b> 11.6% White 5.7% Black 2.9% Coloured 3.8% Indian  <b>Obese:</b> 2.6% White 1.4% Black 0% Coloured 2.6% Indian
Mamabolo et al. <sup>31</sup>	Number: 162 children Age: birth to 3 years Race: Black Area: rural villages, Limpopo Province	BMI for age (Cole et al. <sup>3</sup> , IOTF) Weight for height Z-scores > median by 2SD (WHO)	Overweight: 18% Obese: 24% Prevalence of overweight according to WAZ: 5% WHZ: 18% BMI: 22%
Somers <sup>32</sup>	Number: 338 children Age: 10 to 16 years Gender: 42.31% male; 57.69% female Race: Black and Coloured Area: Western Cape Province	BMI (CDC)	<b>Overweight:</b> 8.31% total 2.80% boys 12.30% girls  <b>Obese:</b> 2.97% total 2.80% boys 3.09% girls
Mukuddem-Petersen et al. <sup>33</sup>	Number: 1250 children Age: 10 to 15 years Gender: 48.3% male; 51.7% female Race: Black, White, Coloured Area: 35.8% rural; 46.4% urban; 17.8% informal (North West Province)	BMI for age (Cole et al. <sup>3</sup> , IOTF) Sum of skinfolds	Prevalence of obesity and overweight combined: 7.9% total 5.6% boys 10.1% girls 14.2% White 7.1% Black 6.4% Indian 2.9% mixed ancestry
Labadarios et al. <sup>34</sup>	Number: 2894 children Age: 1 to 9 years Area: national – 156 enumerator areas (EAs): 82 urban EAs; 74 non-urban EAs Date: 1999	BMI for age (IOTF)	<b>Overweight:</b> 12.1% total national 11.6% rural 12.5% urban  <b>Obese:</b> 5% total national 3.7% rural 6.1% urban
Steyn et al. <sup>35</sup>	Number: 2894 children Age: 12 to 108 months Area: national – 156 enumerator areas (EAs): 82 urban EAs; 74 non-urban EAs Date: 1999	BMI for age (IOTF)	<b>Overweight:</b> 12.1% total national 11.6% rural 12.5% urban  <b>Obese:</b> 5% total national 3.7% rural 6.1% urban
Cameron et al. <sup>36</sup>	Number: 447 children Age: 7 to 18.9 years Gender: 57% male; 43% female Area: rural, Ubombo, Northern Mpumalanga	BMI (Popkin et al. <sup>44</sup> , HANES III) Sum of skinfolds ('overfat') Ratio trunk: limb skinfolds	<b>Total boys:</b> Overweight 2% (10–11 years) Overfat 16% (18–19 years)  <b>Total girls:</b> Overweight 11% (14–17 years) Overfat 14% (18–19 years)
Monyeki et al. <sup>37</sup>	Number: 1336 children Age: 3 to 10 years Gender: 51% male; 49% female Area: rural, Ellisras, Limpopo Province Date: 1996	BMI (> 85th centiles of NHANES III) Sum of skinfolds	Total boys overweight or obese: BMI: 0.55% Sum of skinfolds: 4.15%  Total girls overweight or obese: BMI: 1% Sum of skinfolds: 1.1%
Jinabhai et al. <sup>38</sup>	Number: 802 children Age: 8 to 11 years Gender: male and female Area: rural, Vulamehlo, KwaZulu-Natal Date: 1995	BMI for age (WHO/NCHS standard based on 85th and 95th centiles) BMI for age (IOTF criteria)	<b>Overweight:</b> Total boys: WHO 85%: 5.1% IOTF: 1.95% Total girls: WHO 85%: 5.45% IOTF: 4.9%  <b>Obese:</b> Total boys: WHO 95%: 0% IOTF: 0% Total girls: WHO 95%: 1.3% IOTF: 0.7%
Department of Health <sup>39</sup>	Number: 24 391 Age: 8 to 11 years Area: national	BMI: IOTF BMI: WHO	Overweight: 1.2% Obese: 0.2%

BMI, body mass index; WHO, World Health Organization; IOTF, International Obesity Taskforce; WAZ, weight-for-age Z-score; WHZ, weight-for-height Z-score.



