

ORIGINAL ARTICLE

Marked increase in the prevalence of obesity in children of the Seychelles, a rapidly developing country, between 1998 and 2004

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Abstract

Background. There are few data on overweight in children in developing countries. Such data are important to guide public health policy. We assessed trends in the prevalence of overweight and obesity in children from the Seychelles, a middle-income island state in the Indian Ocean. **Methods.** Multiple cross-sectional surveys were conducted each year between 1998 and 2004 on all students of all schools in four selected school grades (crèche, 4th, 7th and 10th years of mandatory school). Weight and height were measured and children were asked about walking time and frequency of physical exercise at leisure time. Excess weight categories were defined according to the criteria of the International Obesity Task Force (IOTF) and the U.S. Centers for Disease Control and Prevention (CDC). **Results.** Data were available for 33 340 observations in 1998–2004, corresponding to 23 459 individual children measured once or several times. Based on IOTF criteria, the prevalence of 'overweight' or 'obesity' increased from 8.7% to 13.5% in boys, and from 11.8% to 18.6% in girls from 1998 to 2004 ($P < 0.001$). The prevalence of 'obesity' increased from 2.1% to 5.2% in boys and from 3.1% to 6.2% in girls ($P < 0.001$). Using CDC criteria, the prevalence of 'at risk of overweight' and 'overweight' increased by similar proportions. The shift towards higher values over time was larger in the upper than the lower tail of the BMI distribution. Physical activity decreased over calendar years and was inversely associated with excess weight. **Conclusions.** The prevalence of excess weight increased markedly over a seven-year period in children in the Seychelles. This is likely to reflect a rapid nutrition transition with increasingly positive energy balance. These findings stress the need for programs and policies aimed at promoting physical activity and healthy nutrition in countries in epidemiological transition.

Key words: Children, overweight, obesity, physical activity, developing countries, trends

Introduction

The prevalence of obesity and overweight has increased markedly in industrialized countries over the last three decades in adults, adolescents and children (1,2). Emerging evidence suggests that the prevalence of overweight is also increasing in developing countries (1–4), often in addition to an ongoing problem of under-nutrition (5).

The obesity epidemic among children and adolescents is an important health challenge because excess weight tracks into adulthood (6), is associated with adverse health outcomes (7), and is difficult to control (1). As overweight is associated with severe

hazards (e.g. diabetes, hypertension, dyslipidemia and ultimately cardiovascular disease and some cancers), it has been projected that the epidemic of obesity among children could be responsible, at least in Western countries, for a shorter life expectancy in the current generation of children than in their parents (8). In addition, obesity is associated with psychosocial disorders and decreased quality of life (9). At a global level, the World Health Organization has placed the fight against obesity among its top priorities (10).

In developing countries, the epidemiological transition underlies a rise in non-communicable diseases and related risk factors, including overweight

(11–13). Health transition tends to parallel economic development along with a rapidly ageing population and lifestyle modification. Global marketing campaigns and unleashed trade liberalization further fuel changes in nutrition patterns, which is likely to amplify a growing overweight problem (1–4,14). This situation of a growing overweight problem, ongoing under-nutrition and limited resources emphasizes the need to gather reliable epidemiological data to guide early and appropriate preventive strategies.

In this paper, we present trends in prevalence of excess body weight and selected physical activity indicators in the Seychelles between 1998 and 2004, based on a surveillance program among school children. The Seychelles has experienced rapid socio-economic development and our findings may be of interest to other rapidly developing countries.

Methods

The Republic of the Seychelles is an archipelago located in the Indian Ocean, 1800 km east of the coast of Kenya and north of the island of Mauritius. Approximately 90% of the population lives on one island (Mahé) and most of the remaining population reside on two nearby islands. A large majority of the population is of African descent, with a mixture of minorities of European, Indian and Chinese descent. The national gross domestic product per capita grew from US\$600 in 1976 to US\$8492 in 2004 (15), paralleling booming tourism and industrial fishing industries and a growing service-oriented economy. Cardiovascular disease and AIDS account for 38% and 1%, respectively, of all deaths (15) and high levels of cardiovascular risk factors (including obesity and diabetes) have been documented in the adult population (16–18).

