Current Research in Nutrition and Food Science Vol. **3**(3), 269-279 (2015)

Obesity Prevalence in Kenyan Children Aged 24 to 59 Months

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http://dx.doi.org/10.12944/CRNFSJ.3.3.11

(Received: November 13, 2015; Accepted: December 15, 2015)

ABSTRACT

Childhood obesity is becoming an alarming global health problem. However, the prevalence of overweight and obesity in most developing countries remain unknown due to limited data. This study aimed at assessing the prevalence of childhood obesity and underweight among Kenyan children using the internationally recommended BMI definition and to establish any association between childhood obesity and risk factors. The study addressed the following research questions; what Kenyan data are available to estimate prevalence of childhood obesity and underweight?; how has prevalence changed over time?; what do Kenyan data tell us in terms of prevalence and risk factors for obesity and underweight?; how does prevalence differ between different definitions of obesity. We used both the International Obesity Task Force (IOTF) BMI and the UK BMI definitions. Data were derived from the 1993 and 1998 Kenya Demographic and Health Surveys. The Kenya 1993 survey included 2979 subjects aged 24 to 59 months and the 1998 survey had 925 subjects aged 24 to 35 months. Differences between observed and expected prevalence for underweight, overweight and obesity relative to the UK 1990 BMI reference data were tested for significance by Chi-Squared Goodness of–fit–Test. The prevalence of underweight was significantly higher than expected relative to UK 1990 BMI definition for both 1993 and 1998 surveys. There was no significant difference in the prevalence of overweight among Kenyan children for 1993 and 1998 relative to both UK 1990 BMI and IOTF BMI definitions. There was no significant difference in obesity prevalence relative to UK 1990 and IOTF BMI definitions between 1993 and 1998 surveys (Chi-Squared Tests, $P > 0.1$). Both obesity and underweight co-exist among Kenyan children.

Key words: Obesity, Overweight, Underweight, BMI, Prevalence.

INTRODUCTION

Childhood obesity is increasingly becoming an alarming global health problem and an upward trend has been reported in both developed and developing countries[1, 2; 3, 4]. A study carried out among in Philadelphia revealed that among the 32 loci that have been associated with adult BMI, at least nine also contributed to the determination of common obesity in children[5]. However, the prevalence of childhood overweight and obesity in most developing countries remain unknown due to limited data[6, 3 4]. The emphasis in Africa has been on under-nutrition and food security rather than obesity[7]. Martello et al.,[3] suggest that there is a wealth of information from national survey data, which assess nutritional status of preschool children, which can be used to analyse the prevalence of obesity and overweight in children in developing countries. The Kenya Demographic and Health Survey 2003 data was used to establish the prevalence of overweight and obesity among preschool children in Kenya and examine the associations between childhood overweight and selected maternal and child-related factors[8].

Nutritional stunting in early childhood, which is associated with impaired fat oxidation as well as low resting metabolic rate[9] has been associated with obesity in later childhood and adulthood[10, 11]. In Africa, obesity is reported to be aggravated by nutrition and physical activity transition characterized by increased use of energy saving devices, shift to high calorie dense foods and reduced physical activity at home and school. The situation is further complicated by socio-cultural beliefs in which obesity and overweight are admired traits[12]. Close association has been shown between obesity in childhood and high blood pressure, type-2 diabetes, respiratory diseases and psychosocial disorders later in life[3, 6, 13], which calls for early intervention to reduce the impact of the epidemic.

Most expert committees and authorities have recently recommended the use of body mass index (BMI) as the criteria for defining obesity and overweight among children,[14, 15, 4, 16]. The BMI has an advantage over other methods because it is practical, consistent with adult practice, it reflects excess body fat in children, considers age and presents the smallest height bias in children and is biologically meaningful[15]. However BMI in children changes with age and there are gender differences, thus age and sex specific reference data are necessary for meaningful interpretation of the measurements. International reference data are available for global childhood obesity comparisons[17] and a number of countries have national reference data for BMI in the form of centile charts.

