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Overweight and obesity in preschool children from developing countries

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OBJECTIVES: To estimate levels and trends in overweight and obesity in preschool children from developing countries; to study how overweight varies by the educational level of the mother, by urban or rural residence, and by gender; to investigate how these relationships are related to the gross national product (GNP).
DESIGN: 71 national nutrition surveys since 1986 from 50 countries were used.
SUBJECTS: 150,482 children 12 to 60 months from the most recent survey from each country were the primary sample.
MEASUREMENTS: Overweight and obesity were defined as weight-for-height (>1 or >2 s.d., respectively) of the WHO/NCHS reference curves. Stunting was <−2 s.d. of the same reference. Urban was as defined in each of the surveys and higher education was defined as at least one year of secondary schooling or higher.
RESULTS: 32 of 50 countries had a prevalence of obesity below 2.3%, the value in the reference population. The prevalences of overweight and obesity were lowest in Asia and in Sub-Saharan Africa. In 17 countries with serial data, no consistent regional trends could be detected. Overweight was more common in urban areas, in children of mothers with higher education, and in girls; these relationships did not differ by GNP but GNP was related negatively to stunting and positively to overweight.
CONCLUSIONS: Obesity does not appear to be a public health problem among preschool children in Asia and Sub-Saharan Africa. In a number of countries in Latin America and the Caribbean, the Middle East and North Africa, and the region of Central Eastern Europe/Commonwealth of Independent States, levels are as high as in the United States.
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Introduction

The world, including developing countries, is facing a global epidemic of obesity, according to a recent report from the World Health Organization.[1] However, the data to support this claim were limited and mostly derived from non-representative surveys of adults.[1] Recently, Martorell *et al*[2] analyzed data for women 15–49 y of age included in 38 nationally-representative surveys from developing countries that were carried out in the last decade. They concluded that obesity ($\geq 30\,kg/m^2$) is a serious public health problem in Latin America and the Caribbean, the Middle East and North Africa, and in the Commonwealth of Independent States. Obesity, on the other hand, is of less concern in Sub-Sahara Africa and Asia. Martorell *et al*[2] also found that obesity levels increased over time but at varying rates, and concluded that rising incomes in developing countries and increased 'westernization' will most likely lead to increased levels of obesity among women of reproductive age.

There is substantially less published information from developing countries for men than for women, even less for adolescents and school children, and least about preschool children.[1,4] On the other hand, there is a large body of data available to study obesity in preschool children. The data come from the many national surveys which have been carried out over the years which assess nutritional status in preschool children, specifically levels of underweight, stunting and wasting; this very same information can also be used to calculate weight-for-height indicators of overweight and obesity.[3] No one, to our knowledge, has systematically analyzed this type of information to assess obesity in preschool children and its variation across countries and social groups.

In this paper, we use data from 71 national nutrition surveys since 1986 from developing countries to estimate levels and trends in overweight and obesity in children 12–60 months of age. A second objective is to study how obesity varies by the educational level of the mother and by urban or rural residence. A third objective is to investigate how the economic development of the country shapes the relationship between

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obesity and education and residence. Based on the literature[5,6] and on our prior work,[2] we expect a continuum, with very poor countries showing low levels of obesity, mostly in urban areas and in children of better educated mothers, and with relatively better-off developing countries showing greater levels of obesity and a more equal distribution by categories of residence and education. Industrialized countries would be expected to have the highest levels of obesity and greater prevalences among the children of the poor and uneducated.

Methods

Seventy-one national nutrition surveys representing 50 developing countries carried out since 1986 were the focus of study. Most of the surveys were Demographic Health Surveys (DHS) in which women of childbearing age (15–49 y) were interviewed using standard survey instruments; the areas of data collection were family planning knowledge, attitudes and practices, maternal and child health, anthropometry of women (some surveys) and their children (all surveys), and social and economic background indicators.[7] DHS surveys are available to investigators through the World Wide Web [http://www.macroint.com/dhs/].

We grouped countries according to the regional classifications given in the State of the World's Children 1998.[8] The surveys available included 31 for Sub-Saharan Africa, five for the Middle East and North Africa, five for South Asia, one for East Asia, 24 for Latin America and the Caribbean and three for the region of Central Eastern Europe/Commonwealth of Independent States (CEE/CIS). Other surveys included were the 1987 National Nutrition Survey of Mexico, the 1989 National Health and Nutrition Survey of Brazil, the 1991–1992 National Epidemiology and Family Health Survey of Honduras, the 1993 National Family Health Survey of El Salvador, the 1993–1994 Living Standard Measurement Survey of Nicaragua, and the 1996 Micronutrient Survey of Honduras. Repeated surveys were available for Bolivia, Brazil, Colombia, the Dominican Republic, Egypt, El Salvador, Guatemala, Honduras, Madagascar, Mali, Nicaragua, Niger, Peru, Tanzania, Togo, Uganda and Zambia. Data from the third (1988–1994) and second (1976–1980) National Health and Nutrition Survey (NHANES) of the United States were included for comparison to the information from developing countries.