one hand, overweight or obesity is said to contribute to the early onset of puberty,<sup>13</sup> while on the other hand, early onset of puberty is reported to predispose to an increase in BMI and to the development of overweight or obesity in later life.<sup>40</sup> Armstrong et al.<sup>21</sup> observed a phenomenon that may be culture related – overweight increased with age in African girls but decreased with age in White girls. This finding is speculated to be linked to the fact that overweight, in certain African cultures, is seen as an indication of wealth and happiness and, in more recent times, as an indication that the individual does not have HIV or AIDS.<sup>41,42</sup>

South Africa is in a rural-to-urban transition phase and it is known that populations in a transition towards urbanisation may experience an increase in overweight and obesity.<sup>43</sup> Although there are indications of higher rates of overweight and obesity in South African children in urban areas,<sup>34,35</sup> more studies are needed to confirm these indications. To say that urbanisation leads to the development of overweight and obesity is a simplification, as it is known that poor families facing urban industrialisation may be at a risk for the development of nutritional disorders.<sup>23</sup> Higher rates of overweight and obesity in relatively well-fed urban children are probably related to lower activity levels, smaller families, the availability of energy-rich fast-foods and, often, higher parental income.<sup>30</sup>

South Africa, like many other middle-income and low-income countries,<sup>35,44</sup> faces the so-called double burden of disease, where overweight contributes to the burden of disease caused by undernutrition and communicable diseases. Whereas childhood undernutrition leads to stunted growth and underdevelopment, overweight increases the risk for metabolic, cardiovascular and other non-communicable diseases. This coexistence of undernutrition and overweight in child populations from nations in nutritional transition has been known for decades.<sup>44</sup> In addition to communicable diseases, major causes of the double burden of disease, according to the WHO, are inadequate prenatal, infant and young child nutrition, followed by micronutrient-deficient, energy-dense, high-fat foods coupled to a lack of physical activity.<sup>45</sup>

Several local studies investigated the coexistence of stunting, as a measure of undernutrition, and overweight.<sup>26,31,35,38</sup> In a comparison between the incidence of overweight or obesity and stunting found in 1994 with that found in a survey from 2001 to 2004, stunting decreased, but overweight and obesity increased significantly from 1994 to 2004.<sup>23</sup> In addition, lower levels of mild stunting and similar levels of moderate stunting were seen in overweight and obese children than in non-overweight and non-obese children.<sup>23</sup> Despite an apparent decrease in certain areas, alarmingly high levels of stunting, varying with age, were recently still found in rural villages in Mpumalanga with a prevalence of up to 32% at 1 year of age, levelling off to about 3% – 6% at 5 years and, in boys, again rising to 14% – 15% during adolescence.<sup>26</sup> In the same population, stunting and overweight or obesity

coexisted in the same individuals in 18% of the under-5-year-olds.<sup>26</sup> An important observation, which has potential health consequences, was reported by Mukuddem-Petersen and Kruger<sup>33</sup>: increased fat accumulation at umbilical level in stunted girls older than 14 years. The risks of abdominal fat accumulation for the development of diabetes mellitus type 2 and cardiovascular problems are well documented for adults and indications are that the same may apply to children.<sup>10,46</sup> Several studies abroad have shown an association between stunting and the risk of developing overweight at a later stage.<sup>47,48</sup> This association was also reported in a paper by Steyn et al.<sup>35</sup> for a South African population. Several postulates exist for the association between nutritional stunting and the risk of developing overweight at a later stage, including the possibility that nutritional stunting may be marked by impaired fat oxidation<sup>49</sup> and by increased susceptibility to the effects of a high fat diet.<sup>50</sup>

The home environment has, in more than one way, a significant role to play in the prevalence of overweight and obesity. International research showed the probability of overweight or obesity in childhood and adolescence to be dramatically increased when both parents are overweight or obese.<sup>51</sup> A mother's weight and perception of her child's weight have been shown to be important determinants of her child's BMI status.<sup>52</sup> However, this relationship is not always the case and the opposite would appear to be found frequently outside Western countries. An association between underweight children and overweight mothers has, for instance, been reported in Russia, China and Brazil.<sup>35</sup> A similar disparity between mother's weight and child nutritional status has also been shown in a South African study comprising 4000 children from the Eastern Cape and KwaZulu-Natal where a coexistence was found between mothers' or caregivers' overweight or obesity and child malnutrition.<sup>29</sup> In studies on rural communities in Limpopo and the North West Province, between 30% and 50% of underweight children had overweight or obese mothers or caregivers.<sup>53,54</sup> The fact that the mean age-standardised BMI for women in southern Africa increased from about 25.8 kg/m<sup>2</sup> in 1980 to  $\geq 28$  kg/m<sup>2</sup> in 2008,<sup>55</sup> does not augur well for the future BMI status of South African children.