Kenya is a developing country with a fairly diversified economy, although agriculture is the mainstay of the economy and the major employer. Kenya's total population increased from 27.4 million in 1996 to 30.1 million in 2000; life expectancy at birth dropped from 47.7 years in 1999 to 47 years in 2000; fertility rate (total births per woman) went down from 4.7 in 1998 to 4.4 in 2000; infant mortality rate increased from 72 per 1000 in 1998 to 77.7 per 1000 in 2000; illiteracy rate among males and females declined from 14% and 29.6% in 1996 to 11.1% and 24% in 2000 respectively[18]. Kenya is undergoing economic and nutrition transition, as well high rates of urbanization and modernization [7], which are associated increase in chronic degenerative diseases such as obesity.

The present study aimed to assess the prevalence of childhood obesity and underweight in Kenya. Data from the demographic and health survey (DHS), which are currently publicly available, were used to estimate and analyse prevalence of childhood obesity in Kenya. The study aimed to address the following research questions.

1. What Kenyan data are available to estimate prevalence of childhood obesity and underweight?
2. How has prevalence changed over time?
3. What do Kenyan data tell us in terms of prevalence and risk factors for obesity and underweight?
4. How does prevalence differ between different definitions of obesity (e.g. international definition based on adult BMI,[17] compared with a national BMI reference which employs BMI e" 95th centile (e.g. UK or USA)?

MATERIALS AND METHODOLOGY

We conducted an extensive literature search for other relevant studies on childhood obesity and underweight prevalence in Kenya, Africa or other developing countries using Medline, Pub med, Embase, Cinahl, World of Science, ASSIA, the Internet, and International Bibliography of Social Sciences, from 1999 to 2010. Studies prior to this were non-existent and would not have been based on modern obesity definitions using BMI. Over twenty useful references were identified, the majority of which focussed on childhood obesity in the developing world and a few on Africa. However, as noted above, no published Kenyan data, which used BMI, were identified.

Weight-for-height Z-scores have been used for a long time for assessing and defining childhood obesity and underweight in many countries. Body mass index (BMI: weight (kg)/height (m)^2 has been internationally recommended for use in defining childhood obesity by scientific expert committees, namely, the US Expert Committee[19], the International Obesity Task Force (IOTF)[17] and the Scottish Intercollegiate Guidelines Network (SIGN)[14].

There are two main childhood obesity definitions based on BMI, the international definition

based on adult BMI and the national definitions, which are country specific. Even though many countries now have their own national BMI reference data, there is no evidence of the existence of a Kenyan based BMI reference data; and so estimating obesity prevalence for Kenyan children means using non-Kenyan reference data or the IOTF definition, which is claimed to be international[17]. For purposes of comparison, we use both the IOTF BMI cut off values as given by Cole et al[17] and the UK national BMI definitions (BMI e" 95th centile for obesity and BMI d" 5th centile for underweight[14]. The IOTF BMI reference does not give a definition of underweight and so was not used to define underweight.

The IOTF Childhood Obesity Working Group proposed a new international childhood obesity definition, which uses age and sex specific BMI cut offs that correspond to adult BMI of 25 kg/m^2 and 30 kg/m^2 at age 18 years [17, 19, 20, 14]. Consequently, IOTF international definitions of overweight and obesity for children and adolescents were published in 2000 and were derived by averaging the centiles of six countries (Brazil, Hong Kong, Netherlands, Great Britain, Singapore and US) that pass through the adult values of BMI 25 kg/m^2 and 30 kg/m^2 at age 18 years[21]

National BMI reference data for defining childhood obesity are now available in many countries. Accordingly, BMI $\geq$ 85th centile is usually defined as overweight, whereas BMI $\geq$ 95th centile is considered obese[14, 21]. The UK national reference data have an advantage of converting weight and height centiles to SD scores; the centile curves on the charts are placed equally 2/3 of an SD score apart. In the present study, BMI SD scores relative to UK 1990 reference data were used to define a Kenyan child as underweight, overweight or obese in the absence of the Kenyan reference data on BMI. A comparison for overweight and obesity prevalence is made using IOTF BMI definition.

Data for the present study were derived from the Kenya Demographic and Health Surveys of 1993 and 1998. The DHS data have been standardised into individual data files for each country as part of DHS's policy to make the data more accessible to analysts and in a convenient form for analysis. The 1993 and 1998 Kenya DHS were representative cross-sectional surveys implemented by the Government of Kenya through the National Council for Population and Development and funded by United Nations Children's Fund (UNICEF). Other available data include the 1989 Kenya DHS.

