Reductions in the Energy Content of Meals Served in the Chilean National Nursery School Council Program Did Not Consistently Decrease Obesity among Beneficiaries[1–3]

Camila Corvalán,[4,7] Ricardo Uauy,[8] Rafael Flores,[4,5] David Kleinbaum,[6] and Reynaldo Martorell[4,5]*

[4]Nutrition and Health Sciences Program, Graduate School, [5]Hubert Department of Global Health, Rollins School of Public Health, and [6]Epidemiology Department, Rollins School of Public Health, Emory University, Atlanta, GA 30322; and [7]School of Public Health, Faculty of Medicine, University of Chile, 8380453 Santiago, Chile; and [8]Institute of Nutrition and Food Technology, University of Chile, 7830490 Santiago, Chile

Abstract

In 2001, the Chilean National Nursery Schools Council Program reduced by 10% the energy content (~418.7 kJ) of meals served to children to reduce obesity. We assessed the impact of this measure on obesity and stunting among beneficiaries 2–5 y old. The energy reduction was staggered over 3 y, allowing for a quasi-experimental design involving early (2001), mid (2002), and late (2003) intervention groups. Routine anthropometric measurements (~64,000/y) taken from 1996–2005 were obtained from registries; obesity (BMI-for-age Z-score $\geq$2 SD) and stunting (height-for-age Z-score $\leq$2 SD) were defined using the 2006 growth standards. Segmented regression analyses were conducted by intervention group to contrast pre- and postintervention trends. Overall, obesity was high (15.9%), with levels consistently higher in fall and winter as reported in other studies. Preintervention obesity trends increased in the early group ($P = 0.001$) but decreased in the late intervention group ($P = 0.02$). The impact of the energy reduction on obesity was inconsistent, with reductions in the early group ($P < 0.01$) but with no change in mid and late intervention groups ($P > 0.05$). Stunting prevalence was almost as low as in the growth standard (3.2 vs. 2.3%) and decreased preintervention in all groups ($P < 0.05$). Stunting prevalence increased postintervention ($P < 0.05$) in all but the late intervention group, where there was no change. Despite a robust design and the ability to detect small seasonal changes in obesity, our analyses showed that the 10% energy reduction did not consistently decrease obesity. The intervention may have slowed improvements in linear growth, but concern is tempered by the near absence of growth failure.   J. Nutr. 138: 2237–2243, 2008.

Introduction

Childhood obesity has become a major public health threat worldwide. Obesity rates have increased relentlessly in industrialized and developing countries alike in recent decades (1–3). Childhood obesity is directly associated with medical and psychosocial problems, earlier onset of obesity-related chronic diseases (i.e. type 2 diabetes, hypertension, etc.), and higher probability of developing obesity and comorbidities in adult life (4–7). The social and economic cost of obesity and its related problems are staggering (8). Unfortunately, effective interventions to prevent or treat obesity remain elusive and we can show only modest short-term impact in small-scale interventions conducted at an individual level and under controlled conditions (9–13). Although several potentially useful community-based interventions have been implemented, these are seldom evaluated (14,15). Thus, there is limited evidence to support sustainable, effective actions that could inform the policies to address the obesity epidemic (14,16).

Chile has completed the last stages of the "nutrition transition;" in the past 20 y, undernutrition and infectious diseases have been rapidly replaced by obesity and nutrition-related chronic diseases, even among the poorest sectors of the community (17,18). Decreasing obesity prevalence among school-age children from 16 to 12% is one of the key health objectives of the Ministry of Health for the decade (19). The National Nursery Schools Council Program (JUNJI)[9] provides childcare and supplementary feeding to low-income preschool children (20) and thus can play a major role in achieving the stated national

[9] Abbreviations used: BAZ, BMI-for-age Z-score; HAZ, height-for-age Z-score; JUNJI, Chilean National Nursery Schools Council Program.

goal. In 2001, alarmed by the high rates of obesity reported among beneficiaries, the authorities decided to reduce the energy contribution provided by the program meals by 10% or ~418.7 kJ (100 kcal). Because contracts to food providers are staggered over 3 y, this change was implemented during 3 y, involving one-third of all beneficiaries every year from 2001 to 2003. We took advantage of this staggered introduction of the intervention and of the anthropometric information registered by JUNJI before and after the energy reduction (1996–2005) to conduct a quasi-experimental evaluation to assess whether the energy reduction of 10% was effective in curbing the rising trends in obesity.

Methods

Setting. JUNJI is a government agency that provides free daycare and meals to children between 3 mo and 5 y of age. The program is targeted to low-income children, to children of households with a single parent, and to children whose mothers work outside of the home. Participation is voluntary; in 2005, >125,000 children were enrolled in the program. Almost 65% of the beneficiaries participate in the Classical Nursery School program and attend nursery schools 11 mo/y, 5 d/wk, all day (0830–1630), and receive breakfast, lunch, and an afternoon snack while there. For these analyses, we considered all children 2–5 y of age that attended the "Classic Nursery School" program between 1996 and 2005, because the energy reduction was implemented in this age group. The study was approved by the Executive Director of JUNJI and the Institutional Review Boards of Emory University and the Institute of Nutrition and Food Technology of the University of Chile.