The variables of interest were children's age, height, weight, residence (urban or rural) and mothers' educational level. Only records with complete data for all variables were used. Anthropometric *Z*-scores were computed for children relative to the National Center for Health Statistics (NCHS) reference population[9,10] using the Anthropometric Software Package Tutorial Guide and Handbook.[11] Records with height-for-age, weight-for-age, or weight-for-height *Z*-scores $>+5$ or <-5 were excluded from the analyses. All surveys included children less than 12 months of age, but these were excluded from the analyses because the adequacy of the NCHS reference data for assessing the growth of infants, particularly breast-fed infants, has been called into question.[12,13] While children 12–60 months of age were selected for study, some surveys provided data only for children 12–36 months. This was not viewed as a source of bias because overweight and obesity levels were not consistently related to age between 12 and 60 months. Thus, the data reported for all countries correspond to the age range included in each. A total of 150,482 children >12 months were included in the analyses of surveys from the 50 developing countries represented, and 4112 children from the United States survey. Urban/rural was as defined in the data sets. Maternal education was coded as low (primary school or less) and high (at least 1 y of secondary schooling or higher).

Obesity in children was defined as weight-for-height *Z*-scores >2 s.d. as recommended by WHO.[6] In addition, overweight in children was defined as a *Z*-score value >1 s.d. above the WHO/NCHS mean weight-for-height. Wasting and stunting were defined as *Z*-scores more than 2 s.d. below the reference mean for weight-for-height and height-for-age, respectively. By definition, ~15.9% of cases in the reference population are overweight and ~2.3% are obese; the prevalence of either wasting or stunting in the reference population is also ~2.3%.

Sample weights were used in all cases where applicable. The analyses of relationships between weight-for-height and education or area of residence focused on overweight (>1 s.d.) because the prevalence of obesity (>2 s.d.) in children was low and statistical power consequently poor. Odds ratios for overweight (0 = no, 1 = yes) were estimated by multivariate logistic regressions that included residence (0 = rural, 1 = urban) or education (0 = low, 1 = high), gender (0 = male, 1 = female) and age in months. Odds ratios greater than 1 indicate a greater prevalence in the subgroup coded '1' (ie urban areas, high education, females) while values lower than 1 indicate the reverse. Presentation of descriptive statistics and of results from multivariate analyses was restricted to the most recent national survey when countries had more than one survey. Statistical significance was defined as $P<0.05$.

Trends for overweight in children were estimated for countries with multiple surveys. In four countries, Bolivia, Togo, Guatemala and Colombia, children 12–36 months of age were measured in the first survey and children 12–60 months of age were measured in the second survey. Restricting the second survey to 12–36 months provided similar results to those for 12–60 months. The results reported are based on data from the actual age range available in the survey.

Finally, analyses were carried out at the country level to explore whether overweight varied by the level of child stunting or the gross national product (GNP) per capita in 1992. Also, the relationship between GNP and the degree to which overweight is concentrated in urban and higher education groups was tested by correlations between GNP and the odds ratios from the multivariate models described above. Information about GNP was obtained from the State of the World's Children, 1995.[14] In the case of Comoros, the 1992 value was unavailable and instead we used the 1995 value, obtained from the State of the World's Children, 1998.[8]

Results

Sample sizes, age ranges and anthropometric characteristics of children older than 12 months are given in Table 1 for all countries, grouped by region. Growth failure was evident in all regions. Average height-for-age and weight-for-age *Z*-scores were very low in most countries, particularly in South Asia. Levels of stunting were highest in South Asia with levels over 50% in Bangladesh, India, Nepal and Pakistan. Levels of stunting were 29% or greater in all Sub-Saharan African countries and in a number of countries in other regions.

Weight-for-height *Z*-scores, on the other hand, were less negative than those for height-for-age or weight-for-age *Z*-scores, particularly in the Middle East and North Africa, the CEE/CIS region and Latin America and the Caribbean. The prevalence of wasting was highest in South Asia, followed by Sub-Saharan Africa. Mali and Niger had extremely high prevalences, 25.7% and 24.0% respectively, and Benin had nearly as much wasting as Bangladesh and India, 15.7% *vs* around 18%. Yemen in the Middle East and Uzbekistan in the CEE/CIS region had prevalences of wasting of around 12%.

Levels of obesity were below the expected value of 2.3% in 32 of 50 countries (Table 1). The highest prevalence of obesity was found in Uzbekistan, 12.5%, followed by Egypt 7.5%. Levels of overweight are shown in Figure 1 by region. Most countries were below 15.9%, the prevalence in the reference population, with the lowest values found in South and East Asia, followed by Sub-Saharan Africa. Overweight was found in over 20% of children in Egypt, Morocco, Peru and Uzbekistan. For the United States, prevalences of stunting, wasting, obesity and overweight were similar to those in the reference population.

Only 17 countries had data for two or more surveys since 1986 (Table 2). No consistent trend in these data was observed in Sub-Saharan Africa; increases were as common as decreases and absolute differences between surveys were small. In Latin America and the Caribbean, on the other hand, the results are suggestive of an increasing trend in most countries. Levels of overweight and obesity have increased in Bolivia (last two surveys), the Dominican Republic (last two surveys), El Salvador, Guatemala, Nicaragua and Peru. On the other hand, levels declined significantly in Colombia and comparisons of the last two surveys for Brazil and Honduras suggest declines.

