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ARTICLE

Obesity and overweight in South African primary school children – the Health of the Nation Study

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52

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Objectives. To determine the prevalence of overweight and obesity in a sample of South African children aged 6 - 13 years.

Design. Random sampling of schools within each provincial and socio-economic category.

Setting. Primary school children from 5 South African provinces.

Subjects. 10 195 (5 611 male and 4 584 female) primary school children.

Outcome measure. Height and weight were measured and body mass index (BMI) (weight (kg)/height (m)^2) was calculated for each grouping (age x gender x ethnic group). Cut-off points for BMI defining obese and overweight for gender and age (6 - 13 years) were calculated in accordance with international standards.

Results. There were significant differences in height and mass between the different ethnic groups and genders. This trend was not evident for the BMI values. The prevalence of obesity within the sample was 3.2% for boys and 4.9% for girls, whereas overweight prevalence was 14.0% for boys and 17.9% for girls. When the contribution of each ethnic group was adjusted to the demographics of South Africa these values were only slightly different. The prevalence of obesity and overweight among boys was 2.4% and 10.9% respectively, while obese and overweight girls comprised 4.8% and 17.5%, respectively.

Conclusions. South African children show trends of obesity and overweight, similar to values in developed countries about 10 years ago. Intervention strategies to combat an increasingly sedentary lifestyle may need to be developed for the South African context.

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Obesity has become a global health problem, affecting more than 1.3 billion adults, in both developed and developing countries.[1-4] In South Africa it has been suggested that urbanisation[5] is associated with an increased risk of becoming overweight or obese.[6,7] Indeed, high levels of obesity have been identified among urbanised South Africans, particularly among black women.[5,7,8]

The World Health Organization[9] has identified an increase in childhood obesity in developed countries and a high prevalence of childhood obesity has been reported in developing regions such as in Latin America.[10] Despite speculation in the popular media about the high prevalence of overweight and obese children in South Africa, this prevalence has not been quantified in a way that allows accurate international comparisons. Some studies[11-16] have used localised and relatively small samples, considering only basic anthropometry and physical development of children in South Africa. These studies showed differences in height, weight and growth rate among children of varying ethnic and socio-economic backgrounds. More specifically, Cameron *et al.*[13] noted that urbanisation did not lead to increased physical growth among children unless it was accompanied by an improvement in socio-economic status. Monyeki *et al.*[12] showed that by 7 years of age very few rural children (0 - 2.5% of males and 0 - 4.3% of females) had above the NHANES III 85th percentile body mass index (BMI) values.

However, despite these findings, no study has been conducted on a large cohort of South African primary school children with the aim of quantifying the prevalence of obesity and overweight in a way that can be compared with international data. Therefore, the aim of this study was to quantify the prevalence of overweight and obese children according to internationally accepted normative criteria, among a diverse group of South African school children aged between 6 and 13 years.

Subjects and methods

Subjects

The height and weight of 10 195 (5 611 male and 4 584 female) children between the ages of 6 and 13 years were measured. The slight imbalance in numbers may be attributed to random selection. The sample for this study was a representative group of South African primary school children, from diverse socio-economic backgrounds, selected from 5 of the South African provinces, during the Health of the Nation Survey (2001 - 2004). A minimum of 5 schools were tested in each province. Each Provincial Department of Education in South Africa provided a pentile or decile rating for each school according to socio-economic status. Schools were ranked according to this rating, following a random selection process. A low rating was associated with most of the pupils having lower socio-economic status. This cluster-like stratification provided a sample of schools representing the range of socio-economic status that exists in South African primary schools. The principal of each selected school was approached and invited to participate in the study. Those principals who accepted were given 420 informed consent forms and asked to distribute the forms equally among the pupils in the different age groups. In most cases this resulted in a cluster-like sampling method as forms were distributed to a selection of classes in each grade. If a selected school included insufficient pupils, another school was randomly selected from the schools representing the same socio-economic level. This process was also followed if a school declined to participate in the study.

Ethnic distinctions were made between the children tested as follows: Indian (those of East-Asian heritage), black (those of African ancestry), coloured (those of mixed origin, a uniquely South African group), white (those of Caucasian ancestry) and other (those not fitting into any of the previously identified groups). Ethnic group identification was made by members of the testing team. Although testing teams differed between provinces, strict quality control was ensured by using trained testers, standardised testing methods and calibrated scales.