Nature of the intervention. Until 2001, the meals offered by the program provided 3768.1 kJ/d (900 kcal/d) for children aged 2–3 y and 4186.8 kJ/d (1000 kcal/d) for children aged 3–5 y, meeting 80% of the daily energy requirements (21,22). An additional 418.7 kJ/d (100 kcal/d) were provided to the few children with nutritional deficit (<0.5% with weight-for-height < −2 SD). In 2001, JUNJI reduced the energy contribution to 3349.4 kJ/d (800 kcal/d) for children ages 2–3 y (~11% reduction) and to 3768.1 kJ/d (900 kcal/d) for ages 3–5 y (~10% reduction), amounts estimated to meet 72% of daily energy requirements (21). This was achieved by decreasing discretionary energy from nonessential fats (i.e. from 30 to 25%) and increasing nutrient-dense foods (i.e. fruits and vegetables). Daily protein levels were maintained at 12% of total energy, calcium at 600 mg, iron at 8 mg, and other essential nutrients levels were maintained at previous levels (21,22).

Evaluation design. The food services provided by JUNJI are contracted to the private sector. For this purpose, the country is subdivided into 3 regions. Every year, one of these regions is awarded to a different contractor for a 3-y period through an open competitive bidding process (23). Because contracts are legally binding, changes in meal specifications are possible only at the beginning of new contracts. As a result, the energy reduction was implemented in one-third of the nursery schools in March of each year, from 2001 to 2003, resulting in early (2001), mid (2002), and late (2003) intervention groups. We used this staggered implementation of the intervention across time and regions and the availability of well-standardized anthropometric measurements and sociodemographic information of the beneficiaries pre- and postintervention (from March 1996 to November 2005) to conduct a quasi-experimental evaluation, with a multiple baseline design, to assess the impact of a 418.7-kJ/d (100 kcal/d) energy reduction on childhood obesity (24). A multiple baseline design is one of the strongest quasi-experimental designs to infer causality (25).

Data source and variables. We obtained the children's weight and height measurements, age, sex, and date of entry to the program from JUNJI's registries. Weight and height measurements are systematically collected at the JUNJI's nursery school every 3 mo [i.e. March (late summer), May (fall), August (winter), and November (spring)]; ~80% of all children are measured on these occasions. Weight is measured with a beam scale with children wearing light clothing and no shoes. Standing height is measured in children ≥ 2 y with a stadiometer. Measurement techniques and calibration of the instruments are periodically evaluated by program dietitians and, when necessary, workers are restandardized. We reviewed several aspects (i.e. digit preferences, variability, comparison of measurements obtained by dietitian and staff) that confirm adequacy of measurements. Intraclass correlation coefficients between the measurements of JUNJI's staff and those of the trained dietitian were all ≥0.82 [for weight-for-age Z-score, height-for-age Z-score (HAZ), and BMI-for-age Z-score (BAZ)]. Less than 0.5% of the measurements were excluded from the analyses after being flagged as outliers (weight-for-age Z-score < −6 or > 5; HAZ < −6 or > 6; BAZ < −5 or > 5) (26). We used weight and height measurements to calculate BMI [weight (kg)/height^2 (m)] and to estimate Z-scores according to the WHO growth standard (26). The main outcome of the study was obesity prevalence (BAZ ≥ 2 SD). Additional analyses were conducted using stunting prevalence (HAZ ≤ −2 SD) as an outcome to assess the potential detrimental impact of the energy reduction on children's linear growth. Individual socioeconomic information was not available, but we used as a covariate the last recorded nursery school's county poverty level obtained from the National Survey of Socioeconomic Characterization (27). Poverty was expressed as a dichotomous variable with counties in the lower quartile of the distribution considered as being poor.

Statistical analyses. We present descriptive data as proportions, 95% CI in the entire study sample, and stratified by sex, age, and intervention group. We conducted separate segmented regression analyses (also known as spline models and piecewise regression) for each of the 3 intervention groups to contrast obesity trends pre- and postintervention

TABLE 1 Characteristics of the JUNJI from 1996 to 2005 by intervention group[1]

	Early intervention (2001)	Mid intervention (2002)	Late intervention (2003)	Total program
Nursery schools	183	186	169	538
Poor counties	47 (25.7)	45 (25.8)	40 (23.7)	135 (25.1)
Non-poor counties	136 (74.3)	138 (74.2)	129 (76.3)	403 (74.9)
Children	22,646	24,291	20,904	67,841
Gender				
Girls	10,955 (48.4)	11,859 (48.8)	10,182 (48.7)	32,996 (48.5)
Boys	11,691 (51.6)	12,432 (51.2)	10,722 (51.3)	34,845 (51.5)
Age				
2.0–2 99 y	7359 (32.5)	7469 (30.7)	6403 (30.6)	21,231 (31.3)
3.0–3.99 y	8490 (37.5)	9173 (37.8)	7982 (38.2)	25,645 (37.8)
4.0–4.99 y	6797 (30.0)	7649 (31.5)	6519 (31.2)	20,965 (30.9)
Measurements per child	3.2	3.2	3.2	3.2

[1] Values are mean *n* for the 1996–2005 period and mean *n* (%). The energy reduction was implemented in 2001 (early intervention group), 2002 (mid intervention group), and 2003 (late intervention group).

