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The determinants of overweight and obesity among 10- to 15-year-old schoolchildren in the North West Province, South Africa – the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study

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Abstract

Aim: To investigate the determinants of overweight and obesity among 10- to 15-year-old schoolchildren in a population in the transitional phase in the North West Province of South Africa.
Methods: A cross-sectional survey was used to investigate weight status (anthropometric indicators) and determinants of overweight/obesity including dietary intake, physical activity and socio-economic status. A single, random sample ($n = 1257$), stratified for gender, type of school and ethnic group, was used. Data were collected on demographics, family circumstances, habitual physical activity, dietary intake and anthropometry to evaluate weight status and body fat content. One-way analysis of variance, the generalised linear models procedure of SAS and the Tukey *post hoc* honest significant difference test were used to analyse the data.
Results: Few children were overweight or obese (7.8%) according to International Obesity Task Force (IOTF) standards (body mass index (BMI)-for-age). These standards were compared with other accepted standard values. Both Cole's IOTF/BMI-for-age standard and the sum of skinfold thicknesses standard classified normal-weight status similarly at a level of 92% ($P < 0.01$) and were found to be useful in determining overweight/obesity. The prevalence rate was higher in females and white children, and was more apparent in urban areas, smaller households and children of parents with low- or high-income occupations. Boys and pre-menarcheal girls had mean body fat percentage in the normal/optimal range, whereas that of post-menarcheal girls was moderately high. Few variables showed a significant association with high body fat percentage: in boys, only the number of members in the household and physical activity levels over the weekend; in girls, only age. The overweight/obese boys mostly lived in smaller households, and the overweight/obese post-menarcheal girls were most inactive on both weekdays and weekends, and more overweight with increasing age.
Conclusion: Smaller households, inactivity and increasing age for girls were found to be determinants that influence the development of overweight/obesity, while female gender and age post-menarche were identified as determinants of higher body fat content. For overweight/obesity prevention, the focus should be on pre-menarcheal girls, aged 10–13 years, using these determinants to identify overweight/obesity risk. Preventive programmes should aim to increase the physical activity of children to improve their current and future weight status.

Keywords
Overweight
Obesity
Determinants
Adolescents
Dietary intake
Body mass index
Body fat percentage

Overweight and obesity are considered a rapidly growing threat to the health and well-being of populations in countries worldwide, and are emerging as a public health problem in developed countries[1–3]. The prevalence of overweight/obesity in children has doubled in the last two decades, becoming one of the most prevalent nutritional problems in the USA[4]. Similarly, there has been a rise in the prevalence of obesity among British, European and Australian children, although patterns may vary[2,5,6]. However, obesity is emerging in developed and developing countries alike; taking on the proportions of an obesity epidemic among adults and children[1,6,7]. Modern lifestyles

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(inactivity, passive overeating and/or sociocultural/economic influences) in an obesogenic environment cause an increased prevalence of obesity among children[1,2,5].

An increasing trend of chronic energy deficiency coexisting with obesity is evident in many lower-income/developing countries (China, South Africa, Vietnam, Brazil)[1,2]. Understanding the multiple interacting causes and key underlying behaviours, in many populations and a wide range of environments, is critical[1]. Population groups in the process of transition owing to urbanisation experience greater problems with dietary and activity pattern changes, resulting in higher obesity levels[8]. Early identification of children at risk in relatively diverse geographic/cultural populations through suitable determinants is essential for prevention of childhood obesity[7].

The aims of the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study were to determine overweight status according to body mass index (BMI) and body fat percentage (BF%) and to identify determinants of overweight and obesity among 10- to 15-year-old schoolchildren in a population in the transitional phase in the North West Province of South Africa.

Methodology

This research formed part of the THUSA BANA (local Setswana language, meaning 'Help the children') study. A cross-sectional survey was used to investigate the weight status of children and its determinants related to overweight/obesity, including dietary intake, physical activity levels, socio-economic status and demographic profiles. The Department of Education (DOE), North West Province granted permission to conduct this research during school hours. The Ethics Committee of the North-West University approved the study protocol.

