Malnutrition in Argentine preschoolers: 2005-2019

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Abstract: In low- and middle-income countries, studies on children's health focus primarily on their nutritional status, especially the presence of malnutrition. Child malnutrition is a major public health problem in Argentina. The objective of this research is to study the determinants and evolution of young children's nutritional status in Argentina at the national level, and at different socioeconomic levels, between 2005 and 2019. We use data from the 2004-05 and 2018-19 National Survey of Nutrition and Health (ENNyS1 and ENNyS2). We use multivariate logit models, including household risk factors for childhood malnutrition, to estimate the likelihood of the occurrence of stunting and overweight in Argentinian children aged 24 to 60 months. Our results show that the prevalence of overweight among preschoolers has increased significantly between 2005 and 2019, from just below 10%, still a medium prevalence level, to more than 13%, a high prevalence level. The prevalence of overweight increased between 2005 and 2019 at all socioeconomic levels. The prevalence of stunting has not significantly changed in almost 14 years, remaining at around 7%, a low level. Except for the Cuyo region, which is close to the intermediate level, stunting prevalence in all regions remains between 5 and 8%. Understanding the determinants and evolution of young children's nutritional status is key to implementing policies aimed at improving childhood nutrition.

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Malnutrición en preescolares de Argentina: 2005-2019

Resumen: En los países de ingresos bajos y medios, los estudios sobre la salud de los niños se centran en su estado nutricional, especialmente en la presencia de malnutrición. La desnutrición infantil es un importante problema de salud pública en Argentina. Nuestro objetivo es estudiar los determinantes y la evolución del estado nutricional de preescolares en Argentina a nivel nacional, y a distintos niveles socioeconómicos, entre 2005 y 2019. Utilizamos datos de la Encuesta Nacional de Nutrición y Salud 2004-05 y 2018-19 (ENNyS1 y ENNyS2). Utilizamos modelos logit multivariados, que incluyen factores de riesgo de malnutrición a nivel hogar, para estimar la probabilidad de ocurrencia de retraso en el crecimiento y sobrepeso en preescolares de Argentina de 24 a 60 meses de edad. Nuestros resultados muestran que la prevalencia de sobrepeso entre preescolares ha aumentado significativamente entre 2005 y 2019, de poco menos de 10%, todavía un nivel de prevalencia medio, a más de 13%, un nivel de prevalencia alto. La prevalencia de sobrepeso aumentó entre 2005 y 2019 en todos los niveles socioeconómicos. La prevalencia de retraso en el crecimiento no ha cambiado significativamente en casi 14 años, manteniéndose en torno a 7%, un nivel bajo. A excepción de la región de Cuyo, que bordea el nivel medio, la prevalencia de retraso en el crecimiento en todas las regiones se mantiene entre 5 y 8%. Comprender los determinantes y la evolución del estado nutricional de niñas y niños es clave para implementar políticas destinadas a mejorar la nutrición en la infancia.

Palabras clave: malnutrición; preescolares; obesidad; acortamiento.

1. Introduction

Malnutrition occurs when either a diet has insufficient nutrients or some large imbalance/overabundance of certain nutrients so that it causes health problems (United Nations Children`s Found [UNICEF], 2006). Malnutrition includes both undernutrition and overnutrition, which manifests as overweight and obesity (Black et al., 2016). The measures commonly used to estimate undernutrition are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height), and to estimate overnutrition are overweight and obesity (excessive weight-for-height).