In the Seychelles, school nurses screen all children from four selected grades in all public and private schools as part of an ongoing school-based health program. Nearly 100% of children attend school up to the 10th grade with approximately 96% in public schools. The four grades considered in the school program are kindergarten (G0), 4th grade (G4), 7th grade (G7) and 10th grade (G10). Children can attend several surveys as they pass from crèche to G4, G7 and G10 classes. Medical data are not routinely collected for children of other grades. A signed consent by the parents is sought for all children attending the screening program and students participate on a voluntary basis. The name, date of birth and national identity number of all eligible students are extracted from an electronic database maintained by the national civil status office, which is further supplemented with school-

related variables (e.g. school, grade) by the Ministry of Education. In this study, we considered the surveys conducted between 1998 and 2004 because standard measurement equipment was available and data systematically collected into a central database since 1998.

Weight and height were measured with precision electronic scales (Seca 870, Seca, Hamburg, Germany) and fixed stadiometers (Seca 208), respectively. Children were measured without shoes and in light clothing. School nurses were regularly trained on the measurement techniques to ensure consistency over time and between schools. Weighing scales and stadiometers were checked for accuracy at regular intervals. As part of the screening, children in the upper grades (G4, G7 and G10) were asked questions about their average daily walking time to and from school (expressed in minutes per day) and frequency of leisure physical exercise outside of school (less than once per month; at least once per month but less than once per week; once per week; twice per week, and three times or more per week).

Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). 'Overweight' and 'obesity' were defined using the sex- and age-specific BMI criteria of the International Obesity Task Force (IOTF) (19). We also generated z-scores and corresponding percentiles of BMI using reference data of the US Centers for Disease Control and Prevention (CDC) (20). Children with sex- and age-adjusted percentile of BMI ranging between ≥ 85 and < 95 (corresponding to a z-score between 1.04 and 1.64) were considered as 'at risk of overweight' and children with sex- and age-adjusted BMI percentile ≥ 95 (z-score ≥ 1.64) were considered as 'overweight'. The 'at risk of overweight' and 'overweight' categories correspond reasonably well to the 'overweight' and 'obese' IOTF categories, respectively, although the IOTF criteria may provide slightly lower prevalence estimates than the CDC criteria (1,21,22).

Prevalence and standard error were calculated by sex, grade and calendar year. Trends in prevalence estimates across calendar years were tested using the Cuzick method (23). We calculated grade- and sex-specific BMI percentiles for every calendar year and we estimated the linear changes of selected percentiles (P15, P50, P85, P95) over calendar years using quantile regression, adjusting for age. The association between overweight and indicators of physical activity was examined with multivariate logistic regression. As some children were seen several times (as they passed through successive grades), overall prevalence estimates were adjusted for non-independence of repeated measurements using the 'cluster' option in Stata, based on the national identity number of students. Prevalence estimates across grades and

calendar years were adjusted to the age distribution of all observations in 1998–2004. Statistical analyses were performed with Stata 8.2. *P* values less than 0.05 were considered statistically significant.

Results

From a total of 43 259 students who attended the selected grades between 1998 and 2004, weight and height were available for 33 340 children (Table I), which was an overall participation of 77%. The 33 340 observations included 13 742 children seen once, 9224 children seen twice, 449 children seen three times, and 701 children whose national identity number was not available. Assuming that the same proportion of children were seen once, twice or three times among these 701 children as among children for whom a unique identifier was available, the 33 340 observations correspond to 23 459 individual children.

Table II shows mean age, weight, height, and BMI (\pm standard deviation) by sex and school grade, based on all observations in 1998–2004. Girls were taller than boys at G7 but boys were markedly taller than girls at G10 (for both, $P < 0.001$).