The 1993 Kenya DHS had 7532 subjects aged 0 to 59 months. After exclusion (as discussed below), 2979 subjects were eligible for analysis in the current study. The variables of interest potentially available from the survey included subject's age, gender, weight, residence and height, as well as the mother's BMI and level of education. The coding for other variables like ethnicity, and family income were not well defined in the Kenya DHS data and therefore could not be analysed.

The Kenya 1998 DHS included 3532 subjects, aged 0 to 35 months. However, after exclusion (as discussed below) only 925 of the total subjects qualified for inclusion in the current study. The 1989 survey had gaps, although it contained some basic information on the subject's anthropometric measurements. The column for family income was blank and the coding for ethnicity and residence were not clearly explained. Again, no study to date has used 1998 Kenya DHS data to assess obesity and underweight prevalence among Kenyan children.

After exclusion criteria were applied, only 2979 subjects from the 1993 and 925 subjects from the 1998 surveys qualified for inclusion in the final analysis. Subjects were excluded if they were less than two years of age; or had missing entries in their variables for age, weight and height; had questionable anthropometric measurements or BMI; or the columns contained figures described by DHS as missing, inconsistent or negative responses

The surveys contain extensive information on respondent's basic data, maternal and child health, family planning and contraceptive use, AIDS control, child anthropometrics measurements and other household and country specific data. Other variable of interest included is the level of education of the respondent. There are three main categories of educational levels coded as 0, 1, and 2. These are categorised as; no education (0), primary education (2) and secondary or higher education (1) although

the coding may differ with the education system in a country.

The DHS data are now widely being used by researchers for secondary data analysis in estimating and quantifying global and country specific obesity prevalence and trends and other research interests[22, 3, 6, 8]. Secondary data analysis has been generally recommended and described as less costly and convenient for particular researchers especially students[23]

Differences between observed and expected prevalence for underweight (≥ 5th centile, expected: 5%), overweight (≥ 85th centile, expected: 15%), and obesity (≥ 95th centile expected: 5%) relative to the UK 1990 BMI reference data were tested for significance by Chi-Squared Goodness of–fit–Test.

RESULTS

Three studies;[3, 6, 8] presented some limited information on childhood obesity and underweight prevalence in Kenya based on the 1993 and 1998 Kenya national survey and they all used weight for height (> 2 standard deviation (SD) scores) as the basis of their obesity definition. However, childhood obesity prevalence in Kenya using BMI, which is the recommended childhood obesity definition[17], was unknown.

The Kenya DHS data for 1989, 1993 and 1998 were available from the global DHS data sets for analysis. These are cross-sectional surveys conducted using standard survey instruments. The surveys included mainly women of childbearing stage (as respondents), randomly drawn from all over the country and a matching number of children. However, there were gaps (as discussed below) in the Kenya DHS data making it hard for childhood obesity prevalence and the trend over time to be assessed with confidence.

The Kenya 1989 dataset lacked the essential variables for calculating BMI and quantifying obesity and underweight among the subjects. The survey did not have any data on children's anthropometric measurements and other information relevant to the current study. Thus, we could not carry out any analysis on childhood obesity and underweight using data from this survey. This may explain why[3, 6] did not

Table 1: Prevalence of underweight, overweight and obesity among Kenyan children using the UK 1990 BMI definition: 1993 and 1998 surveys

Survey	Age range (Months)	Sample size	Underweight (≤ 5th centile)	Overweight (≥ 85th centile)	Obese (≥ 95th centile)
1993	24-59	2979	436 (14.6%)	438 (14.7%)	212 (7.1%)
1998	24-35	925	140 (15.1 %)	175 (19.0%)	92 (10.0%)

Table 2: Prevalence of underweight, overweight and obesity by gender (estimated using UK 1990 BMI definition)

Survey	Number	Underweight (≤ 5th centile)	Overweight (≥ 85th centile)	Obese (≥ 95th centile)
1993 survey				
Boys	1487	223 (15.0%)	233 (15.0%)	116 (7.8%)
Girls	1492	213 (14.2%)	205 (13.7)	64 (6.4%)
1998 survey				
Boys	462	71 (15.4%)	92 (20.0%)	55 (11.9%)
Girls	463	69 (14.9%)	83 (18.0%)	37 (8.0%)

The prevalence of underweight, overweight and obesity was not statistically significant between boys and girls for both 1993 and 1998 surveys (Chi-Squared Test, P > 0.1).

analyse childhood obesity in Kenya using the 1989 DHS data.