The Research and Ethics Committee of the University of Cape Town gave approval to conduct the study. Permission was also granted by each provincial Department of Education. Informed written consent was obtained from the parent or guardian of each pupil before they were allowed to participate in the study and pupils gave verbal assent.

Testing protocols for calculating BMI

The height and weight of each child was measured. To measure height, a tape measure was attached to the wall. Each child stood with his/her back to the wall, heels touching the wall, arms at the sides, head raised and looking forward. Palms were turned inwards, resting on the thighs. The height measurement was defined as the distance from the floor to the vertex, in the mid-sagittal plane. The value was recorded to the nearest 1.0 mm. Body mass was measured to the nearest 0.1 kg using an electronic scale, which was calibrated before use. The children were measured without shoes and wearing only minimal clothing. Each child was instructed to stand still, with mass equally distributed between the feet, until the scale reading stabilised. The mass was then recorded. BMI was calculated as the body weight (kg) divided by the height squared (m^2).

Reasons for and methods of classification

A measure of obesity based on BMI has advantages, as height and weight can be measured with accuracy in different laboratory and field settings.[17] The method of Cole *et al.*[18] was used to determine cut-off points for BMI for overweight and obesity among children. This method was developed from a sample (N = 192 727) of international subjects. Cole *et al.*[18] predicted the BMI at different ages that would result in an overweight (BMI 25 kg/m^2) or obese (BMI 30 kg/m^2) subject at the age of 18 years. The results from this analysis allow for international comparisons and are better than using previous methods of arbitrarily defined percentile cut-offs. This is based on the fact that the datasets used to derive these definitions each consisted of over 10 000 subjects, adopted strict quality controls and originated from studies conducted in the USA, UK, Hong Kong, Brazil, Singapore and the Netherlands.[18]

Statistics

BMI was calculated from the height and weight measurements of each learner using a Microsoft Excel spreadsheet (Microsoft Office Excel, Microsoft Office Professional Edition, Microsoft Corporation, 2003). The data were then imported into a Statistica spreadsheet (Statistica data analysis software system, version 7, Statsoft Inc, 2004, www.statsoft.com) and analysed. Basic statistics on BMI (mean, standard deviation and sample size) were calculated for each gender, age and ethnic grouping (Tables I and II). The Scheffe post-hoc test was used to determine significant differences. Adjusted mean values were calculated by adjusting each gender- and ethnicity-based age group to account for the same percentage of the subsample. The mean of these values was then calculated. To determine national prevalence, the demographic breakdown of the South African population was taken from the 2001 South African census.[17] This information was used to calculate the demographically adjusted means by multiplying the mean data for the black children by 0.79, the coloured children by 0.089 and the white children by 0.096. These values were then added together and accounted for 97.5% of the South African populace. Indian children comprise 2.5% of the South African population but owing to the small sample size of this group it was not possible to include them in the demographic adjustment. Hence, the demographically representative values calculated were then converted to a percentage value, exclusive of Indian children.

The percentage of children above the internationally acceptable cut-off points for overweight and obesity were calculated for each gender and age group (Tables III and I, 'All' column). These calculations were also completed for gender, age and ethnic groupings (Tables III and IV, 'black', 'coloured' and 'white').

There were insufficient data to conduct a meaningful analysis in the 'Indian' and 'other' ethnicity-specific groupings, although these data are included in the 'All' column results.

Results

Height increased significantly each year among the boys (F = 1 185.0, $p < 0.0000001$) and girls (F = 1 358.0, $p < 0.0000001$).

There was a significant difference in height between ethnic groups among both boys (F = 490.0, $p < 0.0000001$) and girls (F = 358.0, $p < 0.0000001$), with white children being tallest and the black children

Table I. Body mass index of black, coloured and white boys (6 - 13 years). Values are expressed as means ± SD and sample size (*N*)