Table III shows the age-adjusted regression coefficients for percentiles of BMI over calendar years. For example, BMI corresponding to the 95th percentile increased between 1998 and 2004 by 0.36 kg/m² per calendar year in boys and by 0.26 kg/m² per calendar year in girls (for both, $P < 0.001$). An increase over time that was large for the 95th BMI percentile, moderate for 50th percentile and null for the 15th percentile indicates that the upper tail of the BMI distribution shifted to higher values over calendar years (i.e. there were more children with higher weight over time) while the lower tail did not shift (i.e. weight did not change over time for the

15% of the leanest children). It should be noted that, contrary to adults, BMI distribution cannot be easily displayed graphically (e.g. as a histogram) because values for selected BMI percentiles vary by age and sex in children. The increase over calendar years of the highest BMI percentiles (P85, P95) was larger in younger (G0, G4, G7) than older (G10) children. This suggests that weight is increasing more in younger than older children over time.

Table IV shows that the prevalence of overweight and obesity (IOTF criteria) increased over calendar years for both boys and girls (trend test: $P < 0.001$ for both) and in all grades, except for boys at G10.

Table V shows the trends in prevalence of excess weight categories according to both IOTF and CDC criteria. As expected (1,21), the prevalence of ‘at risk of overweight’ and ‘overweight’ (CDC) are slightly higher than ‘overweight’ and ‘obesity’ (IOTF), respectively. Prevalence was increasing over time in all instances, irrespective of sex or criterion used to define excess weight ($P < 0.05$ for all categories).

Table VI shows the proportion of children in G4, G7, and G10 reporting various levels of physical activity by sex, school grade and calendar year. From 1998 to 2004, the prevalence of children walking <30 minutes per day to go to/from school increased substantially in all grades and for both sexes. The prevalence of children exercising at leisure time on ≤ 1 day per week was higher in girls than boys ($P < 0.001$) and increased significantly over calendar years in most sex and grade categories. These findings demonstrate increasingly sedentary habits over time in boys and girls. Analyses based on other cut-off values or using walking time on a continuous scale showed a similar trend toward less physical activity over calendar years.

In multivariate analysis, excess weight (a combination of ‘overweight’ and ‘obese’, IOTF criteria)

Table I. Number of participants by sex, school grade and calendar year.

	1998	1999	2000	2001	2002	2003	2004	All observations
<i>Boys</i>								
G0	382	652	447	592	616	660	631	3980
G4	347	685	559	742	585	811	760	4489
G7	409	679	367	740	778	786	503	4262
G10	447	671	424	639	574	634	552	3941
Total boys	1585	2687	1797	2713	2553	2891	2446	16 672
<i>Girls</i>								
G0	342	652	427	536	565	641	572	3735
G4	314	727	557	728	579	792	714	4411
G7	398	731	349	726	778	778	516	4276
G10	385	699	517	684	664	691	606	4246
Total girls	1439	2809	1850	2674	2586	2902	2408	16 668
<i>All participants</i>	3024	5496	3647	5387	5139	5793	4854	33 340
<i>All eligible</i>	6161	6321	6465	6135	6269	6147	5761	43 259

Table II. Mean values of age, weight, height and body mass index (with SD) by sex and school grade.

	N	Age/years		Weight/kg		Height/cm		BMI/kg/m ²	
<i>Boys</i>									
G0	3980	5.5	(0.4)	19.4	(3.5)	112.8	(5.7)	15.2	(2.0)
G4	4489	9.2	(0.4)	29.5	(7.0)	133.8	(6.3)	16.3	(3.0)
G7	4262	12.5	(0.4)	42.2	(11.0)	151.8	(8.4)	18.2	(3.7)
G10	3941	15.7	(0.4)	57.7	(11.3)	169.7	(7.6)	20.0	(3.3)
<i>Girls</i>									
G0	3735	5.5	(0.4)	19.0	(3.3)	111.9	(5.8)	15.1	(2.0)
G4	4411	9.2	(0.4)	30.1	(7.8)	133.8	(6.8)	16.7	(3.4)
G7	4276	12.5	(0.4)	46.0	(11.5)	154.0	(7.2)	19.2	(4.1)
G10	4246	15.7	(0.4)	54.9	(11.9)	160.2	(6.4)	21.3	(4.2)