No data were available for family income or ethnicity. Some data were available for the 1993 and 1998 surveys for maternal level of education and place of residence. However these were not available in a form which could make them useful, and this is discussed below. As a result, no detailed analysis of risk factors was possible.

Tables 1 and 2 show the prevalence and trends of underweight, overweight and obesity and gender differences among Kenyan children based on the 1993 and 1998 DHS data using the UK 1990 BMI reference data. Tables 3 and 4 show the prevalence of overweight and obesity and gender differences estimated using the IOTF definition. Descriptive statistics of child's age, weight, height, BMI and maternal BMI and given in appendix 1 and a comparison of the prevalence of underweight, overweight and obesity by different obesity definitions is summarised in Appendix 2 and 3

The prevalence of underweight (BMI d" 5th centile relative to UK 1990 reference data) was 14.6% in 1993 and 15.1% in 1998 (Table 1). This was significantly higher than expected 5%, (Chi-Squared Tests; $P < 0.001$) from the UK 1990 BMI reference data.

We found the prevalence of overweight (BMI ≤ 85 centile relative to UK 1990 reference data was 14.7% in 1993 and 19% in 1998 (Table 1). There was no significant difference between the observed and the expected (15%) values for both 1993 and 1998 surveys (Chi–Squared Tests, $P > 0.1$).

The prevalence of obesity (BMI ≤ 95th centile relative to UK 1990 reference data) was 7.1% in the 1993 survey and 10% in the 1998 survey. There was no significant difference between the

Table 3: Prevalence of overweight and obesity among Kenyan children using the IOTF definition

Survey	Age Range (Months)	Sample size	Overweight: equivalent to BMI 25kg/m^2	Obese: equivalent to BMI 30 kg/m^2
1993	24-59	2979	265 (8.8%)	104 (3.5%)
1998	24-35	925	111(12.0%)	50 (5.4%)

Table 4: Prevalence of overweight and obesity by gender estimated using IOTF BMI definition

Survey	Number	Overweight: equivalent to BMI 25kg/m^2	Obese: equivalent to BMI 30 kg/m^2
1993 survey	2979	265	104
Boys	1487	133 (8.9%)	53 (3.6%)
Girls	1492	132 (8.8%)	51 (3.4%}
1998 survey	925	111	50
Boys	462	53 (11.5%)	29 (6.3%)[2]
Girls	463	58 (12.5%)[1]	21 (4.5%)

There was no significant difference in both overweight and obesity between boys and girls based on 1993 survey (Chi- Squared Test, $P > 0.1$).

[1] In the 1998 survey, slightly more girls (12.5%) than boys (11.5%) were overweight.

[2] Slightly more boys (6.3%) than girls (4.5%) were obese according to 1998 survey

observed and the expected prevalence for 1993 (Chi-Squared Test, P > 0.1) but obesity prevalence was significantly higher than expected for the 1998 survey (Chi–Squared Test, P < 0.05).

The prevalence of underweight, overweight and obesity was not statistically significant between boys and girls for both 1993 and 1998 surveys (Chi-Squared Test, P > 0.1).

