

Socioeconomic vulnerability and obesity in Chilean schoolchildren attending first grade: comparison between 2009 and 2013

Vulnerabilidad socioeconómica y obesidad en escolares chilenos de primero básico: comparación entre los años 2009 y 2013

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Abstract

Introduction: Although obesity is related to socioeconomic level, studies are inconclusive. **Objectives:** To determine obesity risk according to socioeconomic vulnerability among Chilean children (1st grade) in 2009 and 2013 and assess its change during that period, by sex and geographical area. **Patients and Method:** Cross-sectional study (N = 175,462 in 2009) and (N = 189,055 in 2013) which included: weight, height, rural / urban, gender and vulnerability obtained from JUNAEB's survey. BMI Z, % obesity and 3 categories of vulnerability (very vulnerable, moderate, non-vulnerable) were determined. For the descriptive analyses, we used t tests and for predictor variables (2 categories of vulnerability) and outcome (obesity) by sex and area, we used χ^2 . Logistic regression models determined OR to develop obesity by **Results:** % obesity was 19.6% and 24.1% in 2009 and 2013, higher in boys. In urban and rural areas respectively, OR to develop obesity were: 0.85 (0.82-0.88) and 0.70 (0.64-0.75) in the most vulnerable students and 0.94 (0.91-0.97) and 0.81 (0.74-0.88) in those with moderate vulnerability in 2009 and 0.96 (0.93-0.98) and 0.89 (0.82-0.96) in the most vulnerable students and 0.99 (0.96-1.02) and 0.94 (0.86-1.02) in students with moderate vulnerability in 2013. The highest increase in obesity was observed among the most vulnerable group from rural areas (16, 6 to 24.3%). vulnerability. **Conclusion:** The non-vulnerable group had the highest % obesity. Although the most vulnerable students in rural areas had the lowest obesity risk in both years, the highest increase in obesity during the period, occurred in that group.

Keywords:

Childhood obesity, socioeconomic vulnerability, first grade, Chile

Introduction

According to World Health Organization (WHO), obesity is defined as an abnormal or excessive fat accumulation and is considered a chronic multifactorial disease whose prevalence has gradually increased in nearly all countries, having an impact on the increase of diseases such as dyslipidemia, metabolic syndrome, heart disease and cancer¹⁻⁴. A systematic review by Reilly and Kelly⁵ showed that there is wide evidence that overweight and obesity in childhood and adolescence, besides having adverse consequences in adult morbidity, is also related to early death.

Over the last decades many efforts have been made to address obesity, however, implemented strategies have not been very effective. This is alarming because the evidence shows that the onset of obesity in childhood substantially increases the possibility of having this condition in adulthood⁶, as shown by a study in the US by Whitaker et al.⁷. The authors showed that the possibility of developing obesity in young adults was 10.3 times higher in children who had been obese between the ages of 6 and 9, compared to those who were not obese at that age.

In Chile, childhood obesity has experienced a steady increase in the last years, as reported by the National Board of School Aid and Scholarships (JUNAEB) in its nutritional map of first grade schoolchildren, which shows an obesity prevalence of 17% in 2001 increasing to 19.4%, 22.1%, and 25.3 % in 2006, 2011 and 2013 respectively⁸. This increase is partly attributed to the country's rapid evolution from an economic pre-transition to a post-transition stage, characterized by an increase in per capita income, increased consumption of high-calorie foods and an increase in sedentary lifestyles which has led to changes in lifestyles and factors that influence them⁹⁻¹².

There is evidence showing a relationship between socioeconomic status (SES) (usually determined through the total or per capita income of household members and/or the educational level of the head of household and/or the mother) and childhood obesity. In this context, it has been observed that this relationship is presented in different ways depending on the stage countries (or regions) find themselves in the epidemiological and nutritional transition. In general, in developed countries an inverse association between SES and childhood obesity has been found¹³⁻¹⁵, however, in developing countries, obesity is more prevalent in families of higher SES^{16,17}, especially in poorer countries. Nearly all studies in Chile show a higher prevalence of childhood obesity in children of lower SES. This has been reported by Amigo H et al.¹⁸; Olivares S et al.¹⁹; Kain et al.²⁰, however, Adjemian et al did not find an association²¹.

The aims of this study were: a) to determine the risk of obesity according to SES in 2009 and 2013 for students attending first grade in public and/or subsidized private schools; and b) to verify how the risk changes in the period, according to gender and urban/rural distribution.