Study sample

A single, random sample ($n = 1257$), stratified for age (10–15 years), gender (male/female), type of school (primary/secondary) and ethnic group (black, white, coloured, Indian), was drawn. The population consisted of 10- to 15-year-old school-going children in North West Province. For statistical significance, at least 100 children were required per age and gender group – a total sample of 1200 children[9]. An estimated prevalence of overweight/obesity was not taken into account in the sample size calculation, as it was unknown for this age group. The DOE supplied a list of schools ($n = 3814$) of which 44 were selected randomly from five regions in North West Province using a two-digit random number. The sample consisted of two secondary and four primary schools from traditional black schools, and one each from traditional white schools in each region. Only one secondary and two primary schools from both traditional Indian and coloured schools were included from two regions. A minimum of 60 children per ethnic group and equal numbers per age group were required to draw comparisons between groups, resulting in a planned sample of 1336 children.

Subsequently, girls and boys of each age group were randomly selected systematically in each school from class lists ($n = 1336$) to be representative of the population of North West Province. The research was conducted during school hours at the respective sampled schools after informed consent was given by the schools' headmasters, the children and their parents (information sheets and consent forms were given beforehand). The final sample comprised 1257 subjects at a response rate of 94%.

Experimental procedures and methods

Trained interviewers tested questionnaires and procedures in pilot studies using face-to-face interviews in the home language of children in different communities from those included in the main study. The research was conducted from May 2000 to June 2001. The weight status and BF% of the children and determinants related to weight status were evaluated with:

- A structured questionnaire on demographic, socio-economic, environmental and health factors.
- A multiple-pass 24-hour recall questionnaire for dietary intake data[10]. Food intakes over the previous 24 h were recorded and portion sizes were estimated with a validated photograph book[11], plastic food models and examples of food packaging materials. Children provided all information on their dietary intake themselves. Thorough checking of data throughout the data-collection phase was implemented to ensure complete datasets. Dietary intake data were tested for reproducibility and variability with a duplicate 24-hour recall on a sub-sample (289 children) and validated with a 3-day estimated-weight food record on a different sub-sample (40 children). These sub-samples were selected through convenience sampling because a high level of researcher/parent involvement was required to ensure accurate data collection on the food records. The dietary data were coded and quantified manually, computerised and analysed using a computer program (Foodfinder; Medical Research Council, 1993) based on the South African food composition tables. Data were evaluated for adequacy of energy and fat intakes only, as these would clearly indicate possible over-consumption of food (energy intakes exceeding daily requirements)[12] or possible over- or underreporting. Frequencies of foods consumed were calculated for the group as a whole and the different strata. The mean intake of each food was calculated to identify poor eating habits and poor dietary practices.
- Anthropometric measurements were done by four trained biokineticists according to standard methods

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with calibrated apparatus. Body weight (Precision electronic scale), stature (IP1465 stadiometer) and skinfold thicknesses (John Bull skinfold calliper) were measured. Overweight/obesity was classified according to BMI-for-age (International Obesity Task Force (IOTF) recommendations), weight-for-age, triceps skinfold thickness (TSF)-for-age and sum of skinfold thicknesses (SST)-for-age. To identify risk of overweight/obesity, the IOTF proposal for the absolute cut-offs defined to pass through BMI of 25 and 30 $kg\,m^{-2}$ at age 18 years (overweight, BMI $\geq 25\,kg\,m^{-2}$; obesity, BMI $\geq 30\,kg\,m^{-2}$) were used[3,9]. BF% was determined with child-specific indicators including TSF-for-age (total body fat) and subscapular skinfold thickness (SSF)-for-age (truncal fat), and assessed using the gender- and child-specific SST categories of Lohman[13].

- A standardised questionnaire regarding physical activities over the previous 24 h and one previous weekend day – the Previous Day Physical Activity Recall[14]. The previous day's activities were recalled in 30-min periods on the list of activities including type and intensity.

Quality control measures included appropriate training of interviewers, data quality checks, and correction of data before and after calculation.

Statistical analyses

The SAS System for Windows Release 8.02 TS Level 02M0 (SAS Institute, Cary, NC, USA, 1999–2001) was used to analyse the data. The FREQ (frequency) and MEANS procedures were used to describe data on demographics, dietary intake, anthropometry and physical activity. The Spearman correlation coefficient was used to assess the reproducibility of the dietary intakes measured by the initial and duplicate 24-hour recalls. The 24-hour recall data were compared with mean intakes from the 3-day food records using a paired *t*-test. Results are presented on a comparative basis between the different strata and determinants of overweight/obesity. Inferential statistics (one-way analysis of variance, the GLM (generalised linear models) procedure of SAS and the Tukey *post hoc* HSD (honest significant difference) test) were used to investigate the relationship between the variables and to identify the most important determinants of overweight/obesity in this population.