(28,29). There were 40 possible measurement times from March 1996 to November 2005, but there were only 3 measurements per child on average. Thus, given the unbalanced nature of our data, we used the nursery school as the unit of analyses and ran logistic regression models considering obesity and stunting as event/trial outcomes (i.e. obese children/total children per nursery school), with the sex and age proportion per nursery school (i.e. percent of girls per nursery school) as covariates. The models were as follows:

$$\text{Logit P}(\text{Outcome} = 1 | n = \text{total children}) = \alpha + \beta_1 \text{Time}_{ij} + \\ \beta_2 \text{Time}_{ij}\_\text{post} + \beta_3 S_1 + \beta_4 S_2 + \beta_5 S_3 + \beta_6 \text{Sex} + \beta_7 \text{Age} + \beta_8 \text{Poverty},$$

where α was a constant term (i.e. baseline level of the outcome); Time_{ij} was a continuous variable that indicated month of measurement (i.e. March 1996 = 3; May 1996 = 5, etc.); Time_{ij} post was a continuous variable that indicated the number of months after the intervention (i.e. it is coded 0 before the intervention); S_1, S_2, and S_3 were dummy variables for season, included to account for the higher obesity prevalence observed in winter; sex and age were the girls and 2 y olds nursery school's proportions at each time of measurement, respectively; poverty was a dichotomous variable indicating whether the nursery school was located in a poor county. The slope of Time_{ij} estimates the mean change in obesity prevalence per month before the intervention and the slope of Time_{ij} post, the change in obesity prevalence trend after the intervention. Pre- and postintervention trends were assumed to be linear after visual inspection. Age, sex, and poverty were included in the models to account for potential variation among nursery schools and over time; however, changes in the proportion of girls and poverty level were minimal throughout the study period. We did not include a term to represent an abrupt change in obesity prevalence level following implementation of the energy reduction, because we did not expect an abrupt drop in obesity prevalence but rather a gradual decline. We tested for interactions by age, sex, and poverty level. Changes in trend and interactions were considered significant if $P < 0.05$. We used generalized estimating equations with an autoregressive variance structure to account for potential autocorrelation within the measurements. To assess serial autocorrelation, we estimated the Durbin-Watson statistic using a SAS macro (30). The values of this statistic range from 0 to 4, with values substantially <2 indicating the presence of autocorrelation (31). Analyses were repeated using: overweight (BAZ $\geq$ 1 SD) (26) as an outcome; BAZ and HAZ as linear outcomes; excluding all nursery schools that opened after the intervention was implemented; and in-
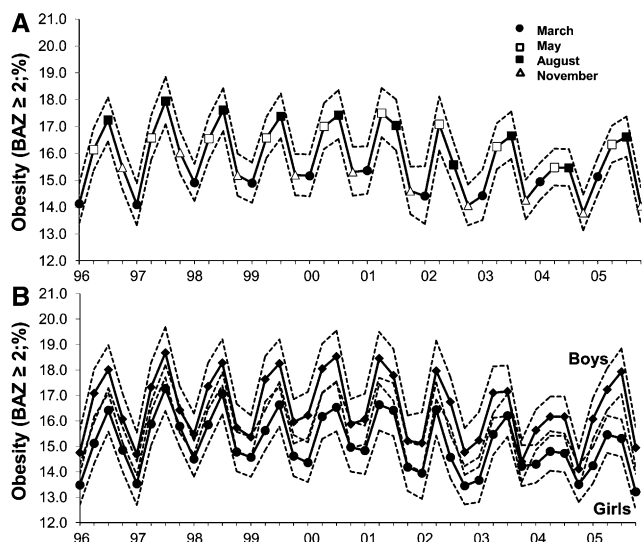
cluding only the measurements of children with >6 mo in the program (i.e. higher exposure to the intervention). All analyses were conducted using SAS software version 9.1 (SAS Institute).

