Secular and Seasonal Trends in Obesity in Chilean Preschool Children, 1996–2004

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ABSTRACT

Objectives: Chile is a unique example of the nutrition transition, with improvements in undernutrition and subsequent rapid increases in obesity occurring at a rate much faster than in other countries. This study aims to describe the cross-sectional obesity trends in Chilean preschool children from 1996 to 2004. **Materials and Methods:** Anthropometric measurements from preschool children (ages 2–5) registered in the Junta Nacional de Jardines Infantiles program from 1996 to 2004 were analysed. The weight-for-height *z* score using the World Health Organization 1977/1985 reference curves for age, sex, height, and weight were defined to estimate overweight and obesity. The overall trends in obesity were described for each study year and generalized estimating equation models were used to describe trends in obesity after adjusting for the correlated nature of repeated measurements in individual children in consecutive years.

Results: The prevalence of obese and overweight children has remained constant in both boys and girls during the past 9 years; however, after adjustment for repeated measurements in individual children, the odds of obesity increased by 30% each year (odds ratio [OR] 1.28, 95% confidence interval [CI] 1.27–1.31, $P < 0.001$). Furthermore, the odds of obesity were significantly greater in both August and November compared with March.

Conclusions: The prevalence of obesity in Chilean preschool children continues to be a major public health concern, and cross-sectional trends may underestimate the magnitude of the problem. ***JPGN 47:339–343, 2008.*** **Key Words:** Chile—Nutrition transition—Obesity—Preschool children.

The nutritional transition toward high-energy foods and sedentary lifestyles has lead to alarming increases in the prevalence of obesity in developing countries (1). Chile is a unique example of this transition because it has undergone these changes at a much faster rate than other countries in the region and around the world (2). Today, Chile is considered to be in the posttransitional phase, as is exemplified by the fact that malnutrition in children has fallen from 15.5% in 1985 to <1% in 1995, and rates of stunting (low height for age) have also declined from 10% in 1985 to 2% in 1998 (3).

Paradoxically, improvements in nutrition and modernization have led to increased consumption of energy-dense foods and an alarming increase in sedentary behaviour, causing sharp increases in the prevalence of obesity across the entire population (4). This is especially seen in preschool children, for whom the rates of obesity have nearly doubled (5). Overweight and obese children have significant health challenges during childhood, with increased rates of cardiovascular diseases (6), diabetes (7), and respiratory problems (8). In addition, obese children tend to have long-term consequences tracking into adulthood (9–12).

In Chile, national food supplementation programs are designed to promote normal growth and development in children by providing food supplements to pregnant or lactating mothers and children younger than 6 years (3). The Junta Nacional de Jardines Infantiles (JUNJI) specifically provides preschool children (ages 2–5) with 58% to 75% of their daily energy needs (13). Children registered in JUNJI usually remain in the program for a period of 2 to 3 years and are routinely assessed for anthropometric characteristics, thus providing an ideal

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population to study cross-sectional and longitudinal obesity trends. This study describes the cross-sectional obesity trends in Chilean preschool children registered in the JUNJI program from 1996 to 2004.

MATERIALS AND METHODS

Sample Population

All of the children registered with the JUNJI preschool program between 1996 and 2004 residing in the metropolitan region of Santiago, Chile, were routinely measured and weighed 3 times per year in March, August, and November. The number of children measured each month during the 9-year study period ranged from 19,082 to 29,217. In 2004 there were approximately 127,000 children registered in JUNJI; therefore, the sample in this study represents roughly 20% of all of the children enrolled in the program nationally. Children registered in the program were from low- and middle-income families, and therefore were not representative of all of the preschool children in Chile.

Anthropometric Measurements

Classroom teachers were instructed by a nutritionist from JUNJI in how to measure weight and height and how to collect general demographic information based on a standard protocol (14). Weight was recorded to the nearest 0.1 kg using a Seca model 720 scale (Seca, Hamburg, Germany) and height to the nearest 0.1 cm using the stadiometer that is incorporated into the scale. Children were measured with light clothes and without shoes. Scales are calibrated once per week and children were weighed during the morning hours.

In 1992, the Chilean Ministry adopted the National Centre for Health Statistics/World Health Organization 1977 reference and weight-for-height index as the official criteria to evaluate the nutritional status of preschool children both in terms of undernutrition and overnutrition (15). The NutStat program within EPI Info 2000 (Centers for Disease Control and Prevention [CDC], Atlanta, GA) was used to evaluate the nutritional status of children using the CDC/World Health Organization 1977/1985 reference curves for age, sex, height, and weight. Children with a weight-for-height z score ≥ 2 were considered obese and children with a weight-for-height z score score less than 2 but greater than 1 were considered overweight.