Evidence exists that childhood overweight and obesity are, in fact, contributing to the non-communicable burden of disease in South Africa. In a recent study, the risk of developing metabolic disease, as estimated from the prevalence of central obesity (waist circumference), was seen to be 16% for girls and only 1% for boys.<sup>26</sup> There have been several reports on a high prevalence of hypertension in children and adolescents, but only a few studies investigated the link between overweight or obesity and hypertension.<sup>56,57,58</sup> Although hypertension rates as high as 22% were found in overweight children, and as high as 35% in obese children, hypertension was found in up to 25% of normal weight children<sup>58</sup> – an indication that factors other than overweight or obesity contribute to the prevalence of hypertension in South African children and adolescents.



In summary, high levels of overweight and obesity are present in South African children and adolescents. The prevalence appears to be strongly dependent on age, gender and population. These differences are important when intervention programmes and policies are considered. The coexistence of overweight or obesity and undernutrition in the same population, the same household or the same individual, confirms malnutrition as a major contributor to the double burden of disease in South African children and adolescents. Whilst a switch to energy-dense diets is considered the major cause of overweight and obesity, several other factors contribute; these factors include physical inactivity, intra-uterine and early life experience, level of education, cultural factors, stress levels and genetics.<sup>59</sup>

It is obvious that there is a need for an increase in research on overweight and obesity in South African children and adolescents. Although large-scale, preferably longitudinal, epidemiological studies on anthropometric aspects, such as height, weight, fat distribution and blood pressure, are essential, further studies into the causes and effects of overweight and obesity are also necessary. Whereas immunological, neural, hormonal, metabolic and other mechanisms are known to influence the weight regulating systems, it is said that genetic factors and genetic-environmental interactions may be amongst the more important.<sup>59</sup> One can only hope that the current surge in the interest in epigenetic research will also ensue in the field of overweight and obesity.

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We declare that we have no financial or personal relationships which may have inappropriately influenced us in writing this article.

### Authors' contributions

H.R. was responsible for the compilation of the table and made conceptual contributions. C.C.G. was involved in the initiation of the project and made conceptual contributions. M.V. wrote the manuscript.