Results

Demographic data

Almost half the children lived in urban areas (formal town, city; 46.4%), about one-third in rural areas (tribal land, farm schools; 35.8%), and the remainder in informal settlements (semi-urban, self-fabricated houses; 17.8%). Most children were black (73.1%), followed by whites (15.2%), Indians (5.5%) and coloureds (mixed ancestry; 6.2%) (Table 1).

Table 1 Characteristics of the THUSA BANA children ($n = 1257$)

Characteristic	*n*	%
Age (years)		
10 (required 224)	208	16.6
11 (required 224)	223	17.7
12 (required 224)	249	19.8
13 (required 224)	194	15.4
14 (required 220)	185	14.7
15 (required 220)	198	15.8
Gender		
Boys	608	48.4
Girls	649	51.6
Race		
Black	919	73.1
White	191	15.2
Coloured	69	5.5
Indian	78	6.2
Language		
Setswana	789	62.8
Afrikaans	252	20.1
English	80	6.4
IsiXhosa	37	2.9
Sesotho	20	1.6
IsiZulu	19	1.5
Other (Pedi, Xitsonga, isiNdebele, Shangaan)	60	4.8
Stratum of urbanisation		
1 – rural	450	35.8
2 – informal settlement	224	17.8
3 – urban	583	46.4

THUSA BANA – Transition and Health during Urbanisation of South Africans (BANA, children).

Dietary intake data

The dietary intake data obtained with the 24-hour recall method were reproducible and reflected the mean energy and nutrient intakes of the children in the sample. Underreporting occurred for fibre and five micronutrients (vitamin A, folate, nicotinic acid, iron, magnesium). Overreporting occurred for two nutrients (vitamins E and C). Low fibre, vitamin A and folate levels are related to low and irregular vegetable and fruit intake (spinach, pumpkin, oranges) due to non-availability, seasonality or expensiveness. Milk, eggs, meat and enriched cereal were consumed in small quantities; sufficient to meet protein needs but too little to comply with other micronutrient needs. The boys' mean energy intake was 8013 kJ (standard deviation (SD) 3022 kJ) compared with the Recommended Dietary Allowance (RDA; 1989) of 8400 and 10 500 kJ for 7–10- and 11–14-year-old boys, respectively. Girls' mean intake was lower (7396 kJ, SD 2763 kJ) compared with the RDA (1989) of 8400 and 9240 kJ for 7–10- and 11–14-year-old girls, respectively. Fat intakes of both genders constituted 26–27% of total energy intake, which complies with the recommended guideline of 30%[15].

Anthropometric data and weight status

Most children's weight was within the normal range (92.1%, $n = 1158$). Only 7.8% ($n = 99$) were either overweight or obese. Twice as many girls were overweight/obese (10.0%) than boys (5.6%) (Table 2).

Table 2 Distribution of overweight and obesity in the THUSA BANA children

	Gender		
	Boys ($n = 608$)	Girls ($n = 649$)	Total
Overweight (BMI = 19.8–23.3 kg m^{-2})*	25 (4.1)	54 (8.3)	79 (6.3)
Obese (BMI = 24.0–29.1 kg m^{-2})*	9 (1.5)	11 (1.7)	20 (1.6)
Overweight and obese	34 (5.6)	65 (10.0)	99 (7.9)

THUSA BANA – Transition and Health during Urbanisation of South Africans (BANA, children); BMI – body mass index.
Data are presented as *n* (%).
*Gender- and age-specific BMI cut-off points corresponding to 25 and 30 kg m^{-2} at the age of 18 years[3].