Age (years)	Black	Coloured	White	All
6	15.8 ± 1.5 (94)	15.0 ± 1.8 (42)	16.6 ± 2.5 (51)	15.9 ± 2.1 (200)
7	15.8 ± 1.5 (223)	15.4 ± 1.8 (69)	16.6 ± 1.9 (134)	16.0 ± 1.8 (445)
8	16.2 ± 2.0 (297)	15.7 ± 1.8 (82)	17.0 ± 2.2 (200)	16.4 ± 2.1 (607)
9	16.2 ± 2.3 (295)	16.3 ± 2.7 (153)	17.0 ± 2.7 (275)	16.5 ± 2.6 (748)
10	17.2 ± 2.7 (384)	17.0 ± 3.2 (172)	17.9 ± 3.2 (300)	17.4 ± 3.1 (889)
11	17.3 ± 2.6 (368)	17.5 ± 3.4 (188)	18.4 ± 3.2 (418)	17.8 ± 3.1 (1 007)
12	18.1 ± 2.8 (396)	17.7 ± 2.8 (159)	18.6 ± 3.2 (470)	18.3 ± 3.1 (1 058)
13	18.3 ± 3.0 (354)	17.3 ± 2.9 (66)	19.7 ± 3.3 (214)	18.7 ± 3.3 (649)
Adjusted mean	17.1 (2 411)	16.8 (931)	18.0 (2 062)	17.4 (5 603

Table II. Body mass index of black, coloured and white girls (6 - 13 years). Values are expressed as means ± SD and sample size (*N*)

Age (years)	Black	Coloured	White	All
6	15.5 ± 1.7 (101)	15.2 ± 2.9 (57)	16.0 ± 2.2 (51)	15.5 ± 2.2 (219)
7	16.1 ± 2.2 (251)	15.7 ± 3.2 (92)	16.4 ± 2.7 (143)	16.1 ± 2.6 (500)
8	16.5 ± 2.6 (297)	16.1 ± 3.0 (75)	16.5 ± 2.8 (199)	16.5 ± 2.7 (590)
9	16.7 ± 2.8 (290)	16.4 ± 2.7 (128)	17.1 ± 2.8 (219)	16.8 ± 2.8 (647)
10	17.8 ± 3.1 (360)	17.1 ± 3.3 (132)	18.1 ± 3.4 (205)	17.7 ± 3.2 (726)
11	18.3 ± 3.3 (389)	18.1 ± 3.9 (175)	18.6 ± 3.5 (175)	18.3 ± 3.5 (757)
12	19.6 ± 3.5 (404)	18.3 ± 3.5 (173)	19.1 ± 4.0 (180)	19.1 ± 3.7 (779)
13	20.7 ± 4.1 (330)	18.2 ± 2.2 (48)	19.5 ± 2.8 (76)	20.2 ± 3.8 (462)
Adjusted mean	18.0 (2 422)	17.1 (880)	17.7 (1 248)	17.7 (4 680)

Table III. Percentage of black, coloured and white boys (6 - 13 years) classified as overweight but not obese*

Age (years)	Black			Coloured			White			All		
	25	30	*N*	25	30	*N*	25	30	*N*	25	30	*N*
6	5.3	4.3	(94)	4.8	2.4	(42)	17.6	9.8	(51)	8.0	6.0	(200)
7	4.9	1.8	(223)	7.2	2.9	(69)	17.9	3.0	(134)	9.2	2.5	(445)
8	7.1	2.0	(297)	6.1	.2	(82)	15.5	3.5	(200)	9.7	2.6	(607)
9	4.7	0.7	(295)	9.2	3.9	(153)	10.5	3.6	(275)	7.9	2.7	(748)
10	8.3	2.9	(384)	10.5	4.1	(172)	15.0	6.0	(300)	11.7	4.3	(889)
11	6.8	1.9	(368)	9.6	4.3	(188)	17.2	4.8	(418)	11.7	3.8	(1 007)
12	11.4	1.8	(396)	9.4	1.3	(159)	15.3	3.2	(470)	12.9	2.6	(1 058)
13	8.8	2.3	(354)	6.1	1.5	(66)	16.4	4.2	(214)	10.8	2.8	(649)
Adjusted mean	7.6	2.1	(2 411)	8.7	3.0	(931)	15.4	4.3	(2 062)	10.8	3.2	(5 603)

*Overweight = ≥ 25 kg/m^2 and < 30 kg/m^2 at 18 years, referred to as 25, and obese = ≥ 30 kg/m^2 at 18 years, referred to as 30, according to curves developed by Cole *et al.*[18]
Values are expressed as percentages (%) and sample size (*N*).

the shortest. When considering the height data of the boys, there was a significant interaction between age and ethnicity (F = 2.0, $p < 0.013$). This was not evident among the girls (F = 1.0, $p < 0.11$).

The mass data showed a successive increase in mass with each year among the boys (F = 418.0, $p < 0.0000001$) and girls (F = 491.9, $p < 0.0000001$), except between 6 and 7 years of age. There was a significant difference in mass between the different ethnic groups in both the boys (F = 220.9, $p < 0.0000001$) and girls (F = 73.5, $p < 0.0000001$), with the white children the heaviest and the black children the lightest in most cases.