## References

- World Health Organization. Global strategy on diet, physical activity and health. What is overweight and obesity? [homepage on the Internet]. No date [cited 2011 Dec 11]. Available from: [http://www.who.int/dietphysicalactivity/childhood\\_what/en/index.html](http://www.who.int/dietphysicalactivity/childhood_what/en/index.html)
- De Onis M, Lobstein T. Defining obesity risk status in the general childhood population: Which cut-offs should we use? *Int J Pediatr Obes*. 2010;5:458-460. <http://dx.doi.org/10.3109/17477161003615583>, PMID:20233144
- Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ*. 2000;320:1240-1243. <http://dx.doi.org/10.1136/bmj.320.7244.1240>, PMID:10797032, PMCid:27365
- De Onis M, Garza C, Onyango AW, Borghi E. Comparison of the WHO child growth standards and the CDC 2000 growth charts. *J Nutr*. 2007;137:144-148. PMID:17182816
- De Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. *Am J Clin Nutr*. 2010;92:1257-1264.
- De Onis M, Blössner M. Prevalence and trends of overweight among preschool children in developing countries. *Am J Clin Nutr*. 2000;72:1032-1039.
- Boutayeb A, Boutayeb S. The burden of non-communicable diseases in developing countries. *Int J Equity Health*. 2005;4:2. <http://dx.doi.org/10.1186/1475-9276-4-2>, PMID:15651987, PMCid:546417
- Prentice AM. The emerging epidemic of obesity in developing countries. *J Infect Dis*. 2005;35(1):93-99.
- Steinberger J, Daniels SR. Obesity, insulin resistance, diabetes and cardiovascular risk in children. *Circulation*. 2003;107:1448-1453. <http://dx.doi.org/10.1161/01.CIR.0000060923.07573.F2>, PMID:12642369
- Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa Heart study. *Pediatrics*. 1999;103:1175-1182. <http://dx.doi.org/10.1542/peds.103.6.1175>, PMID:10353925
- Lee WWR. An overview of pediatric obesity. *Pediatr Diab*. 2007;8(Suppl.9):76-87. <http://dx.doi.org/10.1111/j.1399-5448.2007.00337.x>, PMID:17991136
- Hannon TS, Rao G, Arslanian SA. Childhood obesity and type 2 diabetes mellitus. *Pediatrics*. 2005;116(2):473-480. <http://dx.doi.org/10.1542/peds.2004-2536>, PMID:16061606
- He Q, Karlsberg J. BMI in childhood and its association with height gain, timing of puberty, and final height. *Pediatr Res*. 2001;49(2):244-251. <http://dx.doi.org/10.1203/00006450-200102000-00019>
- Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. *Int J Obes*. 2010;35:891-898. <http://dx.doi.org/10.1038/ijo.2010.222>
- Jeffreys M, Smith G, Martin R, Frankel S, Gunnell D. Childhood body mass index and later cancer risk: A 50-year follow-up of the Boyd Orr study. *Int J Cancer*. 2004;112:348-351. <http://dx.doi.org/10.1002/ijc.20423>, PMID:15352051
- Mathur P, Das MK, Arora NK. Non-alcoholic fatty liver disease and childhood obesity. *Indian J Pediatr*. 2007;74(4):401-407. <http://dx.doi.org/10.1007/s12098-007-0068-0>
- Monyeki MA, Pienaar AE, Mamabolo RL, Temane M. Effect of obesity on physical self-concept of urban school children living in Potchefstroom, South Africa. *Health. AJPHERD*. 2009;15(1):1-14.
- Israel AC, Ivanova MY. Global and dimensional self-esteem in preadolescent and early adolescent children who are overweight: Age and gender differences. *Int J Eat Disord*. 2002;31(4):424-429. <http://dx.doi.org/10.1002/eat.10048>, PMID:11948647
- Doak CM, Visscher TLS, Renders CM, Seidel JC. The prevention of overweight and obesity in children and adolescents: A review of interventions and programmes. *Obes Rev*. 2006;7:111-136. <http://dx.doi.org/10.1111/j.1467-789X.2006.00234.x>, PMID:16436107
- Truter L, Pienaar AE, Du Toit D. Relationships between overweight, obesity and physical fitness of nine-to-twelve-year-old South African children. *SA Fam Pract*. 2010;52(3):227-233.
- Armstrong MEG, Lambert MI, Sharwood KA, Lambert EV. Obesity and overweight in South African primary school children. *The Health of the Nation Study*. *S Afr Med J*. 2006;96(5):439-444. PMID:16751921
- Reddy SP, Resnicow K, James S, Kambaran N, Omdardien R, Mbewu AD. Underweight, overweight and obesity among South African adolescents: Results of the 2002 National Youth Risk Behaviour Survey. *Public Health Nutr*. 2008;12(2):203-207. <http://dx.doi.org/10.1017/S1368980008002656>, PMID:18547451
- Armstrong MEG, Lambert MI, Lambert EV. Secular trends in the prevalence of stunting, overweight and obesity among South African children (1994-2004). *Eur J Clin Nutr*. 2011;65:835-840. <http://dx.doi.org/10.1038/ejcn.2011.46>, PMID:21505505
- Puckree T, Naidoo P, Pillay P, Naidoo T. Underweight and overweight in primary school children in eThekweni district in KwaZulu-Natal, South Africa. *Afr J Prm Health Care Fam Med*. 2011;3(1), Art. #203, 6 pages. <http://dx.doi.org/10.4102.phcfm.v3i1.203>
- Kemp C, Pienaar AE, Schutte AE. The prevalence of hypertension and the relationship with body composition in Grade 1 learners in the North West Province of South Africa. *S Afr J Sports Med*. 2011;23(4):117-122.
- Kimani-Murage EW, Kahn K, Pettifor JM, et al. The prevalence of stunting, overweight and obesity, and metabolic disease risk in rural South African children. *BMC Public Health*. 2010;10:158. <http://dx.doi.org/10.1186/1471-2458-10-158>, PMID:20338024, PMCid:2853509
- Reddy SP, James S, Sewpaul R, et al. Umthente Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2008. Cape Town: South African Medical Research Council; 2010.
- Labadarios D, Swart R, Maunder EMW, et al. National Food Consumption Survey Fortification Baseline (NFCS-FB-I) South Africa, 2005. *S Afr J Clin Nutr*. 2008;21(2):245-300.
- Smuts CM, Faber M, Schoeman SE, et al. Socio-demographic profiles and anthropometric status of 0- to 71-month-old children and their caregivers in rural districts of the Eastern Cape and KwaZulu-Natal Provinces of South Africa. *S Afr J Clin Nutr*. 2008;21(3):117-124.
- Kruger R, Kruger HS, MacIntyre UE. The determinants of overweight and obesity among 10- to 15-year-old schoolchildren in the North West Province, South Africa – the THUSA BANA study. *Public Health Nutr*. 2006;9(3):351-358. <http://dx.doi.org/10.1079/PHN2006849>, PMID:16684387