Prevalences of overweight among children older than 12 months are given by residence, level of maternal education and gender in Table 3. There was a consistent pattern for overweight to be more common in urban areas. In 24 of 50 countries, overweight was significantly greater in urban areas, with odds ratios ranging between 1.5 and 3.5, except in Thailand where the value was 7.5. Overweight was significantly more common in rural areas in only two countries, Yemen and Pakistan, with odd ratios of 0.5 and 0.6, respectively. Overweight was also more common in children of mothers with more education. Prevalences were significantly greater in 22 of 50 countries, for the most part in those from Latin America and the Caribbean and from the Middle East and North Africa; the range in odd ratios in these countries was 1.2−2.2, except in Thailand, where the value was 6.8. In no country was overweight significantly more common in poorly educated women. Overweight was somewhat more common among girls but this was significant in only 11 of 50 countries, with a range in odds ratios between 1.1 and 2.7. Prevalences of overweight in the United States did not differ significantly by residence, maternal education or gender.

GNP was not related to the magnitude of the odds ratio for residence, level of education or gender. The correlation between GNP and the odds ratios for residence was 0.12 ($P=0.43$, $n=50$). The corresponding correlation with level of maternal education was 0.14 ($P=0.33$, $n=48$) and that with gender was −0.23 ($P=0.10$, $n=50$). The latter value suggests that as GNP increases, there is less of a tendency for overweight to be more common among girls.

GNP on the other hand, was strongly and negatively related to levels of stunting ($r=-0.71$, $P<0.0001$, $n=50$). The relationship with overweight, on the other hand, was positive but weaker $r=0.28$, $P=0.05$, $n=50$; Figure 2). Finally, levels of stunting were negatively related to those of overweight ($r=0.43$, $P<0.01$, $n=50$).

Discussion

Shetty[15] highlights the major weaknesses of previous studies: 'The absence of good nationally representative data and the lack of consistency between studies of the classification of obesity in children limits our ability to look at either the comparative prevalence or the secular trends in childhood obesity, both in developed and developing societies' (p 1). Our analyses use nationally representative data and uniform definitions of obesity recommended by the World Health Organization. While we include 71 national nutrition

Table 1 Sample sizes, age and anthropometric characteristics of children older than 12 months measured in 50 national surveys from developing countries and in the United States