The prevalence of overweight (equivalent to BMI 25 kg/m^2) and obesity (equivalent to BMI 30 kg/m^2) increased, from 8.8% to 12% and 3.5% to 5.4% respectively between 1993 and 1998 relative to IOTF BMI definition, but the increase was not significant (Chi-Squared Tests, P > 0.1), (Table 3).The differences between the prevalence of overweight (relative to UK 1990 BMI definition) for boys and girls in both 1993 and 1998 surveys (Table 3) were not significant (Chi–Square Test, P > 0.1).The prevalence of overweight (equivalent to BMI 25 kg/m^2) and obesity (equivalent to BMI 30 kg/m^2) increased, from 8.8% to 12% and 3.5% to 5.4% respectively between 1993 and 1998 relative to IOTF BMI definition (Chi-Squared Tests, P > 0.1), but the increase was statistically not significant (Table 3)

There was no significant difference in the prevalence of overweight (equivalent to BMI 25 kg/m^2) between boys and girls in 1993 survey (Table 4).The prevalence of obesity (equivalent to BMI 30 kg/m^2) was not different in boys than girls for both 1993 and 1998 surveys (Chi-Squared Test, P > 0.1). There was no significant difference in overweight between girls and boys according to the results of 1998 survey (Chi-Squared Test, P > 0.1).

DISCUSSION

Childhood obesity is increasingly becoming a global public health epidemic affecting both the developed and developing countries alike. Kenya is undergoing economic and nutrition transition[7, 17] characterised by changes in eating patterns, physical inactivity and increased urbanization. These changes may have a role in the current upward trends in childhood overweight and obesity incidences among Kenyan children. Further, Kenya may be faced with a double burden of disease resulting from the co-existence of underweight and obesity as suggested by the findings of the current study. In the past, the focus in Kenya, like other developing countries, has been on undernutrition[4, 7] but the trends suggested here indicate change to acknowledge the emerging high trends of childhood obesity.

The recommendation of IOTF BMI reference[24, 17] as the sole international obesity definition for clinical and epidemiological obesity assessment has been met with mixed reactions from experts, with some supporting[7, 15] and others against the idea[14, 21]. The international obesity reference data has merits, but concerns and limitations have been pointed out by[14] and[21]. For instance, a study by[21] revealed the international cut-off points exaggerate the difference in prevalence of obesity and overweight between English boys and girls. Further, as noted by Popkin (2002), previous research has shown that international standards of obesity definition may not be appropriate for some ethnic groups. However, since Kenya does not have its own national BMI definition, we were compelled to use the IOTF BMI and the British 1990 BMI definitions and the findings are quite varied although the trend in obesity prevalence within the study period is similar with either of the definitions.

We could not conduct any meaningful analysis on the association between childhood obesity and risk factors (such as family income, ethnicity, residence and education) due to insufficient explanation and definition of the coding used by the DHS. Some of the variables and their codings are said to be country specific and efforts to reach those involved in survey for clarification were fruitless. A brief description of some of the variables is given below.

Level of education is described in the DHS manual as no education, primary, secondary and higher, but the column for education had codes 0, 1 and 2, which were not well explained. Martorell et al.,[3] defined education as low (primary school or less) and high (at least one year of secondary schooling or higher) and they reported that obesity risk was significantly and positively associated with education across the developing world. It is not clear how they obtained those classifications.

Place of residence implies the place where the respondent was interviewed and is described as either urban or rural based on whether the cluster or sample point was defined as rural or urban. However, the coding of this variable is not well defined in the DHS description for Kenya and thus difficult to differentiate between urban and rural residence from the available data. In the data it was coded 1 or 2 and it is not clear which one indicated urban and rural. We then referred to other studies and found rural was coded as 2 and urban as 1. Further we found that of 2979 subjects, 2701 were categorised as rural and only 278 are from the urban areas. This gives a poor representation of the urban community where obesity is expected to be more prevalent, despite the fact that the DHS survey is claimed to be nationally representative.

Family income is a potentially important determinant of the subject's risk of underweight or obesity. Previous studies have shown an association between social economic status and obesity prevalence in the developing countries: obesity is positively correlated with increasing income[3, 8 25, 26]. However, the column for this variable in the DHS survey was blank. No analysis was therefore possible.

There was no explanation for the coding used for ethnic group, yet it would have been very useful in quantifying obesity prevalence according to different ethnic groups since Kenya is a multi-ethnic nation. No analysis was therefore possible.

Gender has been reported as a risk factor in childhood obesity in the developing countries although the findings have been contradictory. Some studies revealed a significant higher prevalence of obesity in girls than boys [3] while other studies showed significantly higher prevalence among boys than girls especially during the preschool years[27] but we found no clear evidence of either in the present study.