Results

From 1996 to 2005, the number of nursery schools increased from 457 to 633 (40%) and beneficiaries from 62,000/y to 75,000/y, with a similar sex distribution over time but with a greater proportion of children 2–3 y of age in recent years. More than 65% of the anthropometric measurements were from children with >6 mo of participation in the program and this remained largely unchanged over time. The early, mid, and late intervention groups did not differ significantly in terms of: number and poverty level of the nursery schools; number, sex,
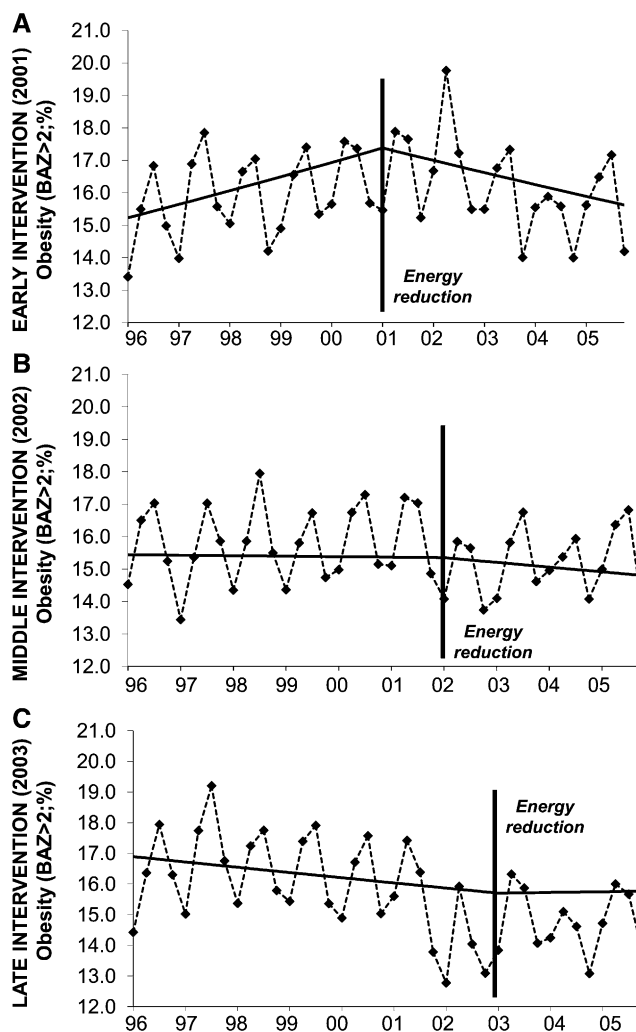
FIGURE 2 Obesity trends (26) and separate segmented regression plots for the early (A), mid (B), and late (C) intervention groups in the JUNJI, 1996–2005. The energy reduction was implemented in the year 2001 (early intervention group; $n = 22,646$ children), 2002 (mid intervention group; $n = 24,291$ children), and 2003 (late intervention group; $n = 20,904$ children). In each figure, the dotted line represents the trends adjusted by season, age and sex distribution, and poverty level and the dashed line represents the probability of the logit of the segmented regression analyses, adjusted by age and sex distribution, and poverty level.

FIGURE 1 Obesity trends in the JUNJI from 1996 to 2000 in all children (A; $n = 67,841$) and by sex (B). Data are mean prevalence and 95% CI. BAZ were based on WHO 2006 growth standards (26). In A, adjusted by age and sex distribution and poverty level and in B, by age distribution and poverty level $n = 67841$ children.

and age distribution of the children; and mean number of measurements per child (**Table 1**).

Overall, obesity prevalence was high [15.9% (15.4, 16.9)], particularly among boys [16.2% (15.6, 16.8)] and in 3-y-old children [16.3% (15.8, 16.8)] (**Fig. 1**). Obesity prevalence was consistently higher during fall and winter [May = 16.4% (15.9, 16.9); August = 17.0% (16.5, 17.5)] than in spring and summer [November = 14.9% (14.5, 15.3); March = 15.1% (14.6, 15.4) (P for differences between fall and winter vs. spring and summer < 0.05, all years)] (Fig. 1).

Preintervention obesity levels increased only in the early intervention group ($P = 0.001$), whereas they decreased in the late intervention group ($P = 0.02$) (**Fig. 2**; **Table 2**). In the early intervention group, obesity decreased after the intervention ($P < 0.001$), whereas the mid and late intervention groups did not change (both $P > 0.05$) (Fig. 2; Table 2). These group differences did not vary by age, sex, or poverty level ($P > 0.10$). Overall, mean obesity prevalence from 1996 to 2005 did not differ among the early [15.6% (14.8, 16.4)], mid [15.5% (14.8, 16.3)], and late [16.5% (15.8, 17.3)] intervention groups. Similar results were obtained using BAZ as a continuous dependent variable. Overall, mean BAZ did not change appreciably throughout the study period ($\sim +1.0$) (Table 2).

Stunting prevalence did not have a consistent seasonal pattern, but prevalence tended to be lowest in November [March = 3.4% (3.2, 3.6); May = 3.2% (3.0, 3.4); August = 3.3% (3.1, 3.5); November = 3.0% (2.8, 3.2)]. The prevalence of stunting decreased in all groups before the intervention ($P < 0.001$) and flattened or slightly increased after the intervention, except in the late intervention group ($P = 0.15$) (**Fig. 3**; Table 2). Overall, mean stunting prevalence from 1996 to 2005 was greater in the late intervention group [3.7% (3.4, 4.0)] than in the mid group [3.0% (2.7, 3.3)] ($P < 0.05$) but similar to that of the early [3.2% (2.9, 3.5)] intervention groups ($P > 0.05$). When using HAZ as a continuous outcome, there was an upward trend in all groups preintervention ($P < 0.05$) that slowed postintervention ($P < 0.05$, except for the late intervention group) (Table 2).

Sensitivity analyses. We also conducted analyses that excluded all nursery schools that opened after the intervention was implemented or that included only the measurements of children with >6 mo in the program (i.e. higher exposure to the intervention). Both analyses provided results that were similar to those of the entire sample (**Supplemental Table 1**). Given the seasonality observed in the obesity prevalence, we repeated all the analyses using only 1 measurement per year (i.e. for each of the 4 measurement occasions). None of the season-specific analyses indicated that the staggered intervention affected obesity (**Supplemental Fig. 1**). Results were also similar when using overweight (BAZ ≥ 1 SD) (26) as an outcome.

Discussion

To our knowledge, this is the first study conducted in a developing country that evaluates the nutritional impact of adapting a large-scale program in response to the obesity epidemic. Using a quasi-experimental design, we found that the 418.7-kJ (100 kcal) reduction implemented by the program was not consistently effective in decreasing obesity.