Country (y)	*n*	*Age range (months)*	*Age (months)*[a]	*Height/age Z-score*[a]	*Weight/age Z-score*[a]	*Weight/height Z-score*[a]	*Percentage stunting*[b]	*Percentage wasting*[b]	*Percentage overweight*[b]	*Percentage obese*[b]	*1992 GNP*[c] *(US$)*
Sub-Saharan Africa											
Benin (1996)	1362	12–35	22.7 (6.9)	−1.5 (1.3)	−1.6 (1.1)	−0.9 (1.1)	33.5	15.7	3.6	0.8	410
Burkina Faso (1992/1993)	2712	12–59	34.2 (14.5)	−1.7 (1.4)	−1.6 (1.2)	−0.8 (1.2)	41.1	13.1	5.4	1.2	300
Burundi (1987)	1294	12–36	23.7 (7.5)	−2.0 (1.3)	−1.8 (1.0)	−0.7 (0.9)	54.4	6.8	2.8	0.3	210
Cameroon (1991)	1708	12–59	33.5 (14.2)	−1.4 (1.3)	−0.9 (1.2)	−0.1 (1.0)	31.1	3.2	12.6	1.9	820
Central African Republic (1994/1995)	1420	12–35	23.2 (7.1)	−1.8 (1.3)	−1.5 (1.1)	−0.6 (1.0)	44.7	7.3	6.0	1.2	410
Chad (1996)	4003	12–59	34.7 (14.4)	−1.9 (1.6)	−1.8 (1.3)	−0.8 (1.1)	48.2	14.0	4.6	0.9	180
Comoros (1996)	564	12–35	22.5 (7.0)	−1.7 (1.4)	−1.4 (1.2)	−0.5 (1.2)	43.6	9.4	8.3	2.3	470
Cote d'Ivoire (1994)	2110	12–35	23.2 (6.8)	−1.5 (1.3)	−1.4 (1.1)	−0.6 (1.1)	32.1	9.4	6.1	1.1	670
Ghana (1993)	1134	12–35	23.2 (6.8)	−1.5 (1.3)	−1.5 (1.2)	−0.8 (1.1)	35.5	11.9	5.1	1.2	450
Kenya (1993)	3729	12–59	34.9 (14.0)	−1.6 (1.3)	−1.3 (1.2)	−0.3 (1.1)	37.7	6.1	10.2	2.0	310
Madagascar (1997)	1774	12–35	22.3 (7.0)	−2.3 (1.3)	−2.0 (1.1)	−0.8 (0.9)	61.6	8.8	2.4	0.2	230
Malawi (1992)	2311	12–59	34.4 (14.2)	−2.2 (1.3)	−1.4 (1.2)	−0.1 (1.3)	58.3	5.6	16.5	5.2	210
Mali (1996)	2725	12–35	23.3 (7.2)	−1.7 (1.5)	−2.0 (1.2)	−1.2 (1.2)	42.6	25.7	2.9	0.6	310
Mozambique (1997)	1784	12–35	22.6 (6.6)	−1.8 (1.4)	−1.5 (1.2)	−0.5 (1.2)	47.4	9.8	10.5	2.6	570
Namibia (1992)	1752	12–59	32.3 (13.7)	−1.4 (1.3)	−1.4 (1.1)	−0.7 (1.0)	31.6	9.7	5.3	1.0	1610
Niger (1997)	2338	12–35	22.5 (7.1)	−2.2 (1.3)	−2.3 (1.1)	−1.3 (1.0)	54.9	24.0	1.5	0.3	320
Nigeria (1990)	3946	12–59	34.0 (13.9)	−1.9 (1.5)	−1.7 (1.2)	−0.6 (1.0)	49.5	9.0	4.0	0.7	320
Rwanda (1992)	3201	12–59	34.5 (14.0)	−2.1 (1.3)	−1.5 (1.0)	−0.3 (1.0)	55.2	2.9	8.7	1.3	250
Senegal (1992/1993)	2809	12–59	33.7 (13.9)	−1.4 (1.3)	−1.3 (1.1)	−0.6 (1.1)	29.3	8.7	5.8	1.0	780
Tanzania (1996)	3832	12–59	33.8 (14.2)	−2.0 (1.3)	−1.5 (1.1)	−0.4 (1.1)	49.4	7.7	8.2	1.5	110
Togo (1998)	2096	12–35	23.3 (6.7)	−1.4 (1.3)	−1.5 (1.1)	−0.9 (1.0)	30.7	14.0	3.5	0.5	390
Uganda (1995)	3142	12–47	27.5 (10.7)	−1.8 (1.4)	−1.3 (1.2)	−0.3 (1.1)	45.7	5.4	9.0	1.6	170
Zambia (1996/1997)	4135	12–59	33.5 (13.8)	−1.9 (1.3)	−1.3 (1.1)	−0.2 (1.0)	48.8	3.9	10.6	2.2	290
Zimbabwe (1994)	1308	12–35	23.6 (6.9)	−1.4 (1.2)	−1.1 (1.1)	−0.3 (1.1)	29.7	5.5	11.6	2.3	570
Middle East and North Africa											
Egypt (1995/1996)	8133	12–59	35.9 (13.5)	−1.4 (1.4)	−0.6 (1.2)	0.3 (1.2)	31.9	3.8	25.1	7.5	640
Morocco (1992)	3582	12–59	35.5 (14.0)	−1.3 (1.3)	−0.6 (1.1)	0.3 (1.1)	27.5	1.9	21.0	5.1	1030
Tunisia (1988)	1422	12–36	23.3 (6.9)	−0.9 (1.4)	−0.7 (1.1)	−0.1 (1.0)	20.7	2.3	11.7	3.1	1720
Yemen (1991/1992)	1452	12–59	31.1 (12.6)	−1.8 (1.3)	−1.5 (0.9)	−0.5 (1.2)	47.5	11.8	11.3	4.0	520
South Asia											
Bangladesh (1995/1996)	3605	12–59	35.1 (14.0)	−2.3 (1.3)	−2.2 (1.0)	−1.1 (1.0)	61.3	18.2	2.0	0.5	220
India (1992/1993)	9849	12–60	32.5 (13.0)	−2.1 (1.5)	−2.1 (1.1)	−1.1 (1.1)	55.8	18.0	3.5	1.1	310
Nepal (1996)	2415	12–35	23.0 (7.0)	−2.3 (1.2)	−2.2 (1.0)	−1.1 (0.9)	60.9	14.3	1.3	0.2	170
Pakistan (1990/1991)	2958	12–59	33.7 (13.9)	−2.2 (1.5)	−1.7 (1.2)	−0.5 (1.1)	55.3	8.9	7.4	2.6	420
Sri Lanka (1987)	1474	12–36	23.6 (7.2)	−1.5 (1.1)	−1.8 (0.9)	−1.2 (0.8)	31.7	14.8	0.8	0.1	540
East Asia											
Thailand (1987)	1352	12–36	23.3 (7.2)	−1.3 (1.1)	−1.5 (1.0)	−0.9 (0.9)	25.6	6.8	2.0	0.4	1840
Latin America and Caribbean											
Bolivia (1997)	4860	12–59	23.5 (13.3)	−1.4 (1.3)	−0.6 (1.1)	−0.4 (0.9)	30.5	0.9	22.7	4.6	680
Brazil (1996)	3165	12–59	35.4 (13.6)	−0.5 (1.3)	−0.3 (1.2)	0.1 (1.0)	11.3	2.0	14.7	4.1	2770
Colombia (1995)	3600	12–59	34.8 (13.6)	−1.0 (1.1)	−0.7 (1.0)	0.0 (0.9)	17.0	1.5	12.3	1.8	1330
Dominican Republic (1996)	2984	12–59	34.9 (13.4)	−0.6 (1.2)	−0.4 (1.2)	0.1 (1.0)	11.5	1.2	15.3	4.6	1050
El Salvador (1993)	2887	12–59	34.7 (15.5)	−1.3 (1.3)	−0.9 (1.1)	−0.1 (1.0)	25.9	1.6	9.5	1.7	1170
Guatemala (1995)	6477	12–59	34.6 (13.3)	−2.1 (1.2)	−1.4 (1.0)	−0.2 (1.0)	56.1	3.5	10.0	2.0	980
Haiti (1994/1995)	2079	12–59	35.0 (14.1)	−1.5 (1.5)	−1.4 (1.2)	−0.6 (1.1)	36.6	8.2	5.7	1.4	370
Honduras (1996)	1329	12.0–60	35.3 (14.4)	−1.6 (1.4)	−1.2 (1.1)	−0.3 (0.9)	36.9	1.1	5.1	1.4	580
Mexico (1997)	5504	12–59	35.3 (14.8)	−1.0 (1.7)	−0.8 (1.3)	−0.2 (1.3)	25.5	6.4	14.5	3.9	3470