There was a significant interaction between age and ethnic group in both the boys (F = 4.0, $p < 0.000001$) and girls (F = 2.4, $p < 0.002$). Tables of the height and weight data by gender, age and ethnic group are available on request from the authors.

Tables I and II show that BMI changed significantly with age in the boys (F = 57.0, $p < 0.0000001$) and from 9 years of age among the girls (F = 74.41, $p < 0.0000001$). The difference in BMI between ethnic groups was significant (F = 59.5, $p < 0.0000001$), with the white boys displaying the highest BMI at any given age. The group of girls also showed a significant interaction between age and ethnicity for BMI (F = 2.31, $p < 0.003684$). Initially the white girls had the highest BMI values but this trend changed after 11 years of age. A significant interaction was evident between age and ethnicity for BMI for the boys (F = 1.7, $p < 0.046534$) and the girls (F = 16.84, $p < 0.0000001$).

Tables III and IV show the percentage of children classified as overweight and obese according to the criteria of Cole *et al.*[18] using the data collected during the Health of the Nation Study, according to gender, age and ethnicity.

Table V shows the percentage of children falling above the cut-off points indicated by Cole *et al.*[18] for overweight and obesity. Since these values are defined as the percentage above the given cut-off points, the overweight cut-off includes both those children who are overweight and those who are obese. The data for the USA were calculated from information comparing different methods of overweight and obesity classification using the NHANES database.[19] That paper presented data for age and gender categories using the classification method of Cole *et al.*[18] and hence the percentages for overweight and obesity used in the present paper were calculated from these tables. The South African data have been changed into the international format by using the cut-off point for overweight, without removing the obese subjects, hence explaining the apparent conflict between the data in Tables III and IV on the one hand, and Table V on the other.

Discussion

Concern for the health of South African children has risen from an awareness of international trends in paediatric overweight and obesity coupled with the results of the National Food Consumption Survey[21] and some factors identified by the Birth to Twenty Study, the longest-running and largest longitudinal study of paediatric health and development in Africa.[22] Therefore, the need to identify the status of overweight and obesity among South African children of all ethnicities and social backgrounds is important so that effective intervention programmes can be implemented at an early stage.

The first finding from this study was that although there were a number of significant differences between the heights and weights of the children from different ethnic groupings, BMI values only displayed one difference in post-hoc analysis, namely that between 13-year-old coloured and white boys. The Birth to Twenty Study[22] showed that when children were grouped according to activity levels, the most active children weighed approximately 2 kg more and were about 3 cm taller than those children who were least active. Consequently, whether this contrast is a result of ethnic, nutritional or physical activity level differences, or a combination is unknown. Another factor to consider is that with increased age the combined percentage of overweight and obese black girls within the sample increased from 11.9% at 6 years to 21.8% at 13 years (Table IV). An opposite

Table IV. Percentage of black, coloured and white girls (6 - 13 years) classified as overweight but not obese*

Age	Black			Coloured			White			All		
(years)	25	30	*N*	25	30	*N*	25	30	*N*	25	30	*N*
6	9.9	2.0	(101)	10.5	5.3	(57)	17.6	7.8	(51)	11.9	4.1	(219)
7	8.8	4.0	(251)	12.0	7.6	(92)	17.5	7.7	(143)	11.8	5.8	(500)
8	14.1	3.4	(297)	8.0	6.7	(75)	12.6	7.5	(199)	12.9	5.4	(590)
9	9.7	4.5	(290)	11.7	2.3	(128)	16.0	4.6	(219)	12.1	4.0	(647)
10	13.6	5.3	(360)	9.8	6.1	(132)	18.0	5.9	(205)	14.0	5.4	(726)
11	12.6	4.4	(389)	14.3	5.1	(175)	17.7	4.6	(175)	14.3	4.6	(757)
12	12.6	4.0	(404)	9.2	4.0	(173)	11.7	5.0	(180)	12.7	4.2	(779)
13	14.2	7.6	(330)	4.2	0.0	(48)	13.2	1.3	(76)	12.8	5.8	(462)

*Overweight = ≥ 25 kg/m^2 and < 30 kg/m^2 at 18 years, referred to as 25, and obese = ≥ 30 kg/m^2 at 18 years, referred to as 30, according to curves developed by Cole *et al.*[18]
Values are expressed as percentages (%) and sample size (*N*).