The quality of routinely collected anthropometric measurements is always a concern and a potential limitation for the internal validity of the findings from studies such as ours. We were fortunate to have data on quality monitoring by the JUNJI program itself that suggested satisfactory quality. Also reassuring was that we observed consistently higher obesity prevalence in winter, probably due to reduced physical activity, as reported in other studies conducted in different age groups (32–34). In our sample, the difference between summer and winter measurements was 0.1 BAZ and 2.0% obesity points, confirming that we had sufficient power to detect intervention effects as small as these. Seasonal variations in weight could also be due to heavier clothing worn during weighing. However, weight, BAZ, and obesity were consistently higher in winter even after subtracting 0.5 kg from each child's weight; also, unadjusted seasonal differences were similar in magnitude to those described in studies that assessed weight with minimal clothing across seasons (34,35). Overall, obesity prevalence among JUNJI children was high, particularly among boys and children 3 y old. We did not observe a consistent seasonal pattern for height,

TABLE 2 Segmented regression models for obesity, BAZ, stunting, and HAZ trends pre- and post-intervention for the early, mid, and late interventions groups, JUNJI, 1996–2005[1]

		Obesity[2]	*P*-value	BAZ[2]	*P*-value	Stunting[2]	*P*-value	HAZ[2]	*P*-value
Preintervention[3]									
Level (intercept)	Early intervention	13.46		1.08		4.38		−0.20	
	Mid intervention	14.52		0.95		3.90		−0.26	
	Late intervention	14.42		0.87		4.57		−0.29	
Trend[4]	Early intervention	0.003 ± 0.001	0.001	0.002 ± 0.001	0.007	−0.005 ± 0.001	0.002	0.002 ± 0.001	0.0001
	Mid intervention	0.002 ± 0.001	0.16	−0.001 ± 0.001	0.42	−0.005 ± 0.002	<0.0001	0.002 ± 0.001	0.001
	Late intervention	−0.002 ± 0.001	0.02	−0.001 ± 0.001	0.02	−0.003 ± 0.001	0.001	0.002 ± 0.001	0.0001
Postintervention									
Change in trend[5]	Early intervention	−0.005 ± 0.001	0.001	−0.003 ± 0.001	0.003	0.006 ± 0.003	0.01	−0.002 ± 0.001	0.01
	Mid intervention	−0.000 ± 0.001	0.52	−0.000 ± 0.001	0.77	0.009 ± 0.002	0.001	−0.002 ± 0.001	0.05
	Late intervention	0.003 ± 0.002	0.22	−0.002 ± 0.001	0.15	0.003 ± 0.003	0.15	−0.002 ± 0.002	0.30

[1] Values are $\beta \pm$ SE. The energy reduction was implemented in 2001 (early intervention group; $n = 22{,}646$ children), 2002 (mid intervention group; $n = 24{,}291$ children), and 2003 (late intervention group; $n = 20{,}904$ children).

[2] Obesity (BAZ ≥ 2 SD), stunting (HAZ ≤ -2 SD), BAZ, and HAZ based on WHO 2006 growth standards (26). Adjusted by season, age and sex distribution, and poverty level.

[3] Preintervention starting level indicates the prevalence or mean of the outcome in March 1996, the first month of the time series.

[4] Preintervention trend indicates the change in prevalence or mean of the outcome per month up to the beginning of the intervention.

[5] Postintervention change in trend indicates the change with respect to the preintervention trend in prevalence or mean of the outcome per month after the start of the intervention. The postintervention trend per se can be estimated by adding the preintervention trend to the postintervention change in trend
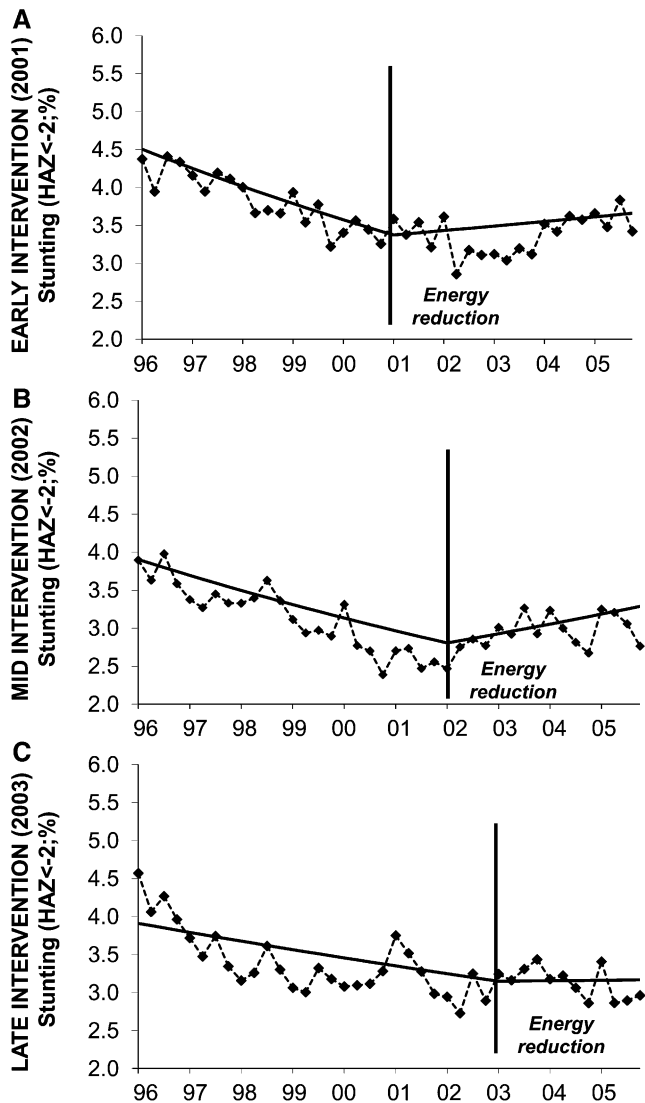
FIGURE 3 Stunting trends (26) and separate segmented regression plots for the early (*A*), mid (*B*), and late (*C*) intervention groups, JUNJI, 1996–2005. The energy reduction was implemented in the year 2001 (early intervention group; $n = 22,646$ children), 2002 (mid intervention group; $n = 24,291$ children), and 2003 (late intervention group; $n = 20,904$ children). In each figure, the dotted line represents the trends adjusted by season, age and sex distribution, and poverty level and the dashed line represents the probability of the logit of the segmented regression analyses, adjusted by age and sex distribution, and poverty level.