31. Mamabolo RL, Alberts M, Steyn NP, et al. Prevalence and determinants of stunting and overweight in 3-year-old Black South African children residing in the Central Region of Limpopo Province, South Africa. *Public Health Nutr.* 2005;8(5):501–508. <http://dx.doi.org/10.1079/PHN2005786>, PMID:17381956
32. Somers A. The prevalence of obesity amongst learners attending the schools in Belhar, Delft and Mfuleni in Cape Town, South Africa. Master's dissertation in Biomedical Technology, Cape Town, Peninsula Technikon, 2004.
33. Mukuddem-Petersen J, Kruger HS. Association between stunting and overweight among 10–15-y-old children in the North West Province of South Africa: The THUSA BANA Study. *Int J Obes.* 2004;28:842–851. <http://dx.doi.org/10.1038/sj.ijo.0802586>, PMID:14758345
34. Labadarios D, Steyn NP, Maunder EMW, et al. The National Food Consumption Survey (NFCS): South Africa, 1999. *Public Health Nutr.* 2005;8(5):533–543. <http://dx.doi.org/10.1079/PHN2005816>
35. Steyn NP, Labadarios D, Maunder E, Nel J, Lombard C. Secondary anthropometric data analysis of the national food consumption survey in South Africa: The double burden. *Nutrition.* 2005;21:4–13. <http://dx.doi.org/10.1016/j.nut.2004.09.003>, PMID:15661473
36. Cameron N, Getz B. Sex differences in the prevalence of obesity in rural African adolescents. *Int J Obes.* 1997;21:775–782. <http://dx.doi.org/10.1038/sj.ijo.0800472>, PMID:9376890
37. Monyeki KD, Van Lenthe FJ, Steyn NP. Obesity: Does it occur in African children in a rural community in South Africa? *Int J Epidemiol.* 1999;28:287–292. <http://dx.doi.org/10.1093/ije/28.2.287>, PMID:10342693
38. Jinabhai CC, Taylor M, Sullivan KR. Implications of the prevalence of stunting, overweight and obesity amongst South African primary school children: A possible nutritional transition? *Eur J Clin Nutr.* 2003;57:358–365. <http://dx.doi.org/10.1038/sj.ejcn.1601534>, PMID:12571672
39. Department of Health (DOH). Anthropometric survey in primary schools in the RSA. Pretoria: DOH; 1994
40. Elrick HD, Samaras TT, Demas A. Missing link in the obesity epidemic. *Nutr Res.* 2002;22:1101–1123. [http://dx.doi.org/10.1016/S0271-5317\(02\)00422-0](http://dx.doi.org/10.1016/S0271-5317(02)00422-0)
41. Mvo Z, Dick J, Steyn K. Perceptions of overweight African women about acceptable body size of women and children. *Curationis.* 1999;22(2):27–31. PMID:11040616
42. Clark RA, Niccolai L, Kissinger PJ, Peterson Y, Bouvier V. Ethnic differences in body image attitudes and perceptions among women infected with human immunodeficiency virus. *J Am Diet Assoc.* 1999;99:735–737. [http://dx.doi.org/10.1016/S0002-8223\(99\)00398-3](http://dx.doi.org/10.1016/S0002-8223(99)00398-3)
43. Wang Y, Popkin BM, Zhai F. The nutritional status and dietary pattern of Chinese adolescents 1991 and 1993. *Eur J Clin Nutr.* 1998;52(12):908–916. <http://dx.doi.org/10.1038/sj.ejcn.1600664>, PMID:9881886
44. Popkin BM, Richards MK, Monteiro C. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. *J Nutr.* 1996;126:3009–3016. PMID:9001368
45. World Health Organization. Obesity and overweight [homepage on the Internet]. No date [updated 2011 Mar; cited 2012 Feb 15]. Available from: <http://www.who.int/mediacentre/factsheets/fs311/en/>