The prevalence of underweight (BMI < 5th centile relative to UK 1990 BMI reference data) was significantly higher than 'expected' (UK1990 reference data) for both 1993 and 1998 surveys (Chi-Squared Test, $P < 0.001$). This is in line with the World Bank report which showed an increase in cases of underweight among Kenyan children between 1998 and 2002[18]. The Kenya National Council for Population and Development[28] further estimated that underweight rose from 22% in 1998 to 23% in 2000 among Kenyan children under 5 years and suggested no improvement in the nutritional status of young children between 1993 and 1998. There was no significant difference in the prevalence of underweight between boys and girls for both 1993 and 1998 surveys in the present study (Chi-Squared Test, $P > 0.10$) although slightly more boys than girls were underweight. Again, this concurs with the report by[28] which states that both girls and boys are at equal risk of underweight and that slightly more boys than girls were stunted based on 1993 and 1998 KDHS. Our findings support an increase in overweight and obesity prevalence among Kenyan children between the study periods based on both British and IOTF BMI definitions. Obesity was significantly higher than expected (relative to UK 1990 BMI definition) based on the 1998 Kenya DHS survey. This may serve as a warning to Kenya to incorporate obesity preventive measures in its health programs. As stated earlier, both emaciation (underweight) and obesity have been found to co-exist in many African countries[17, 7; 29]. This poses a big economic strain on a country like Kenya whose health resources appear to be overstretched.

A summary of the 1993 underweight, overweight, and obesity prevalence among Kenyan children using different definitions (described earlier in the text) are given in Appendix 3. The prevalence of underweight, overweight and obesity was 14.6%, 14.7 % and 7.1% respectively relative to UK 1990 BMI definition and 6.1%, 10.2% and 2.0% respectively relative to weight- for – height (WHZ) definition used by[3]. On the other hand the prevalence of overweight was 8.8% and obesity 3.5% using the IOTF BMI definition. de Onis and Blossner [6] found the prevalence of 'overweight' to be 3.5% relative to WHZ definition, but their WHZ definition was actually identical to that used by[3]. Although Martorell found obesity not to be a serious health problem among children in the developing world, we found obesity an epidemic of Public Health concern among Kenyan children. No study, other than the current one, has analysed the Kenya 1998 DHS data for obesity and underweight prevalence.

Martorell et al.,[3] found overweight to be more prevalent in girls than boys using the WHZ definition. This may be explained by the findings of[15] who, in comparing three obesity definitions, found that obesity was consistently higher in girls than boys only when determined by WHZ. It is surprising to note that Martorell et al., and de Onis and Blossner used the same obesity definitions (WHZ), but different terminologies. Martorell et al.[3] defined overweight as SD score > 1 and 'obesity' as SD score >2 while de onis and Blossner defined 'overweight' as SD score > 2. As pointed out by[15] the prevalence and rate of underweight, overweight and obesity differ with the definition used but the trend is similar for all the definitions. Further,[14] noted that IOTF BMI definition has low sensitivity in British children and greatly underestimates obesity prevalence.

The present study used BMI definition of obesity, which is recommended by the scientific community[19, 17, 14] as the criterion obesity definition. This was the first study to estimate underweight, overweight and obesity prevalence and trends among Kenya children using the recommended BMI definition. It was also the first study to analyse obesity prevalence among Kenyan children based on both 1993 and 1998 national surveys. Using two criteria (UK 1990 BMI and IOTF BMI) to estimate underweight, overweight and obesity prevalence among Kenyan children added more weight to the study.

Our source of data, the DHS data set had some shortcomings. First, the DHS description section is a huge manual that requires patience and sufficient time to go through and understand the details contained therein. Second, the data itself contained thousands of variables and going through each cell to identify what was relevant for the present study was frustrating and time consuming. More than half of the project time was spent cleaning up the data and selecting relevant variables. At one point we had to contact other researchers who have used the same dataset for assistance in defining some codes. Some variables like education, residence, maternal education and ethnicity are not well defined and others like family income had blank columns making it difficult for any analysis to be carried out. The present study was based on secondary data analysis. We were limited since we did not participate in the baseline stages of data collection. Interpretation of some of the variables was difficult and coding posed a small problem which was partly resolved by contacting the other researchers.