trend was evident among the white girls (from 25.4% at 6 years to 14.5% at 13 years) (Table IV). It is postulated that these patterns may in part result from increased awareness of cultural differences with age. Mvo *et al.*[23] noted that it is often desirous for girls to be overweight within the African culture as it indicates wealth and happiness. In contrast, white girls may be more heavily influenced by the Western beauty ideal, which shuns fatness.[24] Additionally, Clark *et al.*[24] stressed that obesity and overweight within the African culture may serve to show that a person does not have HIV/AIDS. This influence is important considering the current AIDS epidemic in sub-Saharan Africa.

There are always methodological constraints when normative data from different countries are compared. Until recently, the debate over appropriate methods of classification for overweight and obesity within the paediatric population has resulted in an inability to make meaningful international comparisons.[2] Recently, internationally derived cut-off points[18] have created more meaningful classifications that can be used for comparative purposes.

The next finding was that when compared with datasets from within and before the 1980s, the South African sample displayed values much higher than those of the other countries, except for data from the USA (Table V). Datasets from other countries in the mid-1990s were closer to those of the present South African sample but were still consistently lower, with the exception of datasets from the USA. On average, South African children showed very similiar overweight and obesity values to children from the USA between 1976 and 1980, with South African boys slightly below reported USA values and South African girls slightly above. The described prevalence of overweight and obesity in the USA by 1994 was higher than in all South African groups considered. However, when split into ethnic groups, the white South African children were within less than 3% of all of the USA values for the 1988 - 1994 sample.[19] The black girls also displayed overweight and obesity values relatively close to those of girls from the USA whereas black boys were less than half as likely to be overweight as those in the USA group. This contrast follows a similar pattern to that observed within the black South African adult population.[8] An editorial released in 2002[22] indicated that less than one-third of black children were offered physical education at school. Subsequent to publication of these statistics the importance of physical education has been de-emphasised through its inclusion as a subsection of the life skills segment of the South African school curriculum, rather than being in a category of its own. This information in association with the above results shows the need to address the risks associated with modern society and increased sedentary living within the South African context as a matter of urgency, to combat any increase in the levels of overweight and obesity among South African children.

The differences observed between ethnic groups may be confounded by differences in socio-economic status. Further investigation is therefore necessary to identify whether targeted intervention strategies need to focus to a greater degree on ethnic or socio-economic differences.

Conclusion

It is evident that the South African children in this sample show relatively high levels of overweight and obesity, similar to the international patterns in developed countries of a decade ago. With increased urbanisation there is a need to assess the influences of modern society within the South African context in order to introduce suitable interventions. The levels of overweight and obesity among South African children indicated in this study are of concern both at present and for the future of South Africa.

Table V. Percentage of children in different countries, above the cut-off points for overweight and obesity*

Country and year	Per cent above cut-off point for overweight: Males	Per cent above cut-off point for overweight: Females	Per cent above cut-off for obese: Males	Per cent above cut-off for obese: Females
USA (1976 - 1980)	14.9	15.1	3.4	4.3
Netherlands (1980)	5.5	6.5	0.3	0.3
Brazil (1989)	4.7	15.2	0.1	2.0
Hong Kong (1993)	11.7	9.8	3.1	1.8
Singapore (1993)	10.5	7.0	1.7	1.0
England (1994)	9.0	13.5	1.7	2.6
Scotland (1994)	10.0	15.8	2.1	3.2
USA (1988 - 1994)	22.1	24.0	7.0	8.2
South Africa (SA) (2001 - 2004)	14.0	17.9	3.2	4.9
Black SA (2001 - 2004)	9.7	17.0	2.1	4.7
Coloured SA (2001 - 2004)	11.7	15.5	3.0	4.8
White SA (2001 - 2004)	19.7	21.1	4.3	5.6
SA demographic adjustment	10.9	17.5	2.4	4.8

*Values taken from curves created to pass through BMI of 25 and 30 kg/m^2 at age 18 (adapted from Cole *et al.*[18] Chinn and Rona[20] Flegal *et al.*[19] and Statistics South Africa[17]). Percentage above 25 kg/m^2 at age 18 gives an indication of overweight and obesity prevalence combined. Percentage above 30 kg/m^2 at age 18 is defined as obesity.

Further research should investigate the socio-economic differences within and between the different ethnic groups.

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