For comparison, body mass index (BMI) was calculated as weight (kilograms) divided by height (centimetres) squared. The CDC 2000 reference was used to calculated age- and sex-adjusted centiles. Children with a BMI greater than or equal to the 95th centile were classified as obese, and children with a BMI greater than the 85th centile but less than the 95th centile were classified as overweight.

Exclusion Criteria

Children were excluded from analysis if they were younger than 2 or older than 5 years of age at the beginning of the school year in March (~6%–10%), or if their sex, date of birth, or date of measurement was not recorded. Children with height-for-age and weight-for-age values outside ±3.5 standard deviations (SDs) from reference values also were excluded (~2%) because they were considered to be potential errors in measurement or data entry.

Data Analysis

After anthropometric indices were calculated, data were transferred into Stata 8.2 (Stata, College Station, TX) for further analysis. The overall secular trends in obesity were described for each study year based on measurements taken in March (the beginning of the school year). Generalized estimating equation models were used to describe longitudinal obesity trends and to account for the correlated nature of the repeated measurements in individual children. Age and sex trends also were examined within each model.

The use of these data for this study was approved by the London School of Hygiene and Tropical Medicine ethics committee and permission to use these routinely collected data was obtained from the JUNJI program.

RESULTS

After exclusion criteria were applied, 10,246 children measured on 96,776 occasions were included in the analyses. On average, children attended the JUNJI program for 2 years (range 1–4) and were measured 5 times (range 1–13). The majority of children enrolled in the JUNJI program were either 3 or 4 years of age at the beginning of the school year in March; the mean age of the study population was 43 months (±9.04 SD). Roughly an equal number of males and females were measured.

Cross-sectional Trends

The prevalence of obese and overweight children has remained constant in both boys and girls during the past 9 years (Table 1), with the prevalence consistently greater in girls (odds ratio [OR] 1.26, 95% confidence interval [CI] 1.16–1.37). The prevalence of obesity also increased as age increased (OR 1.04, 95% CI 1.038–1.047) (Fig. 1). During the 9-year study period, the odds of obesity increased by approximately 10% each year (test for trend OR 1.08, 95% CI 1.07–1.09, $P < 0.001$). Cross-sectional analysis of the prevalence of obesity in each school year showed a consistent peak in August of each year (Fig. 2), during the winter season.

Longitudinal Trends

After adjustment for the correlated nature of repeated measurements in individual children, the odds of obesity increased by 30% each year (OR 1.28, 95% CI 1.27–1.31, $P < 0.001$). The odds of obesity peaked in August, but also were significantly greater in November compared with March (Table 2). Age and sex trends were similar after adjustment for repeated measurements. The time-series

TABLE 1. *Cross-sectional prevalence (%) of obese and overweight preschool children measured in March each year*

	N	Obese WHZ ≥2	Overweight ≥1 WHZ <2	Obese BMI ≥95%	Overweight ≥85% BMI <95%
1996	19,423	8.25	22.20	15.67	21.09
1997	20,417	8.54	22.17	15.55	20.81
1998	19,372	9.11	22.34	16.31	21.27
1999	21,144	8.68	22.17	15.67	20.90
2000	21,423	8.97	23.19	15.68	22.00
2001	21,722	9.41	23.11	16.39	21.87
2002	22,516	8.96	22.28	15.87	21.02
2003	24,410	9.19	22.81	16.25	21.51
2004	25,013	9.15	22.90	16.35	21.64
Girls					
1996	9,245	9.38	23.81	15.67	21.09
1997	9,759	9.81	23.20	15.55	20.81
1998	9,395	10.32	23.54	16.31	21.27
1999	10,255	10.02	23.47	15.67	20.90
2000	10,304	9.81	24.52	15.68	22.00
2001	10,427	10.49	24.54	16.59	21.87
2002	10,785	9.85	24.02	15.87	21.02
2003	11,790	10.19	24.24	16.25	21.51
2004	12,156	10.09	24.12	16.35	21.64
Boys					
1996	10,178	7.23	20.73	15.50	18.32
1997	10,658	7.38	21.23	15.74	18.11
1998	9,977	7.98	21.22	16.60	18.44
1999	10,889	7.42	21.24	15.35	18.29
2000	11,119	8.19	21.95	17.0	18.11
2001	11,295	8.42	21.80	17.7	18.39
2002	11,731	8.15	20.68	15.87	17.71
2003	12,620	8.26	21.48	16.78	18.20
2004	12,857	8.26	21.74	16.91	18.64