(*continued*)

Table 1 (continued)

Country (y)	n	Age range (months)	Age (months)[a]	Height/age Z-score[a]	Weight/age Z-score[a]	Weight/height Z-score[a]	Percentage stunting[b]	Percentage wasting[b]	Percentage overweight[b]	Percentage obese[b]	1992 GNP[c] (US$)
Nicaragua (1998)	5326	12–59	35.8 (13.6)	−1.3 (1.3)	−0.8 (1.1)	0.0 (1.1)	28.2	2.1	14.3	3.3	340
Latin America and Caribbean											
Paraguay (1990)	2853	12–59	35.0 (13.4)	−0.8 (1.2)	−0.3 (1.0)	0.3 (0.8)	15.0	0.3	17.1	2.7	1380
Peru (1996)	11796	12–59	35.5 (13.3)	−1.3 (1.3)	−0.5 (1.1)	0.4 (0.9)	29.2	1.1	23.8	4.7	950
Trinidad and Tobago (1987)	618	12–36	24.0 (7.3)	−0.2 (1.1)	−0.5 (1.2)	−0.5 (1.0)	4.5	3.7	8.9	1.9	3940
Central Eastern Europe/Commonwealth of Independent States (CEE/CIS)											
Turkey (1993)	2438	12–59	35.3 (14.0)	−1.0 (1.4)	−0.7 (1.1)	−0.0 (1.0)	23.7	3.0	12.1	2.2	1980
Kazakstan (1995)	503	12–35	23.0 (6.9)	−0.9 (1.3)	−0.6 (1.2)	0.0 (1.1)	19.8	3.5	16.1	4.6	1680
Uzbekistan (1996)	632	12–35	23.3 (7.0)	−1.2 (1.9)	−0.8 (1.6)	0.0 (1.7)	35.9	11.5	24.7	12.5	850
US (1988–1994)	4112	12–59	35.7 (13.7)	0.1 (1.0)	0.1 (1.0)	0.1 (0.9)	2.1	0.5	15.3	3.1	23240

[a]Mean (s.d.).
[b]Wasting defined as >2 s.d. *below* the reference mean for weight for height; stunting defined as >2 s.d. *below* the reference mean for height for age; overweight defined as >1 and obese as >2 s.d. *above* the reference mean for weight for height.
[c]From 'The State of the World's Children 1995', UNICEF except for Comoros which is from 'The State of The World Children 1998'.

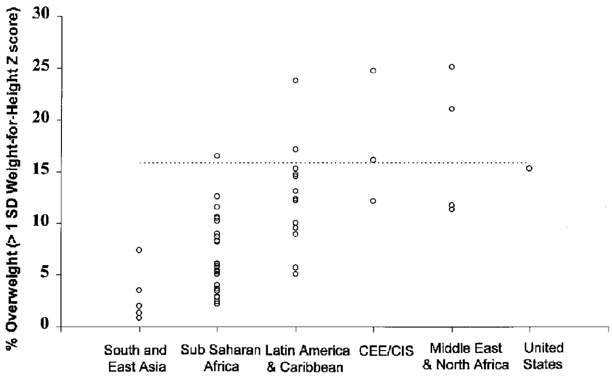


Figure 1 Percentage overweight (>1 s.d. weight-for-Height *Z*-score) in developing country regions and in the USA (hashed line marks the prevalence in the reference population, 15.9%).

surveys from the last decade representing 50 countries, certain of the regions defined by UNICEF are poorly represented. For example, surveys were not available for China and only Thailand represented East Asia.

Most of the datasets used were DHS surveys which use standard methods of data collection and of quality control. Only one of the surveys appeared to give suspicious results, that for Uzbekistan. The standard deviation for the *Z*-scores were very large, near 2, and this country had the highest prevalence of obesity but also showed a very high level of wasting. These values are not improbable, and for this reason, the data for Uzbekistan were included in the analyses; however, the unusually high level of variability can be indicative of poor data quality and these estimates should be interpreted with caution.

We based our definitions of obesity and of overweight on the distribution of weight-for-height, an indicator that is known to have several shortcomings as a measure of fatness.[16] Correlations between weight-for-height indices and measures of adiposity are significant but are lower in children than in adults.[16] A number of factors can cause systematic error in weight-for-height indicators, for example, ethnic or racial variation in body proportions, body water or bone mass could affect the interpretation of relative fatness. Trowbridge *et al*[17] have reported that Peruvian children have higher than expected total body water (as percentage body weight) and state that the high weight-for-height in these children is not obesity but is associated with lower body fat and greater lean tissue. They speculate that this may reflect dietary, environmental or genetic influences. Indeed, the highest estimates of obesity we found in Latin America were those of Peru and Bolivia, 4.7% and 4.6% respectively.