Child malnutrition is a major public health problem in Argentina. Although there is a decreasing trend in infant mortality due to malnutrition (Abeldaño Zuñiga et al., 2018), it continues to have a prominent magnitude, especially in certain areas of northern Argentina (Longhi and del Castillo, 2017; Longhi et al., 2018). There are several studies on the nutritional status of children in Argentina focusing on specific areas or cities of the country (Aparicio et

al., 2012; Bassett et al., 2014; Bejarano et al., 2019; Bergel Sanchís et al., 2017; Bolzán et al., 2005; Bolzán and Mercer, 2009; Bustamante et al., 2021; Cesani et al., 2013; Cordero et al., 2021; de Piero et al., 2017; Garraza et al., 2016; Kovalskys et al., 2011; Lomaglio, 1999; Núñez et al., 2020; Oyhenart et al., 2008; Padula and Salceda, 2013) and at a national level (Durán et al., 2009; Muniagurria and Novak, 2014; Novak and Muniagurria, 2017; Zapata et al., 2020). Only a handful of studies analyze changes in the nutritional status of children over time. All of them show an increase in the prevalence of overweight/obesity (Bejarano et al., 2005; Bustamante et al., 2021; Cesani et al., 2022; Navazo et al., 2018). Bejarano et al. (2005) studied the city of San Salvador de Jujuy, Jujuy province, during the period 1996-2000; Bustamante et al. (2021) the north of Jujuy province for the period 1996-2015; Cesani et al. (2022) the provinces of Buenos Aires, Mendoza and Misiones for the periods 2005-2009 and 2010-2019; and Navazo et al. (2018) the coastal city of Puerto Madryn, in the southern province of Chubut, for the period 2001-2006 to 2014-2016. Although with different indicators, these studies also found that undernutrition levels either decreased or remained constant over time: Bejarano et al. (2005) and Navazo et al. (2018): estimated the prevalence of stunting; Bustamante et al. (2021): the prevalence of underweight; and Cesani et al. (2022): estimated the combined the prevalence of stunting, underweight, and wasting.

Our goal is to study the determinants and evolution of young children's nutritional status in Argentina at the national level between 2005 and 2019. The problem of child malnutrition is particularly complex in the country because epidemiological studies show an unusual pattern: a low prevalence of acute undernutrition,[3] a moderate prevalence of stunting, as well as an increasing prevalence of overweight and obesity (Durán, 2005). Our analysis will focus on stunting, for under-nutrition, and on overweight, for over-nutrition.

2. State of the art

In low- and middle-income countries, studies on children's health focus primarily on their nutritional status, especially the presence of malnutrition. The combination of undernutrition and infectious diseases is still one of the major problems facing public health in these countries (Rice et al., 2000). Undernutrition is the underlying cause of child mortality associated with infections such as diarrhea, measles, pneumonia, and malaria (Caulfield et al., 2004; Kirolos et al., 2021). Beyond mortality, child undernutrition has long-term

[3] Acute malnutrition occurs when the weight of a child is much lower than the reference standard of her or his height (Dipasquale et al., 2020).

consequences on both health (Martins et al., 2011) and neurodevelopment (Galler et al., 2021).

Stunting reflects a cumulative linear delay in growth. That is, it does not measure short-term changes. Stunting is determined by genetic potential and net nutrition over the years (Roth et al., 2017). Underweight has long-term effects such as physical and mental health abnormalities, low educational achievement, and behavioral problems (Acquah et al., 2019). Wasting reflects recent weight loss due to illness and deficient nutritional intake. Wasting, or acute undernutrition, are mortality risk factors that have negative consequences for human development (Karlsson et al., 2022). On the other hand, childhood overweight and obesity have significant effects on physical and psychological health and are very likely to have adverse health effects at younger ages (Sahoo et al., 2015). Obesity in children is associated with immediate health risks (including hypertension and insulin resistance) and a higher likelihood of being obese and develop diabetes and cardiovascular disease at adulthood (Brady, 2017; Marcovecchio et al., 2010). The economic burden of overweight and obesity due to lost productivity and increased health care costs is striking and hinders the economic development of a country. Malnutrition due to excess (overweight) is the most important problem for children and adolescents in Argentina and specially for those in the more vulnerable socioeconomic groups (Secretaría de Salud y Desarrollo Social [Secretary of Health and Social Development], 2018).