WHZ = weight-for-height *z*-score;BMI = body mass index.
Obesity and overweight were defined using 2 indicators (WHZ ≥2 and BMI ≥95%). BMI classified more children as obese. WHZ defined using 1977/1985 World Health Organization reference. BMI defined using 2000 Centers for Disease Control and Prevention reference.

analysis also demonstrated a trend toward slightly lower odds of obesity in more recent years (Table 2).

DISCUSSION

Despite the fact that the prevalence of obesity has remained relatively constant during the past 9 years, there is still overwhelming evidence that suggests both overweight and obese preschool children pose a significant challenge for health care professionals in Chile.

Longitudinal assessment of obesity in preschool children demonstrated that cross-sectional surveys underestimated the prevalence of obesity. The longitudinal analysis also highlights that individual children gain weight throughout each year and in consecutive years.

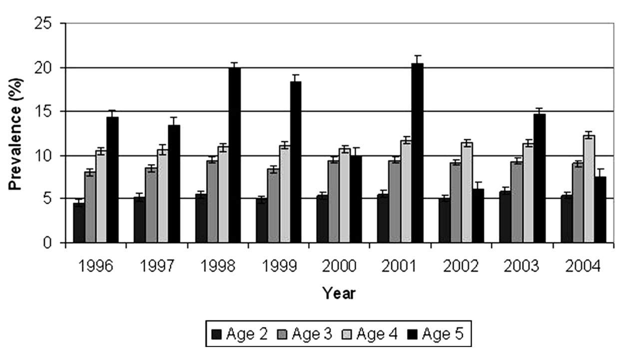

FIG. 1. Cross-sectional obesity trends with age, defined by weight-for-height *z* score ≥2 standard deviations using the 1977/1985 World Health Organization reference. All of the measurements were made at the beginning of the school year in March. The prevalence of obesity increases with increasing age (odds ratio 1.04, $P < 0.001$).

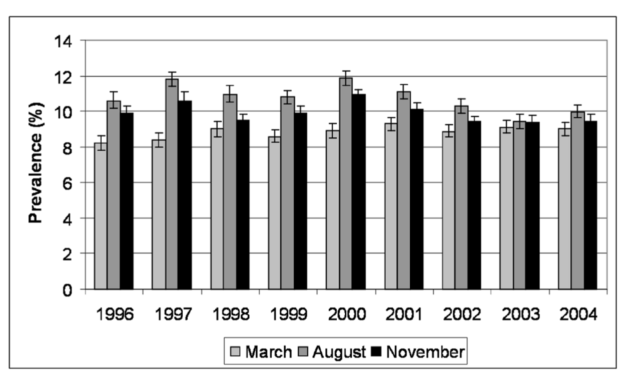

FIG. 2. Obesity trends (weight-for-height *z*-score ≥2 standard deviations, from 1977/1985 World Health Organization reference) within each year during the 9-year study period. The prevalence of obesity consistently peaked in March.

TABLE 2. *Annual obesity trends after adjustment for repeated measurements in individual children within the same year*

	N	OR	95% CI	*P*
1996				
March	19,423	1.00	1.0	
August	21,077	1.41	1.35–1.49	<0.001
November	22,220	1.34	1.27–1.41	<0.001
1997				
March	20,417	1.00	1.0	
August	21,069	1.58	1.51–1.66	<0.001
November	22,097	1.44	1.37–1.51	<0.001
1998				
March	19,372	1.00	1.0	
August	19,765	1.27	1.21–1.33	<0.001
November	22,478	1.12	1.07–1.18	<0.001
1999				
March	21,144	1.00	1.0	
August	19,765	1.39	1.33–1.45	<0.001
November	22,478	1.26	1.21–1.32	<0.001
2000				
March	21,423	1.00	1.0	
August	23,077	1.47	1.40–1.53	<0.001
November	23,461	1.34	1.28–1.40	<0.001
2001				
March	21,722	1.00	1.0	
August	22,196	1.26	1.21–1.31	<0.001
November	24,142	1.16	1.11–1.21	<0.001
2002				
March	22,516	1.00	1.0	
August	22,717	1.23	1.18–1.28	<0.001
November	25,367	1.13	1.08–1.18	<0.001
2003				
March	24,410	1.00	1.0	
August	25,367	0.92	0.88–0.97	0.001
November	17,553	1.06	1.00–1.10	0.025
2004				
March	25,013	1.00	1.0	
August	26,308	1.17	1.13–1.22	<0.001
November	21,013	1.11	1.06–1.16	<0.001

OR = odds ratio; 95% CI = confidence interval.
Obesity was defined using weight-for-height z score ≥ 2 using the 1977/1985 World Health Organization reference. The odds of obesity in August were consistently greater than in March.