Participants and Method

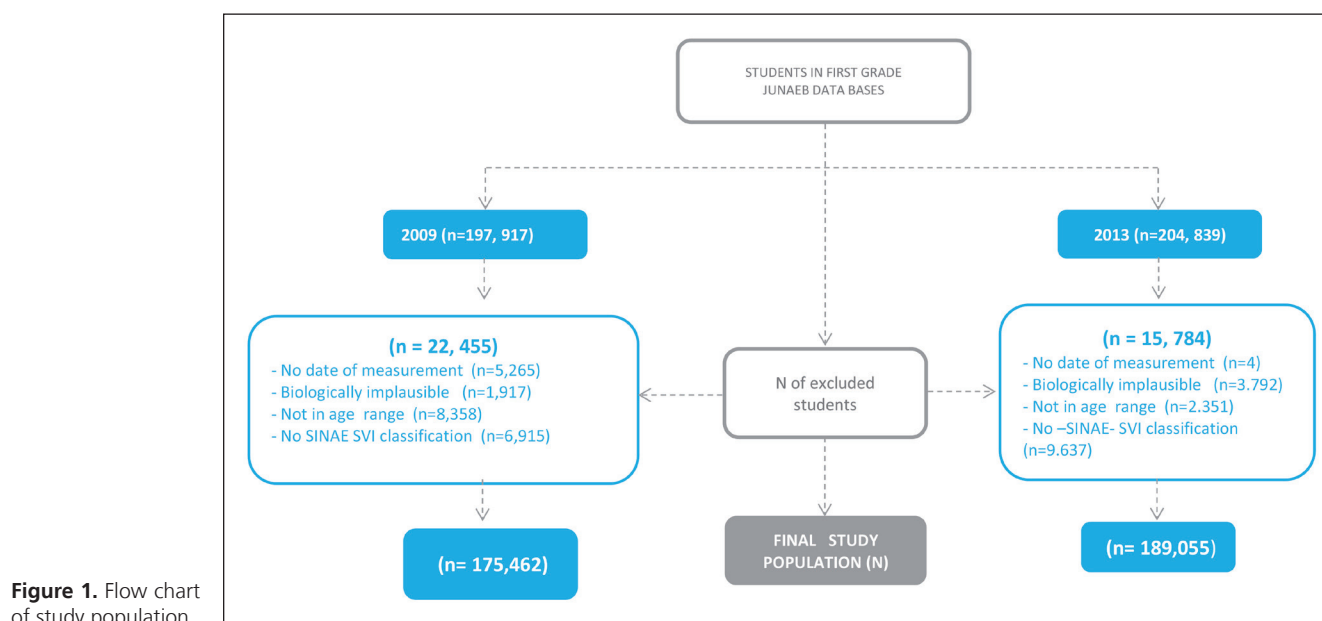
Participants

The study population included the total number of students who attended first grade during 2009 and 2013, with no errors in the records and who met the age inclusion criteria, between 60 and 96 months and plausible Z scores on BMI/age, weight/age or height/age indicators. The study populations was 175,462 in 2009 and 189,055 in 2013 (Figure 1).

This population was obtained from databases that JUNAEB collects annually, which includes approximately 65% of children attending first grade in the country. With these data, the institution determines the nutritional status of the students and the results are published in the so called Nutritional Map (www.junaeb.cl). For nutritional classification, the BMI/age Z score has been used since 2001, defined as the distance of an individual's BMI from the BMI of a reference population for his or her age and gender²². In this study, this variable was determined using i WHO Anthro-Plus software which uses the WHO 2007 reference^{8,23}. The cut-off point to determine obesity was defined as BMI/age Z ≥ 2 of the reference.

Although the collection of weight and height data is carried out by trained teachers using different types of equipment and precision²⁴, due to its wide coverage, this data is considered a census of first-grade students attending public schools in the country.

JUNAEB also registers the SES of the students, according to the National System Allocation for Equality (SINAE), which is expressed through the SINAE School Vulnerability Index (SINAE-SVI)²⁵, that is mainly based on the score of the Social Protection Survey (FPS), a methodology applied since 2007 to determine the SES of households to remain or fall into poverty and thus focus social programs²⁶. The SINAE-SVI allows classifying students individually as vulnerable, not vulnerable and without information. The SES category is classified into 3 sub-categories: category 1 includes those children who are more vulnerable, while category 2 and 3 include children with a moderate vulnerability. The only difference between these two categories is that category 2 includes children with educational risk. For the purposes of this study, the last two categories were merged.