The results of the present study show prevalence of underweight and obesity among Kenyan children. We found obesity and underweight co-existing among Kenyan children and this could pose a big economic strain on a country already faced by other epidemics like HIV/AIDS. The results of this study show that Kenya requires an assessment program to identify appropriate public health strategies for control and prevention of the childhood obesity epidemic among the children.

ACKNOWLEDGEMENT

I wish to thank Dr. John J Reilly for the high quality of supervision, patience and encouragement that contributed enormously to the final outcome of this project. Special thanks to Dr. Collette

Appendix 1: Descriptive statistics of child's age, weight, height, BMI and maternal BMI

	1993 Mean (StDev)	1998 Minimum	Maximum	Mean (StDev)	Minimum	Maximum
Age (years)	3.4(0.9)	2.0	4.9	2.4 (0.3)	2.0	2.9
Weight (kg)	13.1(2.7)	4.7	30.0	11.6 (2.2)	5.0	41.7
Height (M)	0.9(0.1)	0.5	2.0	0.8(0.07)	0.6	1.2
Child BMI	15.8 (2.9)	3.4	56.7	16.3 (2.8)	7.7	55.1
MaternalBMI	22.0 (3.4)	14.2	53.2	22.4 (6.9)	13.5	59.2

Lower values for 1998 may be as a result of differences in age ranges; 24-59 months for 1993 survey and 24 –35 months for 1998 survey

Appendix 2: **Differences in prevalence of overweight and obesity in 4 – 11 year old English children when the international definitions and UK national definitions are compared.**

	Prevalence 1984 (%)		Prevalence 1994 (%)		Change In Prevalence (95% CI)		Prevalence ratio (95 % CI)	
	Inter-national	UK	Inter-national	UK	Inter-national	UK	Inter-National	UK
Over-Weight								
Boys	5.4	10.2	9.0	13.8	3.6 (2.3-3.5)	3.7 (1.9-5.4)	1.66 (1.38-2.3)	1.36 (1.18-1.58)
Girls	9.3	9.1	13.5	13.5	4.1 (2.4-5.9)	4.4 (2.7-6.1)	1.44 (1.23-1.69)	1.48 (1.28-1.74)
Obese								
Boys	0.6	1.0	1.7	2.5	1.2 (0.6-1.7)	1.5 (0.8-2.1)	3.12 (1.8-5.67)	2.46 (1.61-3.82)
Girls	1.3	1.2	2.6	2.2	1.4 (0.5-2.4)	1.1 (0.4-1.7)	2.1 (1.35-3.35)	1.92 (1.26-2.99)

Source : Chinn and Rona (2002).

Appendix 3: Prevalence of underweight, overweight and obesity defined by different criteria explained in the text: 1993 DHS data

Study/definition	Sample size	Age range	% Underweight	% Overweight	% Obese
UK 1990 BMI definition[1]	2979	24–59 months	14.6	14.7	7.1
IOTF definition[2]	2979	24–59 months		8.8	3.5
Martorell(WHZ) [3]	3729	12–59 months	6.1 (emaciation)	10.2	2.0
De Onis and Blossner (WHZ)[4]	4753	0-4.99 months		3.5	

[1] UK 1990 BMI definition: Underweight $\leq 5^{th}$ centile; overweight $\geq 85^{th}$ centile; obesity $\geq 95^{th}$ centile

[2] IOTF BMI definitions: Age and sex specific cut offs that correspond to adult BMI of 25kg/m^2 (overweight) and 30kg/m^2 (obesity) at age 18years.

[3] Martorell et al (2000): Overweight and obesity defined as weight-for-height Z-scores (WHZ) > 1SD and WHZ > 2 SD respectively.

[4] De Onis and Blossner (2000): Overweight defined as WHZ > 2 SD

Montgomery and Mr A Fletcher from the Department of Human Nutrition, Glasgow University, for their input on data analysis. My sincere thanks to the following organization for funding my training: Nestle Limited, Switzerland; All Saints educational Trust, UK; Abbott Laboratories, UK; The Nutrition Society, UK

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