except for higher HAZ and lower stunting rates during the spring measurement (i.e. November). Height increases during spring and after weight gain have been described in prepubertal children in populations with presumed adequate nutrition (36,37). Overall, the mean height of JUNJI children was within the range found in the populations included in the WHO Multicentre Growth Reference Study and prevalence of stunting was almost the expected (i.e. 3.2 vs. 2.3% of the reference population) (26,38).

We observed reduced obesity in the early group but not in mid and late intervention groups. This raises some concerns regarding the actual implementation of the intervention. We examined several lines of available evidence provided by the JUNJI program to confirm that the intervention indeed took place. First, different providers were in charge of the food distribution, making

systematic noncompliance unlikely. Secondly, the energy reduction of meals was cost neutral to contractors; increases in fruits and vegetables were offset by cost reductions associated with less fat. Finally, the energy reduction was documented through periodic evaluations of the nutrient content of rations that was conducted by the program as part of the monitoring of compliance by contractors. In 2006, we conducted a pilot study in Santiago (the capital city) that included an estimate of intakes through food weight measurements. This study confirmed that JUNJI children were receiving 3349.4 kJ/d (800 kcal/d) at 2–3 y of age and 3768.1 kJ/d (900 kcal/d) at 3–5 y of age. An alternative explanation for the differential impact of the intervention across groups may be related to the existence of unmeasured differences among the 3 groups. However, the fact that we assessed the impact of the intervention using an interrupted time series design (i.e. each of the series acts as its own control) makes this explanation unlikely. Finally, it is also possible that factors external to the program may have been responsible for the leveling off of obesity in 2001 in the early intervention group. National data provided by the Chilean Ministry of Health also show stabilization of childhood obesity levels around 2001; possible causes include increased public recognition of the epidemic of obesity (because of educational efforts through the health care system and mass media campaigns) and the economic recession that ensued at the time (18,39,40). Overall, these results highlight the advantages of using a multiple baseline design for assessing the effectiveness of interventions (25,41). If the energy reduction had been implemented only in the early intervention group in 2001, we would have erroneously concluded that the intervention was an effective approach for reducing obesity. The systematic incorporation of monitoring and evaluation components to the implementation of public health policies will be critical for defining sustainable effective actions to address the obesity epidemic.

Unfortunately, we did not have dietary intake measurements at home and at school; therefore, we cannot be fully sure that the energy intake of the JUNJI children actually decreased after the intervention. It is possible that before implementing the energy reduction, children were not consuming all the food offered by the program and that afterwards, they ate the entire ration or left less than before on the plate; under this scenario, no changes in overall food intake at the school would have occurred. It is also possible that the energy reduction was compensated for by increased food intake at home. Even under controlled situations, only a few of the obesity prevention studies targeted at school environments demonstrate impact while the majority show no effect (10–13). Because children spend only a portion of their waking hours at the schools, interventions targeted solely at schools do not fully address a large number of contributors to the obesity epidemic (42). There is evidence that JUNJI beneficiaries spend >3 h/d viewing TV at home, receive 2–3 additional meals at home during the school week, and exceed energy requirements during weekends (43–45). Another factor that may have contributed to the lack of impact of the JUNJI intervention is that it did not consider improving physical activity levels along with the energy reduction of meals (46).

Our results also suggest that the energy reduction may have unintentionally slowed the improvement of linear growth among the JUNJI beneficiaries. However, flattening of the upward trend in height would be expected soon after 2001 as the population was approaching its full biological potential for linear growth (i.e. they had almost the expected stunting prevalence). However, the reversal of the upward trend in 2 of the intervention groups, although quite small, was not anticipated and may be an unintended negative consequence of the intervention.