The distribution of overweight and obese children was similar in all age groups, being smallest in the 11-year age group (6.7%) and largest in the 10-year (9.1%) and 15-year (9.1%) age groups. The highest prevalence of overweight/obesity was found among white children (14.2%), compared with black (7.1%), Indian (6.4%) and coloured children (2.9%) (Fig. 1). The overweight prevalence rate was twice as high in females and white children, and was also more apparent in urban areas, smaller households and children of parents with high and low incomes. Families with fewer than five members had higher incomes, more food available per person, and almost double the overweight/obesity rate (10.5%) than larger families (5.4%).

Weight status of the children (Table 3) was evaluated with the adult BMI cut-off point for overweight (>25 kg m^{-2}) to correspond with the IOTF age-specific child standard[3] of 19.8–23.3 kg m^{-2}, and the adult BMI cut-off point for obesity (>30 kg m^{-2}) to correspond with the IOTF child standard of 24.0–29.1 kg m^{-2}. Activity levels were generally low, boys being more active than girls. Overweight/obese children were always least active of all, more during the week than over weekends. The composition of the normal-weight and overweight/obese children's diets was not significantly different. Overweight/obese children consumed more fat resulting in a higher percentage energy from fat, but when the carbohydrate and fat contents of the overweight/obese and normal-weight children's diets were compared, the fat/sugar ratio ($P < 0.396$), total carbohydrate ($P < 0.145$) and added sugar ($P < 0.06245$) were not significantly different. Urban children consistently had the highest anthropometric and dietary values (BMI: 18 kg m^{-2}, SST: 23.5 mm, energy intake: 7814 kJ, total fat intake: 56 g, 27% of energy).

Body fat percentage

SST (calculated from SSF + TSF) revealed a lower mean BF% for boys, but the girls had varying BF% related to menarche (defined as onset of menstruation). Lower mean BF% was apparent for pre-menarcheal girls than for post-menarcheal girls (Fig. 2).

An optimal mean BF% was found for both the boys (14.5% vs. optimal 12–21%) and the pre-menarcheal girls (20.5% vs. optimal 15–26%), and a moderately high mean BF% for the post-menarcheal girls (26% vs. moderately high 26–35%).

Determinants of overweight and obesity

Six variables (energy intake, total fat intake, age, physical activity on weekdays and weekends, family size) were compared between the groups with normal (<25% for males, <30% for females) or high (≥25% for males, ≥30% for females) BF%[13].

Body fat content and related variables

Boys. Dietary intakes in the overfat group (BF% ≥ 25) did not show any relationship with weight status. There was also no difference in the mean age of boys with normal versus higher BF%. Overfat boys came from smaller families and were less active on weekdays and weekends, with no variation from week to weekend.

Girls. Overfat girls (BF% ≥ 30) consumed similar amounts of energy and fat, but their percentage energy intake from fat was higher, they were older, and their family size was no different from that of girls with normal

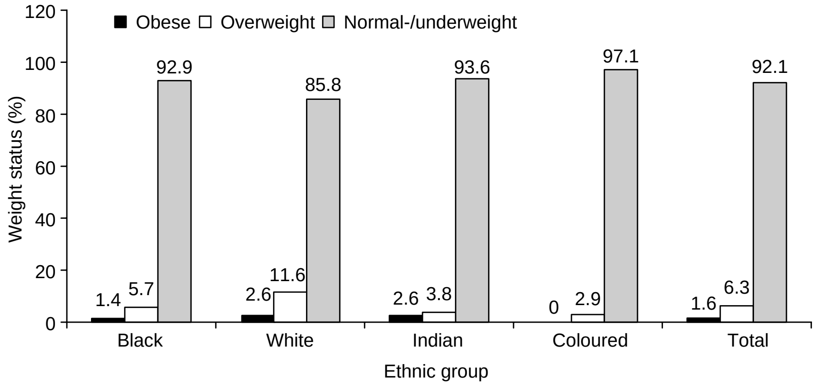

Fig. 1 Weight status of the different ethnic groups. Obese children – body mass index (BMI) = 24.0–29.1 kg m^{-2}; overweight children – BMI = 19.8–23.3 kg m^{-2}; normal-/underweight children – BMI < 19.8 kg m^{-2}

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Table 3 Descriptors of weight status and gender in the THUSA BANA children