Statistical analysis

A descriptive analysis of the frequencies of the categorical variables was carried out by gender, geographical area, SES categories, and nutritional status of the students in 2009 and 2013. Subsequently, an exploratory analysis was carried out in order to assess normality of the variables through Shapiro-Wilk test and a bivariate analysis for the predictor variable (SES category) and the response variable (obesity) stratified by gender and geographical area through the Chi-square test. Student's t-test was also used to compare the mean population of independent samples of the variable BMI/age Z in order to make the following comparisons: between years (2009 and 2013), between genders of the same year and different years; between geographical areas of the same year and different years; between years by SES category and between SES categories per year.

In order to determine the association between obesity and SES, a logistic regression model with dichotomous response variable (obese/non-obese) was used to calculate their respective Odds Ratio (OR) for each year of the study, adjusting for gender and stratified by geographical area. The SES category used as a reference was the group of non-vulnerable students.

Finally, the Homer-Lemeshow goodness of fit test was applied, which defined if the logistic regression model was adjusted to what was observed in the data that were analyzed.

For statistical analysis a level of confidence of 95% and significant values of $p < 0.05$ were considered. For statistics and data analysis STATA 12.0® software was used.

For the purposes of the study, the databases provided by JUNAEB did not include variables of personal identification according to what is stipulated in Law 19,628 about protecting private life, so therefore it was not necessary to submit this study to the Ethics Committee of Institute of Nutrition and Food Technology (INTA).

Results

The percentage of excluded subjects in both years was acceptable 15.7% in 2009 and significantly lower in 2013, 7.7% (Figure 1). These percentages should not affect the study results, due to the large population size.

Table 1 shows the distribution of studied variables in 2009 and 2013 by gender and geographical area and their comparison in the period. According to gender, only the obesity prevalence and consequently the mean BMI Z was significantly higher in boys in both years, while according to geographical area, significant differences were observed in the percentages of subjects in each SES category. In the rural area, the proportion of vulnerable children was significantly higher than in the urban area in both years. The most important changes in the period were a significant increase in both obesity and mean BMI Z ($p < 0.01$) in both genders and the proportion of very vulnerable children (similar in both genders). The proportion of very vulnerable students in urban areas showed the highest increase in the period (33.9% to 40.8%) ($p < 0.01$).

Figure 2 shows the obesity prevalence according to SES by gender in 2009 and 2013. In both years, this

Table 1. Distribution of study variables by gender and geographical area 2009 and 2013

Nutritional Status	Total n (%)	Gender		Geographical Area	
		Boys	Girls	Urban	Rural
2009	175462	88592	86870	148208	27254
Obesity (%)	34389 (19.6)	22.3	16.8 ¹	19.8	18.6 ¹
BMI Z (mean and SD)	0.86 ± 1.38	0.93 ± 1.46	0.8 ± 1.3 ¹	0.9 ± 1.39 ¹	0.87 ± 1.33
Very vulnerable (%)	63979 (36.5)	36.8	36.1	33.9	50.1 ¹
Moderate Vulnerability (%)	49345 (28.1)	28.2	28	27.9	29.5 ¹
Non-vulnerable (%)	62138 (35.4)	35	35.9	38.2	20.4 ¹
2013	189055	95828	93227	164712	24343
Obesity (%)	45558 (24.1)	27.0 ²	21.1 ¹	24.0 ²	25.1 ²
BMI Z (mean and SD)	1.03 ± 1.42	1.11 ± 1.49 ²	0.95 ± 1.33 ^{1,2}	1.02 ± 1.42 ²	1.10 ± 1.42 ²
Very vulnerable (%)	80297 (42.5)	43 ²	42 ²	40.8 ²	53.4 ^{1,2}
Moderate Vulnerability (%)	46850 (24.7)	24.5 ²	25 ²	24.4 ²	27.7 ^{1,2}
Non-vulnerable (%)	61908 (32.8)	32.5 ²	33 ²	34.8 ²	18.9 ^{1,2}

1 = significant difference the same year by gender and geographical area. 2 = significant difference between both years by sex and geographical area.

prevalence was higher in non-vulnerable students, however, in both genders, the highest increase was observed in the most vulnerable group. Figure 3 shows the same distribution according to geographical area. In both years, non-vulnerable students showed a greater proportion of obesity which was higher in rural areas, however, the largest increase was observed in the most vulnerable group in both areas.