As developing countries move into advanced stages of the nutrition transition, obesity and obesity-related chronic diseases become more prevalent, particularly among low-income people (47–49). It has been proposed that in this new scenario, nutrition assistance programs that have been historically oriented to decrease undernutrition and micronutrient deficiencies have to refocus on improving food quality (rather than food quantity) as well as increasing physical activity patterns (50,51). Nutrition assistance programs targeted to preschoolers can play a particularly important role in preventing obesity, because accelerated gain in weight relative to height after 2 y of age is associated with increased risk of later obesity (52–55); also, physical activity and feeding behaviors are acquired at this age and track thereafter (56–59). Nonetheless, our results suggest that interventions implemented to prevent childhood obesity will have to assess both desired and unintended consequences with equal rigor to provide policy makers with the necessary information for balancing risks and benefits from the proposed measures. Thus, continued monitoring of both linear and BMI growth is critical, particularly in countries that face an emerging obesity epidemic while still dealing with high rates of stunting.

Obesity is a complex and multi-factorial disease whose prevention will necessarily require population-wide, public health measures. Actions taken, however, have to be evaluated and the results used to improve programs and policies. Our study showed that JUNJI's efforts to improve quality and to reduce the energy contribution of meals were ineffective and should be considered only as a starting point in building a more comprehensive strategy that considers enhanced physical activity at school and other aspects of the environment, both while at JUNJI and at home.

Literature Cited

1. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes. 2006;1:11–25.

2. Jackson-Leach R, Lobstein T. Estimated burden of paediatric obesity and co-morbidities in Europe. Part 1. The increase in the prevalence of child obesity in Europe is itself increasing. Int J Pediatr Obes. 2006;1:26–32.

3. de Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. Am J Clin Nutr. 2000;72:1032–9.

4. Lobstein T, Jackson-Leach R. Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease. Int J Pediatr Obes. 2006;1:33–41.

5. Nader PR, O'Brien M, Houts R, Bradley R, Belsky J, Crosnoe R, Friedman S, Mei Z, Susman EJ. Identifying risk for obesity in early childhood. Pediatrics. 2006;118:e594–601.

6. Puhl RM, Latner JD. Stigma, obesity, and the health of the nation's children. Psychol Bull. 2007;133:557–80.

7. Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. Epidemiol Rev. 2007;29:62–76.

8. Powers KA, Rehrig ST, Jones DB. Financial impact of obesity and bariatric surgery. Med Clin North Am. 2007;91:321–38.

9. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C, Tough SC. Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. Obes Rev. 2006;7 Suppl 1:7–66.

10. Bluford DA, Sherry B, Scanlon KS. Interventions to prevent or treat obesity in preschool children: a review of evaluated programs. Obesity (Silver Spring). 2007;15:1356–72.

11. Campbell KJ, Hesketh KD. Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature. Obes Rev. 2007; 8:327–38.

12. Summerbell CD, Ashton V, Campbell KJ, Edmunds L, Kelly S, Waters E. Interventions for treating obesity in children. Cochrane Database Syst Rev. 2003;CD001872.

13. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. Cochrane Database Syst Rev. 2005;CD001871.

14. Lobstein T. Comment: preventing child obesity–an art and a science. Obes Rev. 2006;7 Suppl 1:1–5.

15. Reynolds KD, Spruijt-Metz D. Translational research in childhood obesity prevention. Eval Health Prof. 2006;29:219–45.

16. Institute of Medicine of the National Academies (IOM). Progress in preventing childhood obesity: how do we measure up? Report Brief. Washington, DC: Institute of Medicine of the National Academies; 2006.

17. Albala C, Vio F, Kain J, Uauy R. Nutrition transition in Chile: determinants and consequences. Public Health Nutr. 2002;5:123–8.

18. Vio F, Albala C, Kain J. Nutrition transition in Chile revisited: mid-term evaluation of obesity goals for the period 2000–2010. Public Health Nutr. 2008;11:405–12.

19. Ministry of Health. Health Objectives for the Decade 2000–2010 (in Spanish). Santiago: Government of Chile; 2001.

20. National Nursery Schools Council Program (JUNJI). What is JUNJI? (in Spanish) [cited 2007 Oct 5]. Available from: http://www.utopia.cl/junji/?navid=q001

21. FAO. Human energy requirements report of a joint expert consultation. Rome: FAO; 2004.

22. Rojas J, Uauy R. Evolution of the nutrition and dietary guidelines and changes in the nutritional status of preschool children beneficiaries of the JUNJI program over the past 3 decades. Rev Chil Nutr. 2006;33:91–101.

23. Government of Chile National Council of School Support and Fellowships. Bid for meals supply at the nursery schools (in Spanish) 2003–2006 [cited 2007 Oct 5]. Available from: http://www.junaeb.cl/proveedores/licitacion.htm

24. Shadish W, Cook T, Campbell D. Experimental and quasi-experimental designs for generalized causal inference. Boston: Houghton Mifflin Company; 2002.

25. Hawkins NG, Sanson-Fisher RW, Shakeshaft A, D'Este C, Green LW. The multiple baseline design for evaluating population-based research. Am J Prev Med. 2007;33:162–8.

26. WHO. The WHO child growth standards [cited 2007 Oct 5]. Available from: http://www.who.int/childgrowth/standards/en/

27. Government of Chile Ministry of Social Development. National Survey of Socioeconomic Characterization (CASEN) [cited 2007 Oct 5]. Available from: http://www.mideplan.cl/casen/index.html

28. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther. 2002;27:299–309.

29. Weiss R. Modelling longitudinal data. New York: Springer; 2005.

30. Kleinbaum DG. SAS Macro: Durbin Watson statistic. Atlanta (GA): 2008.

31. Bhargava A, Franzini L, Narendranathan W. Serial correlation and the fixed effects model. Rev Econ Stud. 1982;49:533–49.