was associated with calendar years; low frequency of physical exercise at leisure time, and, for boys, walking for less than 30 minutes to/from school (Table VII). For example, having exercise on ≤ 1 day per week was associated with a 1.4 times (40%) greater risk of excess body weight in boys and 1.2 times (20%) greater risk in girls. The association was robust because similar associations were found using walking time as a continuous dependent variable or BMI percentiles as an independent variable.

Discussion

The main finding of this study is that the prevalence of obesity more than doubled over a short period of seven years in children of the Seychelles, a country

undergoing rapid nutritional transition. To our knowledge, this is a most rapid increase in the prevalence of pediatric obesity reported in a developing country. This finding is significant because rapid socio-economic and environmental changes, such as those taking place in the Seychelles, are also occurring in other developing countries and may lead to similarly rapid increases in pediatric obesity.

The prevalence of excess body weight in the Seychelles (overweight or obesity in 14% of boys and 19% of girls) was lower than in North America (with the prevalence of obesity of more than 30% in 1999–2002) or southern Europe (typically 25–35% in Greece, Italy, or Spain). The prevalence of obesity was similar to Western Europe (typically 15–25% in the Netherlands, UK, France and Switzerland) or

Table III. Age-adjusted regression of selected percentiles of body mass index over calendar years by sex and school grade.

School grade	Percentile	Boys			Girls		
		QRC	se	P	QRC	se	P
G0	P15	0.00	0.02	0.840	0.04	0.02	0.020
	P50	0.03	0.02	0.076	0.03	0.02	0.116
	P85	0.10	0.04	0.008	0.03	0.02	0.116
	P95	0.22	0.10	0.025	0.15	0.07	0.041
G4	P15	0.01	0.02	0.642	0.02	0.02	0.362
	P50	0.06	0.02	0.002	0.07	0.02	0.001
	P85	0.27	0.07	0.000	0.24	0.06	0.000
	P95	0.54	0.11	0.000	0.40	0.11	0.000
G7	P15	0.01	0.02	0.727	0.03	0.03	0.195
	P50	0.10	0.03	0.000	0.10	0.03	0.002
	P85	0.32	0.08	0.000	0.33	0.07	0.000
	P95	0.36	0.13	0.004	0.40	0.15	0.007
G10	P15	-0.01	0.02	0.830	-0.01	0.03	0.729
	P50	-0.03	0.02	0.183	0.08	0.04	0.021
	P85	0.08	0.06	0.223	0.15	0.08	0.050
	P95	0.23	0.19	0.210	0.01	0.15	0.971
All	P15	0.00	0.01	0.975	0.03	0.01	0.017
	P50	0.03	0.01	0.002	0.07	0.01	0.000
	P85	0.17	0.03	0.000	0.18	0.03	0.000
	P95	0.36	0.06	0.000	0.26	0.05	0.000

QRC: quantile regression coefficients; P: percentile; se: standard error.

Table IV. Prevalence (percent and standard error) of overweight and obesity by sex, grade and calendar year based on the IOTF definition.