Obesity does not carry the same disease risks in children as in adults. Among adults, obesity increases the risk for many chronic conditions including diabetes mellitus, hypertension, dyslipedemia, coronary heart disease and some cancers.[18] It also increases the risk of death from coronary heart disease and diabetes melli-

Table 2 Percent of obesity and of overweight in children (≥12 months) for countries with multiple surveys

Country	1975–1980	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Obesity Changes+	Overweight Change+
Sub-Saharan Africa																
Madagascar								0.4/2.2					0.2/2.4		−0.2	+0.2
Mali			0.3/1.7									0.6/2.9			+0.3	+1.2
Niger								0.6/2.4					0.3/1.5		−0.3	−0.9
Tanzania							2.1/8.4					1.5/8.2			−0.6	−0.2
Togo				0.2/3.4										0.5/3.5	+0.3	+0.1
Uganda				1.8/10.6							1.6/9.0				−0.2	−1.6
Zambia								1.5/8.4					2.2/10.6		+0.7	+2.2
Latin American and Caribbean																
Bolivia					2.1/15.9					2.1/13.1			4.6/22.7		+2.5	+6.8
Brazil		2.6/14.8			5.2/17.5							4.1/14.7			+1.5	−0.1
Columbia		4.2/17.8									1.8/12.2				−2.4	−5.6
Dominican Republic		2.6/12.3					1.4/10.1					4.6/15.3			+2.0	+3.0
El Salvador				1.2/7.4					1.7/9.5						+0.5	+2.1
Guatemala			0.5/4.9								2.0/10.0				+1.5	+5.1
Honduras			1.3/7.4				1.0/7.4					1.4/5.1			+0.1	−2.3
Nicaragua										2.2/12.2				3.3/14.3	+1.1	+2.1
Peru								3.9/20.6				4.7/23.9			+0.8	+3.3
Other Countries																
Egypt								8.5/25.5				7.5/25.1			−1.0	−0.4
US	2.8/12.5									3.1/15.3					+1.0	+2.7

+Change is difference between most recent and oldest survey.

tus.[19–21] On the other hand, obesity is rarely an immediate and serious health concern in children; rather, its consequences among children are often psychosocial, such as low self esteem, poor peer acceptance, and low participation in social and sports activities.[22] Most important is the concern that childhood obesity continues to adulthood. The literature suggests that the influence of obesity in childhood on adult status rises as children age. For example, Serdula *et al*[23] report that the risk of adult obesity was 2.0–2.6 times greater in obese than in non-obese preschool children but to 3.9–6.5 times greater for the same comparison among older children. Whitaker *et al*[24] found that that childhood obesity was not a significant predictor of adult obesity at 1–2 y of age but that it did become a significant predictor at 3–5 y, and even a stronger one at older ages.

A concern is that the yardstick we used for measuring overweight and obesity in young children is based on statistical criteria applied to data from the United States. The cutoff points of over 1 s.d. of weight-for-height for overweight and over 2 s.d. for obesity are arbitrary and have not been validated against functional consequences as have the cutoff points used in adults.[18–20] We presume that values lower than found in the reference population decrease the likelihood that obesity is a public health problem and that higher values increase it.

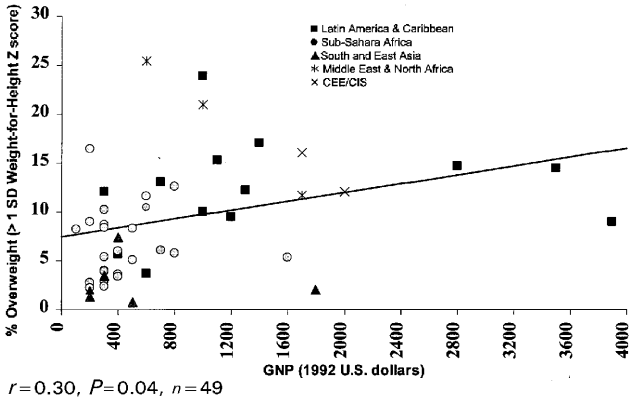
Our results therefore suggest that obesity (>2 s.d. of weight-for-height) in young children is not a public health problem in most developing countries. The prevalence of obesity in the reference population is 2.3% and that in the United States was 3.1% in 1988–1994. Out of 50 countries represented in our study, 32 had a prevalence below the reference value of 2.3%. Repeated surveys were available for 17 countries and we could not detect any trend, in either direction, in these data in Sub-Saharan Africa. In Latin America and the Caribbean, the trends were more variable. Using comparisons of the last two surveys in cases where countries had 3 surveys, six of nine countries experienced increases in levels of overweight and obesity, whereas three of nine experienced decline. Additional data are needed for more countries before definitive conclusions can be made about trends in Latin America.

There is great concern in the United States about increasing levels of obesity among adults.[25] Using the definition of overweight of a BMI ≥ 27.8 in men and ≥ 27.3 for women, the authors found that prevalences increased dramatically among adults 20–74 y of age between 1976–1980 and 1988–1991. In men, the prevalence of overweight went from 24.2% to 32.0%, and in women from 24.4% to 33.5%; these changes represented an average difference of 3.6 kg in weight between surveys. However, the increases in overweight and obesity among children 12–60 months of age were not as dramatic as in adults. Overweight in children 12–60 months was 12.5% in 1976–1980 ($n = 2878$) compared with 15.3% in 1988–1994;

Table 3 Overweight (%) in children older than 12 months by residence, and maternal education and gender in developing countries and in the United States