32. Kobayashi M, Kobayashi M. The relationship between obesity and seasonal variation in body weight among elementary school children in Tokyo. Econ Hum Biol. 2006;4:253–61.

33. Riddoch CJ, Mattocks C, Deere K, Saunders J, Kirkby J, Tilling K, Leary SD, Blair S, Ness A. Objective measurement of levels and patterns of physical activity. Arch Dis Child. 2007;92:963–9.

34. Visscher TL, Seidell JC. Time trends (1993–1997) and seasonal variation in body mass index and waist circumference in the Netherlands. Int J Obes Relat Metab Disord. 2004;28:1309–16.

35. Tobe H, Arai K, Togo M. Seasonal variation of growth in body weight of Japanese children and its relationship to physique. Am J Hum Biol. 1994;6:227–35.

36. Gelander L, Karlberg J, Albertsson-Wikland K. Seasonality in lower leg length velocity in prepubertal children. Acta Paediatr. 1994;83:1249–54.

37. Tillmann V, Thalange NK, Foster PJ, Gill MS, Price DA, Clayton PE. The relationship between stature, growth, and short-term changes in height and weight in normal prepubertal children. Pediatr Res. 1998;44:882–6.

38. WHO Multicentre Growth Reference Group. Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. Acta Paediatr Suppl. 2006;450:56–65.

39. Central Bank of Chile. Gross Domestic Product series, constant prices (Producto Interno Bruto, precios constantes) Economics Database (base

de datos estadisticos) [cited 2007 Oct 16]. Available from: http://si2.bcentral.cl/Basededatoseconomicos/951_417.asp?m=CN21&f=A&i=E

40. El Mercurio. News database [cited 2007 Nov 5]. Available from: http://www.infomercurio.com/

41. Biglan A, Ary D, Wagenaar AC. The value of interrupted time-series experiments for community intervention research. Prev Sci. 2000;1:31–49.

42. Institute of Medicine of the National Academies. Preventing childhood obesity: health in the balance. Washinton, DC: Institute of Medicine of the National Academies; 2004.

43. Cardona O, Salazar G, Diaz E. Measurement of energy expenditure and physical activity patterns of children beneficiaries of JUNJI. Santiago: University of Chile; 2001.

44. Kain J, Andrade M. Characteristics of the diet and patterns of physical activity in obese chilean preschoolers. Nutr Res. 1999;19:203–15.

45. Rebolledo A, Atalah E, Araya H, Mondaca A, Garrido S, Castillo L, Herrera P. Evaluation of an intervention model to stimulate healthy life habits in preschool children. Rev Chil Nutr. 2000;27:368–75.

46. Hills AP, King NA, Armstrong TP. The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: implications for overweight and obesity. Sports Med. 2007;37:533–45.

47. Monteiro CA, Conde WL, Popkin BM. Income-specific trends in obesity in Brazil: 1975–2003. Am J Public Health. 2007;97:1808–12.

48. Monteiro CA, Moura EC, Conde WL, Popkin BM. Socioeconomic status and obesity in adult populations of developing countries: a review. Bull World Health Organ. 2004;82:940–6.

49. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. Am J Clin Nutr. 2006;84:289–98.

50. Solomons NW. Programme and policy issues related to promoting positive early nutritional influences to prevent obesity, diabetes and cardiovascular disease in later life: a developing countries view. Matern Child Nutr. 2005;1:204–15.

51. Uauy R, Kain J. The epidemiological transition: need to incorporate obesity prevention into nutrition programmes. Public Health Nutr. 2002;5:223–9.

52. Corvalan C, Gregory CO, Ramirez-Zea M, Martorell R, Stein AD. Size at birth, infant, early and later childhood growth and adult body composition: a prospective study in a stunted population. Int J Epidemiol. 2007;36:550–7.

53. Sachdev HS, Fall CH, Osmond C, Lakshmy R, Dey Biswas SK, Leary SD, Reddy KS, Barker DJ, Bhargava SK. Anthropometric indicators of body composition in young adults: relation to size at birth and serial measurements of body mass index in childhood in the New Delhi birth cohort. Am J Clin Nutr. 2005;82:456–66.

54. Victora CG, Sibbritt D, Horta BL, Lima RC, Cole T, Wells J. Weight gain in childhood and body composition at 18 years of age in Brazilian males. Acta Paediatr. 2007;96:296–300.

55. Wells JC, Hallal PC, Wright A, Singhal A, Victora CG. Fetal, infant and childhood growth: relationships with body composition in Brazilian boys aged 9 years. Int J Obes (Lond). 2005;29:1192–8.

56. Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. Pediatrics. 2002;109:634–42.

57. Mannino ML, Lee Y, Mitchell DC, Smiciklas-Wright H, Birch LL. The quality of girls' diets declines and tracks across middle childhood. Int J Behav Nutr Phys Act. 2004;1:5.

58. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. Br J Nutr. 2005;93:923–31.

59. Salmon J, Timperio A, Cleland V, Venn A. Trends in children's physical activity and weight status in high and low socio-economic status areas of Melbourne, Victoria, 1985–2001. Aust N Z J Public Health. 2005;29:337–42.