46. Asayama K, Oguni T, Hayashi K, et al. Critical values for the index of body fat distribution based on waist and hip circumference and stature in obese girls. *Int J Obes Relat Metab Disord.* 2000;24:1026–1031. <http://dx.doi.org/10.1038/sj.ijo.0801355>, PMID:10951542
47. Walker SP, Gaskin PS, Powell CA, Bennet FI. The effects of birth weight and postnatal linear growth retardation on body mass index, fatness and fat distribution in mid and late childhood. *Public Health Nutr.* 2002;5:391–396. <http://dx.doi.org/10.1079/PHN2002275>, PMID:12003649
48. Florencio TM, Ferreira HS, Da Franca AP, Cavalcante JC, Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceio in north-eastern Brazil. *Br J Nutr.* 2001;86:277–284. <http://dx.doi.org/10.1079/BJN2001396>
49. Hoffman DJ, Sawaya AL, Verreschi I, Tucker KL, Roberts SB. Why are nutritionally stunted children at increased risk for obesity? Studies of metabolic rate and fat oxidation in shantytown children from Sao Palao, Brazil. *Am J Clin Nutr.* 2000;72:702–707. PMID:10966887
50. Sawaya AL, Grillo LLP, Verreschi I, Da Silva AC, Roberts SB. Mild stunting is associated with higher susceptibility to the effects of high fat diets: Studies in a shantytown population of Sao Paulo, Brazil. *J Nutr.* 1998;128(Suppl.2):415S–420S. PMID:9478039.
51. Li Y, Zhai F, Yang X, et al. Determinants of childhood overweight and obesity in China. *Br J Nutr.* 2007;97(1):210–215. <http://dx.doi.org/10.1017/S0007114507280559>, PMID:17217578
52. Manios Y, Moschonis D, Grammatikaki E, Anastasiadou A, Liangkovinos T. Determinants of childhood obesity and associations with maternal perceptions of their children's weight status: The GENESIS study. *J Am Diet Assoc.* 2010;110(10):1527–1531. <http://dx.doi.org/10.1016/j.jada.2010.07.004>, PMID:20869492
53. Steyn NP, Nel PH, Tichelaar HY, et al. Malnutrition in Pedi preschool children, their siblings and caretakers. *S Afr J Clin Nutr.* 1994;7:12–18.
54. Tladinyane P. The difference in factors affecting childcare between mothers/caregivers of undernourished and nourished children in Oukasie (Brits), North West Province. Master's dissertation, Pretoria, Medical University of South Africa, 2003.
55. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: Systematic analyses of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet.* 2011;377:557–567. [http://dx.doi.org/10.1016/S0140-6736\(10\)62037-5](http://dx.doi.org/10.1016/S0140-6736(10)62037-5)
56. Monyeki KD, Kemper HCG, Makgae PJ. The association of fat patterning with blood pressure in rural South African children: The Ellisras longitudinal growth and health study. *Int J Epidemiol* 2006;35(1):114–120. <http://dx.doi.org/10.1093/ije/dyi219>, PMID:16260449
57. Makgae PJ, Monyeki KD, Brit SJ, Kemper HCG, Mashita J. Somatotype and blood pressure of rural South African children aged 6–13 years: Ellisras longitudinal growth and health study. *Ann Hum Biol.* 2007;34(2):240–251. <http://dx.doi.org/10.1080/03014460601144219>, PMID:17558594
58. Goedecke JH, Jennings CL, Lambert EV. Obesity in South Africa. In: Steyn K, Fourie J, Templen N, editors. Chronic diseases of lifestyle in South Africa: 1995–2005. Technical Report. Cape Town: South African Medical Research Council; 2006.
59. Friedman JM. A war on obesity, not the obese. *Science* 2003;299:856–858. <http://dx.doi.org/10.1126/science.1079856>, PMID:12574619