	Weight status		Gender	
Descriptor	Normal weight ($n = 1158$)*	Overweight/obese ($n = 99$)*	Boys ($n = 604$)*	Girls ($n = 642$)*
BMI (kg m^{-2})	16.8 ± 2.3 ($n = 1147$†)	24.9 ± 3.6	16.9 ± 3.0	18.0 ± 3.5
Low activity levels (% of children)				
Week	54.4	68.3	45.5	64.9
Weekend	43.3	50.0	34.6	52.6
TSF (mm)	10.8 ± 4.9 ($n = 1147$†)	22.4 ± 9.9	9.7 ± 5.7	14.1 ± 6.8
SST (mm)	19.6 ± 9.2 ($n = 1147$†)	48.5 ± 20.4	17.5 ± 10.9	26.2 ± 13.8
Energy intake (kJ)	7706 ± 2876	7576 ± 3240	8014 ± 3022	7397 ± 2763
Total fat intake (g)	54.0 ± 32.9	56.8 ± 39.5	55.9 ± 35.4	52.7 ± 31.7
Total fat intake (% of energy)	26.7	28.5	26.5	27.1

THUSA BANA – Transition and Health during Urbanisation of South Africans (BANA, children); BMI – body mass index; TSF – triceps skinfold thickness; SST – sum of skinfold thicknesses.
Data are presented as mean ± standard deviation unless indicated otherwise.
*Sample size.
†Missing data. Some children were unable to provide all the required information or were absent from certain stations due to tests, practical classes, etc. Children from the first two schools visited were only required to give information on weekday activities, resulting in a smaller sample for physical activity on weekends.

BF%. Older post-menarcheal girls had higher BMI and BF%. Overfat girls were consistently less active, but more active on weekends than during the week.

Determinants of obesity

Stepwise regression was done with BF% (dependent variable) and all the other variables mentioned to identify possible determinants of obesity (Table 4).

Boys. The number of household members and physical activity over weekends were negatively associated with BF% in regression analysis. For overfat boys (BF% ≥ 25) only two variables (number of household members and the boys' physical activity levels over weekends) were confirmed as determinants of overweight/obesity.

Girls. In regression analysis, none of the variables significant for boys was significant for girls. Only age showed any association with BF%. For the overfat girls

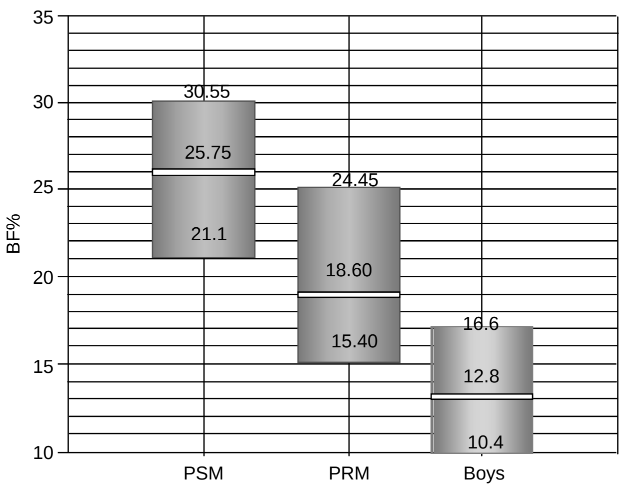

Fig. 2 Body fat percentage (BF%) ranges for post-menarcheal girls (PSM), pre-menarcheal girls (PRM) and boys

(BF% ≥ 30) only one variable (age) was confirmed as a determinant of overweight/obesity.

Discussion

Children from rural areas lived on farms or small settlements away from large cities, adhering to traditional habits and practices, not being exposed to the more obesogenic urban environments. Fewer of the determinants expected to influence the development of obesity were thus evident in these areas. However, children living in urban areas in towns/cities or informal settlements close to towns/cities were more exposed to the influences of the Western, urbanised lifestyle with an increasing prevalence of obesity. The prevalence of overweight/obesity in the THUSA BANA children corresponds with that of the South African National Food Consumption Survey (NFCS)[16] (8%), with most overweight/obese children living in urban areas. This rate is also comparable to that in other developing countries such as China (7%), Egypt (14%) and India (16%)[17,18]. A pattern emerged from the results indicating that the prevalence of overweight/obesity in children increases with age, particularly after puberty in girls. Other South African data show an increased prevalence rate of obesity in females to above 10% after the age of 15 years, thereafter constantly increasing with age and peaking at 45–54 years[19,20]. Girls just before the age of menarche should therefore be targeted for the prevention of overweight/obesity with regard to three major components: their diet, focusing on fat and energy intakes; increased participation in physical activities and sport; and behaviour therapy on lifestyle issues. Special attention should be given to food choices and eating habits and involvement in formal and informal physical activities, as most other risk factors are not easily addressed[21]. Some studies report a higher prevalence of overweight in boys[22], while others, mostly from