		1998	1999	2000	2001	2002	2003	2004	P trend
<i>Boys</i>									
Overweight or obese	G0	7.6 (1.6)	8.4 (1.2)	8.7 (1.5)	7.8 (1.3)	10.9 (1.4)	11.5 (1.4)	11.7 (1.4)	0.002
	G4	8.1 (1.7)	8.9 (1.2)	11.3 (1.5)	14.0 (1.4)	11.8 (1.5)	14.8 (1.3)	14.9 (1.4)	<0.001
	G7	9.3 (1.7)	10.9 (1.3)	13.9 (2.0)	11.9 (1.3)	14.4 (1.4)	15.5 (1.4)	15.9 (1.8)	<0.001
	G10	9.8 (1.6)	7.5 (1.2)	10.4 (1.7)	9.2 (1.3)	9.1 (1.4)	12.3 (1.4)	11.6 (1.5)	0.022
Obese	G0	1.8 (1.0)	3.2 (0.8)	2.9 (1.0)	3.2 (0.9)	4.9 (1.0)	3.5 (0.9)	6.0 (1.1)	0.001
	G4	2.3 (1.1)	3.2 (0.8)	3.0 (0.9)	4.9 (0.9)	5.0 (1.1)	5.8 (0.9)	6.3 (1.0)	<0.001
	G7	2.2 (1.0)	3.5 (0.9)	5.2 (1.4)	3.9 (0.8)	3.7 (0.8)	6.1 (1.0)	4.6 (1.1)	0.014
	G10	2.2 (0.9)	2.7 (0.8)	3.1 (1.1)	2.8 (0.8)	3.1 (0.9)	3.3 (0.9)	3.8 (1.0)	0.130
<i>Girls</i>									
Overweight or obese	G0	9.4 (1.8)	12.1 (1.4)	10.1 (1.7)	11.6 (1.5)	13.6 (1.6)	13.3 (1.5)	14.2 (1.6)	0.015
	G4	12.1 (2.1)	15.4 (1.4)	17.4 (1.7)	17.2 (1.5)	18.8 (1.7)	19.7 (1.5)	20.0 (1.6)	<0.001
	G7	11.1 (1.8)	18.1 (1.5)	19.5 (2.3)	17.6 (1.5)	21.7 (1.6)	22.0 (1.6)	19.4 (1.9)	<0.001
	G10	14.5 (2.0)	17.6 (1.5)	18.2 (1.8)	16.1 (1.5)	18.1 (1.6)	20.5 (1.6)	21.0 (1.8)	0.006
Obese	G0	3.2 (1.3)	4.0 (0.9)	2.1 (0.9)	3.9 (1.0)	5.5 (1.1)	4.1 (0.9)	5.9 (1.2)	0.016
	G4	1.9 (1.1)	4.3 (0.9)	4.5 (1.1)	7.1 (1.1)	5.7 (1.1)	7.4 (1.0)	6.7 (1.1)	<0.001
	G7	3.0 (1.1)	4.9 (0.9)	3.7 (1.3)	4.8 (0.9)	5.4 (0.9)	7.2 (1.0)	6.4 (1.3)	0.002
	G10	4.4 (1.3)	5.3 (1.0)	6.0 (1.2)	4.2 (0.9)	6.2 (1.1)	5.2 (1.0)	5.6 (1.1)	0.542

IOTF: International Obesity Task Force (19).

North African and Middle Eastern countries (typically 15–20%), but higher than in China (typically around 8%) or South East Asia; and much higher than in sub-Saharan Africa (typically less than 5%), although the prevalence can be high in some areas (e.g. 25% in girls in South Africa in 2002) (1,24–27).

The prevalence of obesity more than doubled over a 7-year period in the Seychelles, with no sign of decline. In comparison, the prevalence of obesity has more than tripled in American children in the past 25 years (28); doubled in boys and increased by 50%

in girls in England over the past 6 years (29), and more than tripled between 1985 and 1995 in Australia (30). The prevalence of obesity also increased rapidly in non-Western countries. Overweight increased by 20% over a 7-year period in China (14); tripled among Brazilian children between 1974 and 1997 (13,31); tripled over a 13-year period in six-year-old children in Chile (32), and increased by six times between the ages of 11 and 12 in Singapore between 1976 and 1983 (33). More generally, our results in a rapidly developing country

Table V. Prevalence (percent and standard error) of excess weight categories by sex and calendar year, based on the IOTF or CDC definitions.