Table 2 shows the results of the logistic regression model which assess the association between SES and obesity. Firstly the interaction between gender and SES

was assessed showing non-significant results for both study years ($p > 0.05$), therefore, the results are shown together for both genders. In assessing the interaction between geographical area and SES, a significant result was obtained in 2009 ($p < 0.05$) and a non-significant one in 2013 ($p > 0.05$).

In urban areas in 2009, the most vulnerable students (compared to non-vulnerable ones) presented an OR of 0.85 (CI: 0.82-0.88) in contrast, in students with moderate SES an OR of 0.94 (CI: 0.91-0.97) was observed. In the rural areas, the OR was of 0.70 (CI:

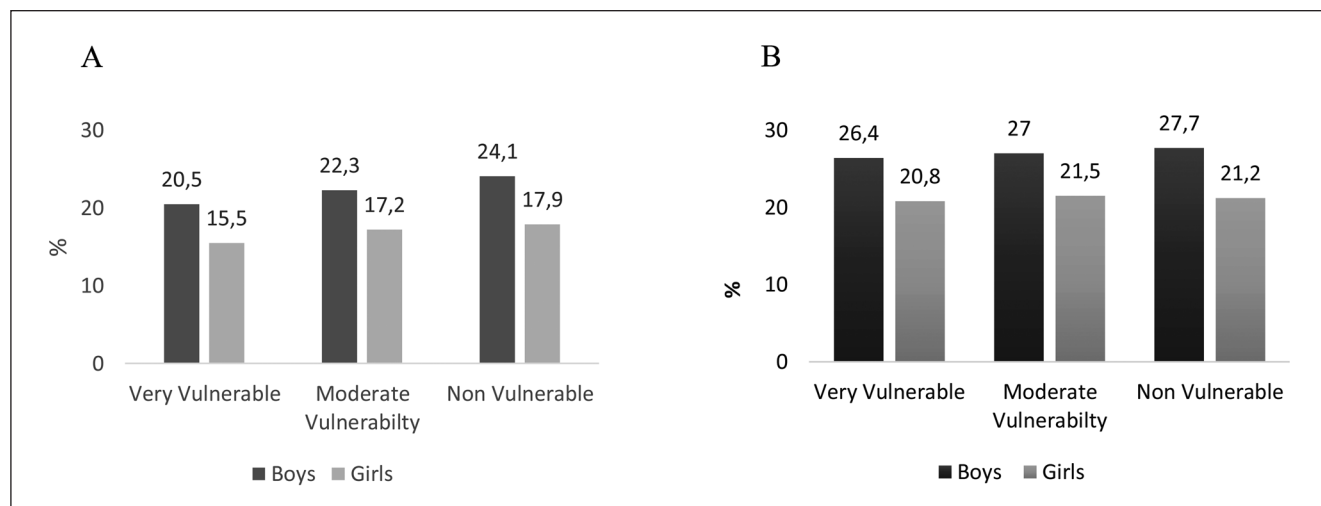


Figure 2. Prevalence of obesity according to socioeconomic vulnerability and gender 2009 (A) and 2013 (B). Chi-square for categorical variables: prevalence of obesity by socioeconomic vulnerability in boys 2009 and 2013 $p < 0.01$; prevalence of obesity by socioeconomic vulnerability in girls 2009 and 2013 $p < 0.01$; prevalence of obesity by vulnerability and gender in 2009 $p < 0.01$; prevalence of obesity by vulnerability and gender in 2013. $p < 0.01$.