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Table 4 Stepwise regression with BF%* as the dependent variable

Gender group	Variable	Parameter estimate	Standard error	*F*-value	*P*-value†
Boys	Physical activity on weekends	−0.91 478	0.36 413	6.31	0.0123
Boys	Number of people in the household	−0.49 241	0.13 213	13.89	0.0002
Girls	Age	1.14 316	0.15 628	53.50	0.0001

BF% – body fat percentage.
*BF% as indicator for obesity: ≥ 25% for boys; ≥ 30% for girls.
†Significant when $P < 0.05$.

transitional countries similar to South Africa, such as India and Thailand, report a higher prevalence in girls[18,23].

Dietary intake assessment is exceptionally difficult in children as they tend to underreport their usual food intake (especially adolescents and obese individuals), and they have difficulty in quantifying foods eaten away from home[6]. Comparisons between the 24-hour recalls and the 3-day estimated-weight records revealed that under-reporting occurred for fibre and five micronutrients, thus contributing to the lack of association between the dietary intake data and the measures of obesity. Kruger *et al.*[20] also found underreporting in obese women to be a confounding factor in the weak correlation between energy and fat intakes and BMI. These children's underreporting may be ascribed to their inability to precisely recall their own food intake. Low fibre and high fat intakes are usually related to increased consumption of fast foods and snack foods[22]. In this study group snack intakes (e.g. cheese curls, sweets) were consistently high, but fast-food intakes (e.g. hamburgers) were low.

Intakes recorded with the 24-hour recall method may reflect poor intakes when less nutritious foods are consumed on the particular day or because an approximation of intake is usually given. Dietary records could have been influenced by honesty, simplifying food intake data, varied perceptions of portion sizes according to personal preference, the role of food in the meal, the type of food, and obese individuals who selectively underreport high-fat foods[24]. Adolescents quickly become bored or irritated by food-intake assessment methods, resulting in underreporting due to forgetfulness and lack of compliance[25]. The eating patterns of all of the children, however, indicated high consumption of cereal- or starch-based staple foods (maize meal, bread, rice), empty-kilojoule snack foods (cheese curls) and cold drinks, and low consumption of nutrient-dense foods (milk, meat, fruit, vegetables). High consumption of sugar-sweetened soft drinks may increase energy intake and replace nutrient-dense foods in the diet, and the high glycaemic index may stimulate overeating, contributing to weight gain[26].

Dietary intake data for the group revealed normal to low mean energy and fat intakes (26–27% of total energy), with no difference between normal-weight and overweight/obese children. These reported intakes were much lower than international review information[2]. Overweight/obesity is generally associated with increased fat intake, but Bray and Popkin[27] reported a high prevalence of overweight with low percentage energy from fat in the South African population. Kruger *et al.*[20] found a weak correlation between dietary fat intake and BMI in the THUSA study, which is similar to the poor association of dietary intake and BMI found in the present study, confirming Bray and Popkin's findings. Diet (regarding energy and fat intake) therefore does not seem to be the main cause for overweight/obesity. Low activity levels seem to be a more important determinant of obesity[24], as was found among these children.

The children's physical activity levels were higher over weekends than on weekdays. Boys were more active than girls, supporting previous research reports[6]. Both genders were least active on weekdays due to low involvement in school activities or sport and increased daily television watching. Overweight/obese children were least active at all times. These results support the increasing worldwide trend towards sedentary lifestyles leading to increased overweight prevalence among children/adolescents, possibly tracking to adulthood. Activity levels usually peak at 13–14 years, declining thereafter[6]. With such low activity levels in adolescence, the risk for overweight/obesity in adulthood is very high[6].