The prevalence of obesity (BMI $\geq$ 95th centile) in preschool children was similar but slightly higher compared with a similar study that reported obesity trends in 6-year-old Chilean children measured in 2002 (4), 15.9% vs 14.5% in boys and 15.9% vs 13.2% in girls. The preschool results may reflect higher obesity rates in urban Santiago, given that the 6-year-old survey was nationwide. Comparing the results of our study with data collected in the United States between 1980 and 2001 using the same CDC 2000 reference (16) demonstrates a higher prevalence of obesity in Chilean children (15% vs 10%). Recent surveys in preschool children in Italy (17) and Greece (18) during the same period used the International Obesity Taskforce reference and therefore cannot be directly compared.

The fact that the odds of obesity were greater in August than in November likely reflects the winter season in Chile (June to September), when energy intake is probably greatest while expenditure is low. When children return to normal activity patterns in the spring, expenditure is likely to increase and obesity to decrease. This study was limited because activity levels and eating trends were not measured, making interpretation of these trends difficult. Nonetheless, these findings provide a platform for future program-planning studies, which could help to focus programming at periods during which children are at greatest risk.

The slight decrease in prevalence observed after 2001 could reflect the effects of program changes introduced to JUNJI in 2001, which included adaptations to reduce the energy content of food (ie, reduction in sugar and saturated fat, provision of skim milk and additional fruits and vegetables) and increasing physical activity (19). These changes in combination with the population-wide prevention program "Vida Chile" implemented in 1997 could explain the trends toward stabilized or decreasing obesity figures. "Vida Chile" is a marketing campaign for healthy lifestyles promoting physical activity for all ages (20,21). The program has been implemented in schools, workplaces, and communities, and targets healthy diet, physical activity, tobacco control, psychosocial needs, and the environment. An evaluation of the "Vida Chile" program, specifically changes in activity levels and eating habits, will prove invaluable to public health policy in Chile and other Latin American countries undergoing nutritional changes.

As shown in previous studies, the prevalence of overweight and obesity were markedly different between the 2 definition criteria (22,23). These differences have important implications when comparing prevalence rates between studies and countries. The validity of BMI as an indicator in young children (<5 years of age) has been questioned (22), but in reality neither indicator (weight-for-height z score > 2 SD or BMI centile ≥ 95) can distinguish between fat mass and body mass (24,25), nor are they related to clinically meaningful outcomes (22). Furthermore, systematic differences in both indicators—such as ethnic and racial variations in body proportions, body water, and body mass (26)—may introduce further biases, especially in Chilean children. Now that new World Health Organization growth standards have been established (27), further definition of a more clinically meaningful cutoff for different pediatric populations can be undertaken.

Strengths and Limitations

This study has strength in its large sample of children with repeated measurements within each year and in consecutive years, with relatively few measurement error exclusions. Although measurement error is possible, these would likely be random nondifferential errors because the measurements were prospectively and routinely taken by individuals who were not associated with the study. All of the children who attended JUNJI were measured, but children who were chronically ill would have been excluded. It is possible that obese children were more likely to be absent from school. The study also is limited because the sample of children included in the analysis represents low- and middle-income families from urban Santiago and therefore is not representative of the Chilean population. Given that previous studies have found significant associations between obesity and socioeconomic status in transitional countries (28–30), further national surveys are necessary to more accurately estimate the obesity prevalence in Chile.

Although the exclusion criteria in this study were routinely used in similar studies (31,32), approximately 2% of children had weight-for-age z scores >3.5 SD and were excluded from analysis. Although measurements outside this range are typically errors, it is possible that children who were grossly overweight were excluded.

Conclusions

The prevalence of obesity in Chilean preschool children continues to be a major public health concern, and cross-sectional trends tend to underestimate the magnitude of the problem.

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