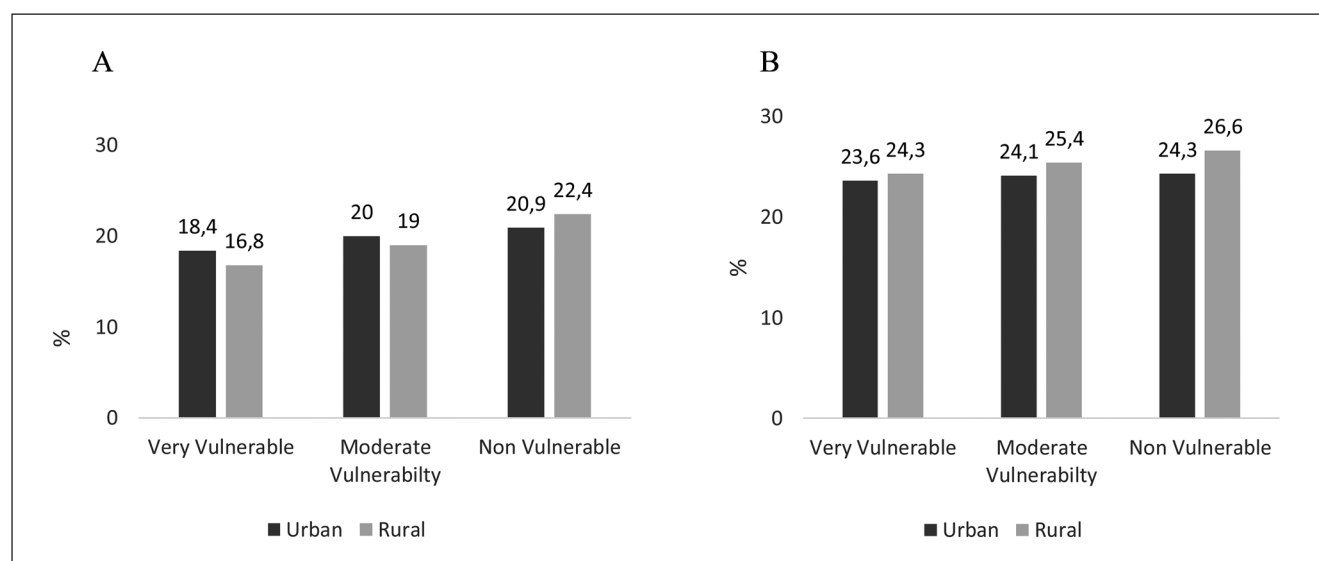


Figure 3. Prevalence of obesity according to socioeconomic vulnerability and geographical area 2009 **(A)** and 2013 **(B)**. Chi-square for categorical variables: prevalence of obesity by socioeconomic vulnerability in urban areas 2009 and 2013 $p < 0.01$; prevalence of obesity by socioeconomic vulnerability in rural areas 2009 and 2013 $p < 0.01$; prevalence of obesity by vulnerability and geographical area in 2009 $p < 0.01$; prevalence of obesity by vulnerability and geographical area in 2013. $p < 0.01$.

Table 2. Logistic Regression Model between socioeconomic vulnerability and obesity 2009 and 2013

Socioeconomic vulnerability Ref=Nn-vulnerable	2009		2013	
	[OR (95% CI)]	p	[OR (95% CI)]	p
<i>Urban</i>	(n = 148208)		(n = 164712)	
Vulnerable cat. 1	0.85 (0.82 , 0.88)	< 0.01	0.96 (0.93 , 0.98)	< 0.01
Vulnerable cat. 2+3	0.94 (0.91 , 0.97)	< 0,01	0.99 (0.96 , 1,02)	0.36
<i>Rural</i>	(n = 27254)		(n = 24343)	
Vulnerable cat. 1	0.70 (0.64 , 0.75)	< 0.01	0.89 (0.82 , 0.96)	< 0,01
Vulnerable cat. 2+3	0.81 (0.74 , 0.88)	< 0.01	0.94 (0.86 , 1.02)	0,16

Hosmer Lemeshow t est $p > 0.05$.

0.64-0.75) and 0.81 (CI: 0.74-0.88) in the same groups mentioned above ($p < 0.01$) in the two categories and in each geographical area. In 2013, when comparing non-vulnerable student with the most vulnerable ones and with those who with moderate vulnerability, the results showed OR of 0.96 (CI: 0.93-0.98) ($p < 0.01$) and 0.99 (CI: 0.96-1.02) ($p = 0.36$) in the urban area, and OR of 0.89 (CI: 0.82-0.96) ($p < 0.01$) and 0.94 (CI: 0.86-1.02) ($p = 0.16$) in rural areas, respectively.

When determining the variation of OR between both years, OR increased in the two categories of vulnerability, with the highest increase among the most vulnerable students [of 0.85 (CI: 0.82-0.88) to 0.96 (CI: 0.93-0.98) in the urban areas, and of 0.70 (CI: 0.64-0.75) to 0.89 (CI: 0.82-0.96) in rural areas].

Discussion

The main results of this study showed that the obesity prevalence increased significantly in all groups between 2009 and 2013. The prevalence was higher in boys, however, the increase in the period was similar in both genders. The risk of obesity was lower in the most vulnerable children in both years, however, the highest obesity increase was in this group, especially in rural areas. This would indicate that the nutritional profile and physical activity might be changing at a faster pace in rural areas²⁷.