	Residence			*Maternal Education*			*Gender*		
Country (y)	*Urban*	*Rural*	*Odds ratio*[a]	*High*	*Low*	*Odds ratio*[a]	*Female*	*Male*	*Odds ratio*[a]
Sub-Saharan Africa									
Benin (1996)	4.2	3.4	1.3	2.9	3.7	0.8	3.2	4.0	0.8
Burkina Faso (1992/1993)	6.0	5.3	1.2	4.6	5.4	0.8	6.3	4.5	1.4*
Burundi (1987)	8.7	2.7	3.5*	5.2	2.8	1.9	3.0	2.8	1.1
Cameroon (1991)	14.6	11.1	1.4*	15.2	11.7	1.4*	12.3	12.7	1.0
Central African Republic (1994/1995)	7.4	5.3	1.4	10.8	5.6	1.7*	7.0	5.2	1.2
Chad (1996)	5.7	4.3	1.3	6.1	4.5	1.4	4.4	4.7	1.0
Comoros (1996)	8.7	8.2	1.0	12.9	7.5	1.8	6.9	9.5	0.7
Cote d'Ivoire (1994)	7.1	5.2	1.4*	8.9	5.5	2.0**	6.4	5.6	1.4
Ghana (1993)	5.6	4.9	1.1	2.9	5.3	0.5	5.9	4.3	1.4
Kenya (1993)	19.9	9.0	2.5***	11.6	9.9	1.2	10.8	9.7	1.2
Madagascar (1997)	3.8	2.0	2.0	2.5	2.4	1.1	2.3	2.4	1.0
Malawi (1992)	—[b]	—[b]	—[b]	20.1	16.4	1.3	17.0	16.0	1.1
Mali (1996)	2.9	3.0	1.0	5.1	2.8	1.9	3.1	2.8	1.2
Mozambique (1997)	9.0	11.1	0.8	12.6	10.4	1.2	10.9	10.1	1.1
Namibia (1992)	9.4	3.4	3.0***	7.9	4.0	2.1***	4.9	5.7	0.8
Niger (1997)	2.8	1.2	2.3**	4.4	1.4	3.3	1.8	1.3	1.3
Nigeria (1990)	3.5	4.2	0.8	3.4	4.1	0.8	4.0	4.0	1.0
Rwanda (1992)	8.5	8.7	1.0	12.5	8.5	1.5	9.4	7.9	1.2
Senegal (1992/1993)	6.6	5.3	1.3	7.5	5.7	1.4	5.9	5.6	1.1
Tanzania (1996)	11.9	7.6	1.7***	8.9	8.2	1.1	8.6	7.8	1.1
Togo (1998)	4.5	3.1	1.5	4.3	3.3	1.3	3.2	3.6	0.9
Uganda (1995)	9.0	9.0	1.0	9.3	8.9	1.0	9.8	8.1	1.2
Zambia (1996/1997)	9.9	11.1	0.9	11.7	10.3	1.2	11.3	10.0	1.2
Zimbabwe (1994)	17.4	9.3	2.1***	16.1	9.1	1.9***	15.1	7.9	2.1***
Middle East and North Africa									
Egypt (1995/1996)	25.7	24.6	1.1	26.8	24.2	1.2**	26.8	24.0	1.2**
Morocco (1992)	18.1	26.1	1.7***	29.9	20.1	1.7***	23.1	19.0	1.3**
Tunisia (1988)	14.7	8.6	1.8***	20.1	10.8	2.1***	12.6	11.0	1.2
Yemen (1991/1992)	7.3	13.0	0.5***	3.8	11.6	0.3	15.2	6.4	2.7***
South Asia									
Bangladesh (1995/1996)	2.9	1.9	1.5	3.6	1.7	2.2**	2.6	1.4	1.9**
India (1992/1993)	3.1	3.6	0.8	4.0	3.3	1.3	4.2	2.8	1.5***
Nepal (1996)	3.8	1.1	3.5***	1.8	1.2	1.5	1.3	1.2	1.0
Pakistan (1990/1991)	5.3	8.7	0.6***	7.2	7.5	1.0	7.8	7.1	1.1
Sri Lanka (1987)	2.3	0.6	3.7*	1.4	0.0	—[c]	1.1	0.6	1.7
East Asia									
Thailand (1987)	7.2	1.0	7.5***	7.3	1.1	6.8***	2.0	2.0	1.0
Latin America and Caribbean									
Bolivia (1997)	24.8	19.8	1.4**	24.2	21.7	1.2*	24.6	20.9	1.3***
Brazil (1996)	15.9	10.8	1.6***	17.1	11.9	1.5***	15.5	13.9	1.1
Colombia (1995)	13.9	9.4	1.6***	13.6	10.9	1.3**	13.0	11.5	1.2
Dominican Republic (1996)	19.3	10.1	2.1***	18.7	13.2	1.5***	16.7	14.1	1.2*
El Salvador (1993)	10.8	8.4	1.3*	14.0	7.8	1.9***	10.1	9.0	1.1
Guatemala (1995)	12.5	8.7	1.5***	12.8	9.5	1.4**	11.3	8.7	1.4***
Haiti (1994/1995)	6.8	5.2	1.3	7.2	5.5	1.4	6.0	5.4	1.01
Honduras (1996)	8.5	3.1	2.9***	8.2	4.5	1.9*	4.8	5.3	1.0
Mexico (1987)	15.7	14.2	1.1	17.2	13.4	1.3***	15.2	13.9	1.1
Nicaragua (1998)	15.1	13.3	1.2***	16.5	13.2	1.3***	14.3	14.2	1.0
Paraguay (1990)	17.9	16.6	1.1	17.0	17.2	1.0	17.3	17.0	1.0
Peru (1996)	28.0	17.3	1.9***	27.7	20.0	1.5***	24.9	22.8	1.1*
Trinidad and Tobago (1987)	11.2	7.5	1.6	9.9	8.1	1.2	7.0	11.1	0.6
Central Eastern Europe/Commonwealth of Independent States (CEE/CIS)									
Kazakstan (1995)	20.0	13.3	1.7*	16.1	32.9	0.5	18.2	13.9	1.4
Turkey (1993)	11.6	12.9	0.9	15.3	11.5	1.4*	12.9	11.4	1.1
Uzbekistan (1996)	35.9	20.1	2.2***	24.8	0.0	—[d]	27.0	22.6	1.2
USA (1988–1994)	15.8	14.9	0.9	14.8	20.5	0.7	16.6	14.1	1.2