		1998	1999	2000	2001	2002	2003	2004
<i>Boys</i>								
IOTF	‘Overweight’ or ‘obese’	8.7 (0.7)	8.9 (0.5)	11.1 (0.8)	10.7 (0.6)	11.5 (0.6)	13.5 (0.6)	13.5 (0.7)
	‘Obese’	2.1 (0.4)	3.2 (0.3)	3.5 (0.4)	3.7 (0.4)	4.2 (0.4)	4.7 (0.4)	5.2 (0.4)
CDC	‘At risk’ or ‘overweight’	10.2 (0.8)	10.5 (0.6)	12.2 (0.8)	12.3 (0.6)	12.6 (0.7)	14.6 (0.7)	15.3 (0.7)
	‘Overweight’	4.7 (0.5)	4.8 (0.4)	6.3 (0.6)	6.0 (0.5)	6.4 (0.5)	7.7 (0.5)	8.2 (0.6)
<i>Girls</i>								
IOTF	‘Overweight’ or ‘obese’	11.8 (0.9)	15.8 (0.7)	16.3 (0.9)	15.6 (0.7)	18.1 (0.8)	18.9 (0.7)	18.6 (0.8)
	‘Obese’	3.1 (0.5)	4.6 (0.4)	4.1 (0.5)	5.0 (0.4)	5.7 (0.5)	6.0 (0.4)	6.2 (0.5)
CDC	‘At risk’ or ‘overweight’	11.8 (0.9)	16.1 (0.7)	16.3 (0.9)	15.9 (0.7)	18.0 (0.8)	19.2 (0.7)	19.0 (0.8)
	‘Overweight’	4.5 (0.5)	6.8 (0.5)	6.1 (0.6)	6.8 (0.5)	7.8 (0.5)	7.9 (0.5)	7.9 (0.6)
<i>All</i>								
IOTF	‘Overweight’ or ‘obese’	10.2 (0.6)	12.3 (0.4)	13.7 (0.6)	13.2 (0.5)	14.8 (0.5)	16.2 (0.5)	16.1 (0.5)
	‘Obese’	2.6 (0.3)	3.9 (0.3)	3.8 (0.3)	4.4 (0.3)	4.9 (0.3)	5.3 (0.3)	5.7 (0.3)
CDC	‘At risk’ or ‘overweight’	11.0 (0.6)	13.3 (0.5)	14.3 (0.6)	14.1 (0.5)	15.3 (0.5)	16.9 (0.5)	17.1 (0.5)
	‘Overweight’	4.6 (0.4)	5.8 (0.3)	6.2 (0.4)	6.4 (0.3)	7.1 (0.4)	7.8 (0.4)	8.0 (0.4)

‘At risk’ means ‘at risk of overweight’.

P < 0.001 for trend test for all excess weight categories.

IOTF: International Obesity Task Force (19).

CDC: Centers for Disease Control (20).

Estimates are weighted for the age distribution by grade in the total sample.

Table VI. Prevalence (percent and standard error) of categories of physical activity, by sex and calendar year.