Data regarding urbanisation revealed no significant associations with overweight/obesity. However, a pattern emerged from the data. Urban children consumed slightly more energy and fat, and had the highest BMI, TSF and SSF values, followed by children from rural and informal areas. Compared with children from rural and informal areas, urban children had moderately high mean BF%. This finding is confirmed by NFCS data, where most overweight children in South Africa lived in formal urban areas[16]. Urban areas tend to be more obesogenic in nature, having more fast-food outlets or street hawkers selling foods with more refined carbohydrates and fatty foods to children, as was seen with the children in this research study. Children in all three areas always had low activity levels (lowest during the week), reflecting sedentary lifestyles.

When the four ethnic groups' data were compared, the prevalence of obesity was double among white children compared with black, coloured and Indian (BCI) children. White children had higher BMI, TSF and SSF values than BCI children, indicating a higher BF%. White children were most active during the week while BCI children were most active over weekends. In both groups, almost half the children lived in urban areas, but only black and coloured children lived in the informal settlements. BCI

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children's parents mostly had larger families and were employed in the informal work sector with a lower income. White children's parents were mostly self-employed or in the business sector with higher incomes and smaller families. The white, more overweight/obese children thus lived in the more obesogenic, sedentary environments, closer to fast-food outlets and other highly available energy-dense food products, where activity is discouraged by the availability of indoor recreation and travelling by vehicle.

Family size showed an association with obesity prevalence. In all ethnic groups, the highest level of overweight/obesity (double that of larger families) was found in smaller households with five or fewer family members. Also, the parents in these smaller families mostly earned higher salaries. Overweight/obesity seemed to occur in households with higher incomes. With fewer mouths to feed, the children from smaller families consumed the most energy as they had more food available per person and better access to food due to the higher income[23].

When the parent's occupations were compared with the children's weight status, overweight/obesity was prevalent in families in two occupation categories. The least overweight/obese children's parents were employed as domestic/contract workers, while more overweight/obese children's parents had professional/business occupations (higher incomes) or were self-employed in the informal sector (variable incomes). Other researchers reported a similar pattern whereby the prevalence of overweight/obesity increased when the parents were employed in the business sector, earning a higher family income compared with those working as labourers[18,23]. Dietary intakes (energy and fat) were highest for informal sector (8188 kJ, 58.6 g) and high-earning (7947 kJ, 56.6 g) professional occupations. Highest activity levels occurred in households with breadwinners as domestic or contract workers. The socio-economic level of the household is therefore linked to the occupation and income of the parents, ultimately influencing the food intake and activity patterns of a household. Children from low-income families had the lowest dietary intakes, highest activity, and thus the lowest BMI.

The overweight/obese girls with the highest BF% were older and had the lowest activity levels. The mean age of the girls in the post-menarcheal group in the four quartiles of body fat content was in the range 13.8–14.1 years, indicating that menarche occurred between the ages of 13 and 14 years. The youngest girls in this group were 10 years old, indicating that the adolescent growth spurt sometimes occurs at an earlier age, leading to earlier maturation and increased adiposity[28]. Children experiencing the adolescent growth spurt earlier are more likely to have higher BMI in early adulthood or to become heavier adults[29]. These results indicate that activity levels became lower with increasing BF% and with increasing age in the girls, confirming previous research results showing that inactivity contributes to obesity in girls[18,23]. Of all the variables, only physical activity showed a significant association and was confirmed to be a determinant of obesity in post-menarcheal girls.

Conclusion

The double burden of disease is evident in transitional communities (countries such as South Africa), where obesity and undernutrition now commonly occur simultaneously. A shift from energy deficiency to excess among older children and adolescents is evident, and relates to changes and differences in key environmental factors[30]. The present research identified some of the determinants of overweight/obesity in schoolchildren. Female gender and post-menarche age were identified as determinants of higher body fat content in adolescents. For prevention of obesity later in adolescence and even adulthood, the focus should be on pre-menarcheal girls, aged 10–13 years. Few variables showed a significant association with high BF%, but the number of members in the household (fewer), physical activity levels (low), and for girls their age showed a significant association.

As the treatment of adult obesity generally has poor results, assessment strategies should seek to identify children who are prone to overweight/obesity to prevent or address the public health problem of obesity at an earlier stage[21]. The results from this research study could be used to plan intervention programmes to increase the physical activity of schoolchildren and to improve their current and future weight status.

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