[a]Odds ratios were estimated in multivariate logistic regression that included obesity (0 = no, 1 = yes) as the dependent variable and area of residence (0 = rural, 1 = urban) or educational level (0 = none or primary, 1 = 1 y of secondary or higher), gender and age. [b]The Malawi data set does not have a residence variable. [c]There were no overweight children among mothers with low education in Sri Lanka. [d]Over 99% of women report high education in Uzbekistan. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.



$r=0.30$, $P=0.04$, $n=49$

Figure 2 Relationship between overweight (>1 s.d. weight-for-height *Z*-score) in children and GNP at country level.

obesity increased from 2.8 to 3.1% over the same period. Just as in the United States, obesity levels were a greater concern in developing countries among adults, as reported by Martorell *et al*,[2] than appear to be in this study for young children.

Many changes are taking place in developing countries, which are of concern. These include the adoption of 'Western' diets, which are high in saturated fats, sugar and refined foods, and changes in lifestyle which include reduced levels of physical activity, increased use of alcohol and tobacco, and increased stress, particularly in urban areas.[26] This phenomenon has been labeled the 'Nutrition Transition' by Popkin[26] and is the probable cause of the emerging problem of obesity among adults in developing countries.[1,2] Undoubtedly, children are exposed to these influences as well, but perhaps the impact of this exposure increases with age. The acquisition of adiposity is also cumulative and overweight would be expected to rise with age; however, we did not find this to be the case over the narrow range of 12–60 months.

Our study informs us about the distribution of overweight by gender, urban/rural residence and level of maternal education. Knowing the distribution by subgroups is important for planners at country level because it helps to target interventions. We find that overweight is more common in urban areas, and to a lesser extent, in children of mothers with more education. However, GNP did not, as expected, influence these relationships. In a previous paper focusing on women 15–49 y old, obesity ($\geq 30\,kg/m^2$) was more strongly related to residence and education than was found here for preschool children[2] and these relationships were strongly dependent on GNP. In very poor countries, such as in those in Sub-Saharan Africa and South Asia, obesity among women was greatly concentrated in urban and higher educated women, whereas in more developed regions, obesity levels were more equally distributed in the general population. Given these results, it would be difficult to argue for resources for obesity programs in very poor countries but in countries such as Mexico and Brazil, one could more easily do so, given the higher levels of obesity found. Also, the fact that nearly the same percentage of women were affected in rural as in urban areas and the same or lower in poorly educated as is better educated women facilitates advocacy for such programs because all groups, rather than just the privileged, are affected. In young children, in contrast to the situation in women, the problem of obesity is of lesser magnitude, levels of overweight are weakly related to residence and education, and these relationships are not affected by GNP.

Overweight tended to be more common among girls, and this was significant in 11 of 50 countries. Among the 11 are included India and Bangladesh, with odds ratios of 1.5 and 1.9 respectively. We have no adequate explanation for the tendency for overweight to be greater in girls nor for the observation that in India and Bangladesh, where overweight is rare, it is more often found in girls. Discrimination against girls, which is said to occur in the Indian subcontinent, might have been expected to lead to less food being given to them and hence to lower rates of overweight among them.

GNP was negatively related to stunting and positively related to overweight. Does this mean that with economic development, the problem of stunting will not be eliminated without overweight and obesity rising to at least the levels found in the reference population? We lack the data to argue one way or another but the question poses a grave challenge for developing countries: eliminating malnutrition and growth failure while preventing obesity from rising.

In summary, in contrast to the situation in women, we do not believe that overweight and obesity are likely to be a public health problem among preschool children in most developing countries and particularly in Asia and Sub-Saharan Africa. However, there are countries where levels are as high as in the US and in these the causes of obesity should be investigated and the need for public health programs considered.

We speculate that overweight may be a greater issue in a greater number of countries among school age children. There is currently lack of information about school children from nationally representative surveys. Countries contemplating nutrition surveys ought to seriously consider including school age children. Also, the lack of a serious public health problem among preschool children does not mean that preventative efforts may not be directed at this age group. Quite the contrary, eating habits and tastes, as well as activity patterns, are determined early in life[27] and in countries where obesity is a growing problem among women, efforts to reach very young children with preventive interventions may be justified.

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