		1998	1999	2000	2001	2002	2003	2004	P trend
<i>Boys</i>									
G4	Walk <30 min/day	46 (3)	42 (2)	39 (2)	55 (2)	64 (2)	60 (2)	66 (2)	<0.001
	Exercise ≤1/week	27 (2)	40 (2)	52 (2)	41 (2)	38 (2)	31 (2)	32 (2)	<0.001
G7	Walk <30 min/day	59 (3)	47 (2)	53 (3)	57 (2)	59 (2)	59 (2)	71 (2)	<0.001
	Exercise ≤1/week	14 (2)	31 (2)	20 (2)	15 (1)	27 (2)	17 (1)	23 (2)	0.619
G10	Walk <30 min/day	58 (2)	55 (2)	66 (3)	58 (2)	67 (2)	72 (2)	77 (2)	<0.001
	Exercise ≤1/week	15 (2)	23 (2)	31 (2)	19 (2)	22 (2)	20 (2)	30 (2)	0.003
All	Walk <30 min/day	55 (1)	48 (1)	51 (2)	57 (1)	63 (1)	63 (1)	71 (1)	<0.001
	Exercise ≤1/week	18 (1)	31 (1)	36 (1)	25 (1)	29 (1)	23 (1)	29 (1)	0.943
<i>Girls</i>									
G4	Walk <30 min/day	40 (3)	45 (2)	35 (2)	55 (2)	65 (2)	61 (2)	68 (2)	<0.001
	Exercise ≤1/week	31 (3)	46 (2)	59 (2)	50 (2)	43 (2)	39 (2)	45 (2)	0.212
G7	Walk <30 min/day	54 (3)	42 (2)	45 (3)	53 (2)	58 (2)	58 (2)	63 (2)	<0.001
	Exercise ≤1/week	31 (2)	45 (2)	33 (3)	39 (2)	47 (2)	40 (2)	47 (2)	0.001
G10	Walk <30 min/day	51 (3)	48 (2)	61 (2)	55 (2)	58 (2)	68 (2)	66 (2)	<0.001
	Exercise ≤1/week	43 (3)	49 (2)	54 (2)	48 (2)	62 (2)	47 (2)	58 (2)	<0.001
All	Walk <30 min/day	49 (2)	45 (1)	47 (2)	54 (1)	60 (1)	62 (1)	66 (1)	<0.001
	Exercise ≤1/week	35 (1)	47 (1)	50 (1)	46 (1)	51 (1)	42 (1)	50 (1)	0.001
<i>All boys and girls</i>									
	Walk <30 min/day	52 (1)	47 (1)	49 (1)	56 (1)	61 (1)	63 (1)	68 (1)	<0.001
	Exercise ≤1/week	26 (1)	39 (1)	44 (1)	35 (1)	40 (1)	32 (1)	39 (1)	0.012

'Walk' category refers to walking <30 minutes per day to go to/from school; 'Exercise' category refers to physical leisure exercise activity outside of school.

are consistent with the finding that the prevalence of overweight increases rapidly when a country's gross domestic product (GDP) is about 5000 international dollars (34).

Similar to other pediatric and adult studies of secular trends (21,30,32), the prevalence of 'obesity' in the present study increased more rapidly than the prevalence of 'overweight'. This reflects, at least partly, the mathematical fact that the 'obesity' category is not constrained on upper limits for BMI values and the increase in the prevalence of obesity over time is, therefore, unbounded.

The increasing prevalence of obesity has significant public health implications as obese children are most likely to develop complications related to excess weight. At the current prevalence of 5–6%,

obesity is rapidly becoming one of the most frequent medical conditions among children in the Seychelles and, indeed, a few obese teenagers are already receiving treatment for type 2 diabetes. As obesity is difficult to treat and data do not suggest a decline in the increasing prevalence of obesity, the burden of obesity-related diseases is likely to increase substantially over the next decades in adolescents and young adults, with subsequent additional pressure on the health system.

A challenge in many developing countries is the persistence of a problem of under-nutrition in addition to the rising prevalence of obesity (5). Although the prevalence of underweight is low in our study (data not shown), our finding that the value of the 15th BMI percentile did not change significantly over the time period of the study indicates that the proportion of children with low BMI did not decrease substantially over time. The persistence of a substantial prevalence of underweight generally points towards differences in socio-economic status (e.g. lower purchasing power in poorer segments of the population and a subsequent higher consumption of energy dense foods) or environment (e.g. urban vs. rural) (5). This underlies the need to maintain programs and policies to address the continuing problem of underweight, in addition to measures to tackle the obesity epidemic.

The increase over time in the prevalence of excess body weight was less marked among older compared with younger students. This may relate to various

Table VII. Association between excess body weight (overweight or obese, IOTF definition), calendar years and low levels of physical exercise in school children of grades G4, G7 and G10.