Our study found a weak and inverse association between SES and obesity in 2009 which decreased and it was significant only among the most vulnerable stu-

dents in rural areas in 2013. This would indicate that those students with higher SES have a lower risk of obesity compared to non-vulnerable students. These results are similar to those reported by Carrillo et al. in Peruvian children who reported higher incidence of childhood obesity among the less poorer group²⁸ and Friedman et al. in Ukraine who observed that middle-class children were 60% more likely to be overweight than those in the lower socioeconomic class²⁹.

The results described in this study are usually observed in countries that are in nutritional post-transition and in societies with a high level of development, where the most vulnerable people are more susceptible to weight gain³⁰⁻³². This was also raised by Figueroa Pedraza³³ in his publication about obesity and poverty in Latin America when he observed that in different countries, this relationship can be “influenced by the level of social and economic development of the country” and among the factors that influence both the process of urbanization and the industrial development of rural areas. Both situations would be associated with an increase in the consumption of foods with high-calorie density and a decrease in caloric expenditure.

In this study, the highest proportion of students with some level of vulnerability lived in rural areas. The difference in SES between urban and rural areas has also been reported in other Latin American countries such as Argentina and Colombia^{34,35}.

It is worth mentioning that students who constitute the JUNAEB databases are mostly classified in the first three income quintiles, therefore the “non-vulnerable” schoolchildren on average, would be in the third income quintile. Peroni A³⁶ showed, using the income classification from the National Socio-Economic Characterization Survey (CASEN) 2006, the highest prevalence of childhood obesity was found in children from the third income quintile, a situation that varied in 2015, since the percentage of childhood obesity was higher in children from the first quintile, in other words, the poorest³⁷.

The differential increase in obesity according to SES over time that we observed in this study has also been reported in Chilean adults, as shown by the National Health Surveys 2003 and 2010, where, in adult women with a low educational level, the prevalence of obesity increased from 38.4% to 46.7%, while in those with a high educational level of, it increased from 15.9% to 19.0% between 2003 and 2010^{38,39}.

The prevalence of obesity was significantly higher in boys, a result that did not vary when stratified by SES. The difference in prevalence by gender has also been reported by Kain et al. in 2014, where it was 22.7% and 16.5% in 6-year-old boys and girls respectively²⁰; and in Mexico, the United States and Brazil, where the prevalence was 17.4% and 11.8%, 20.1% and 15.7%,

16.6% and 11.8% in boys and girls respectively⁴⁰⁻⁴². This difference could be partly due to the use of the WHO reference to determine the prevalence of obesity as reported by Monasta et al. who compared the prevalence of obesity in 61-months-old children using the WHO and IOTF references, finding that it was 9% in boys and 4% in girls using the WHO reference and 4% and 3% using the IOTF reference respectively⁴³ and Rolland-Cachera in children aged 7-9 years, 10.8% in boys and 6.8% in girls using the WHO reference and 4.0% and 3.7% using the IOTF reference⁴⁴.

The main strength of this study is its representativeness among the Chilean population in first grade since it includes approximately 65% of all children in this level. In addition, as this study determined the prevalence of obesity stratified by SES and geographical area (rural/urban) over a period of 4 years, it was possible to quantify in each group the change in the period.

Among the weaknesses of the study, it is necessary to mention that we do not know how reliable is the weight and height data, due to the inadequate training received by the personnel who carry out the measurements and the equipment used, however, a study carried out by INTA showed that there is a good concordance when comparing the measurements registered by JUNAEB and highly qualified nutritionists (without significant differences)⁴⁵. Additionally, there is a bias in the SES classification and this is mainly due to the assignment of the Social Protection Survey score and the fact that the standard allows the most vulnerable students to remain in this condition for 3 years (even if their situation varied during the period). As a result, the proportion of vulnerable students was not only very high, but increased over time in contrast with what is reported in the CASEN surveys on the evolution of the poverty level in the country. Thus, the CASEN Survey 2013 (www.mds.cl) shows that using any of the current criteria, in other words, “multidimensional poverty” or “poverty by income level”, poverty decreased significantly during the study period. For instance, using the second criterion, the percentage of poor population was 11.4 and 7.8% in 2009 and 2013 respectively. The bias that originates when using the SINA-E-SVI cannot be measured, since in the JUNAEB bases it is impossible to know if the child actually comes from a family classified with the indicators used by the CASEN survey to determine poverty, however, it is most likely that the poorest are included in the very vulnerable group.

In conclusion, both in 2009 and 2013, the most vulnerable students in rural areas presented the lowest risk of obesity, however, the increase in this risk was only significant in the most vulnerable group, mainly those residing in rural areas.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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