	Odds ratio	95% CI	P
<i>Boys</i>			
Calendar year	1.07	1.04–1.11	<0.001
Walk <30 min/day	1.13	1.00–1.27	0.047
Exercise ≤1/week	1.42	1.25–1.60	<0.001
<i>Girls</i>			
Calendar year	1.06	1.04–1.09	<0.001
Walk <30 min/day	0.95	0.86–1.04	0.263
Exercise ≤1/week	1.21	1.10–1.33	<0.001

IOTF: International Obesity Task Force (19).

factors. Figures can be biased if obese adolescents increasingly avoid participation in surveys for fear of being stigmatized in a context of increasing societal perception that overweight is undesirable (a few such cases were reported by school nurses). Alternatively, adolescents (compared with younger children) may pay increasing attention to their weight in response to peer pressure and social norms. A differential change in the prevalence of overweight at different ages has been reported. In Western Europe, overweight seemed more prevalent at the ages of 5–9 than 13–17 (1). In the US, the prevalence of pediatric obesity increased in absolute values between 1988–1994 and 1999–2000 by 7–10% at the ages of 2–5 years; by 11–15% at the ages of 6–11, and by 11–16% at the ages of 12–17 (28). In the Asian-Pacific region and South America, an inverse pattern is observed; the prevalence of overweight has increased more in adolescents than in younger children (1).

Diet in the Seychelles is still based largely on rice and fish. However, the number of points of sale of take-away food (served in fairly large portions and often including fried foods) has markedly increased over time. Furthermore, the production of carbonated soft drinks by the main manufacturer on the Seychelles has tripled in the past 25 years (data from Seychelles Breweries Ltd).

The increasing prevalence of overweight in our study is also consistent with our observed trends towards less physical activity, particularly among girls. There is indirect evidence for increasingly sedentary lifestyles in the Seychelles. TV and video viewing equipment is now found in virtually all households and video renting stores have become a flourishing business throughout the country. While the total population increased by 9% in the past 10 years, the numbers of both private cars and passengers transported by public buses have doubled in the past 10 years (data from the Licensing Authority and the Seychelles Public Transport Company, respectively), which mirrors the significant decrease in children's walking time documented in this study. However, while secular trends in decreasing physical activity are frequently mentioned as a cause of the obesity epidemic worldwide, empirical data to support this claim are scarce (35,36). The present study provides strong evidence for such a trend in a country in rapid epidemiological transition.

There are several limitations to this study. Participation varied over calendar years. However, fluctuation in participation rate was largely driven by organizational contingencies unrelated to the anthropometric variables of interest (e.g. temporary shifts of school nurses to clinical health services).

Less than perfect intra- or inter-observer reliability could occur in measurements in view of the large numbers of students and school nurses involved, despite our efforts to train the school nurses and standardize measurements. Our physical exercise questionnaire was not formally validated because no instrument has been validated for children from the Seychelles so far. Furthermore, physical activity other than walking to/from school and leisure physical activity was not measured. However, all these limitations did not change over time and they are, therefore, unlikely to have biased our findings on trends. The study also has several strengths: a design involving the entire target population, a large sample size, a high overall participation, and the same standardized methods used throughout the seven year period.

In conclusion, the escalating prevalence of obesity demonstrated in this report calls for programs and policies to promote physical activity and healthy nutrition among all children as well as ensuring that appropriate health care is provided to obese children (10,37–41). It has been suggested that failing to address the epidemic of overweight would expose current younger generations to shorter life expectancy than their parents due to increased obesity-related disease burden (9,42–44). In all countries, but perhaps even more so in developing countries, a main societal challenge will be to successfully create less obesogenic – or ‘toxic’ (45) – environments while pursuing policies aimed at increasing the comfort of the population in a context of scarce resources. This tension between progress and preservation of traditional lifestyles is further complicated by the recognition that a traditional environment is not necessarily protective of increasing obesity-related problems and, inversely, modern life is not necessarily conducive to unhealthy behavior and increased rates of non-communicable diseases (46,47). In any case, surveillance of pediatric obesity, as presented in this report, is a critical tool for monitoring the epidemiological situation at both national and international levels and for guiding intervention (48).

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