Malnutrition is considered an important risk factor for the development of different types of diseases and other outcomes that are not limited to health (Grantham-McGregor et al., 2007). Stunting has long-term effects on cognitive development, school performance, maternal reproductive outcomes, and economic productivity in adulthood (Dewey and Begum, 2011). Studies for Latin America and the Caribbean have shown that stunting and wasting are related to the manifestation of negative emotions (Flores Villavicencio et al., 2005) and that stunting at early ages is related to educational and cognitive deficits, both in childhood (Freeman et al., 1980) and adolescence (Walker et al., 2007). A relationship has also been found between stunting, obesity and motor, social and emotional developmental disorders in infants (Bove et al., 2012). Evidence from the biological and social sciences points to the importance of early childhood conditions as determinants of well-being and economic success later in life (Case and Paxson, 2010; Conti and Heckman, 2012). Child health affects the acquisition of traits linked to economic success in adulthood and therefore plays a role in the transmission of inequalities (Palloni, 2006).

3. Conceptual framework

This study uses the conceptual framework developed by UNICEF in 1990 as a component of the UNICEF Nutrition Strategy (UNICEF, 1998). This framework places malnutrition in the broad context of economic and social development. According to this theoretical perspective, child malnutrition is the result of a set of multisectoral factors operating at the individual, household or family, and societal levels. These factors can be considered immediate, underlying, and basic causes of malnutrition. The immediate causes of malnutrition are inadequate dietary intake and diseases, particularly infectious diseases; these causes interact with each other. The underlying causes of malnutrition include insufficient access to food; inadequate maternal and childcare practices; and poor water/sanitation and inadequate health services. The basic causes at societal level comprise both quantity and quality of actual resources and the way they are controlled (UNICEF, 1998). This framework provides a comprehensive approach to identify the risks of malnutrition associated with factors at different levels.

Under this framework and considering the information provided by the data sources used, we include information on household factors of child malnutrition (household economic well-being as a function of housing characteristics and physical assets and the educational level of the household head), and social factors (considering the six regions into which the country is divided).

4. Data and methods

4.1. Data

We use data from the National Survey of Nutrition and Health [*Encuesta Nacional de Nutrición y Salud*] (ENNyS) conducted by the Argentine Ministry of Health in 2004-05 (ENNyS1) and in 2018-19 (ENNyS2) (Ministerio de Salud [Ministry of Health], 2022). ENNyS1 was the first nationally representative survey with anthropometric/bio measures for children younger than 5 years of age. Although both surveys were conducted nationwide, geographically they only considered the urban population in localities with 5,000 or more inhabitants, according to National Population Censuses.

Both datasets contain information on health, anthropometry, nutrition, and socioeconomic indicators for several groups. However, there are differences between the groups in the two surveys. ENNyS1 has information on children aged 6 months to 5 years, women aged 10 to 49 years, and pregnant women and is representative at the national and either the provincial or the regional levels, for each age group. In contrast, ENNyS2 divides the sample into lactating children aged 0 to 23 months, children aged 2 to 17 years and adults

18 years and older and is representative at national and regional levels for each age group. Both surveys were based on a probability sample that covered all social strata of the target population providing socioeconomic information at household and individual levels. While ENNyS1 also provides information on other aspects of nutrition like food intake, ENNyS2 includes information on patterns of food consumption, breastfeeding, physical activity, food consumption is school facilities, food labelling and marketing links to choices. One major difference between surveys is the sample size for children between 6 to 60 months of age: while for ENNyS1 the sample size is around 27,000 for ENNyS2 it is around 6,000 children. Of these samples, only 15,513 children are of preschool age in ENNyS1 and 1,738 in ENNyS2.

4.2. Methods

4.2.1. Determination of the nutritional status of children

We use two indicators to measure very different aspects of nutrition and health: height-for-age and weight-for-height. To compare children of different age and sex, for ENNyS1, we combined anthropometric data with date of birth to create a height-per-age z-score (HAZ) and weight for height z-score (WHZ) using the World Health Organization guidelines (WHO, 2006). We used the WHO Anthro statistical package developed by the WHO, version 3.22 (WHO, 2010). The package uses the standards obtained by WHO (WHO Child Growth Standards) based on a study involving healthy children from several countries (WHO, 2006).

The z-score statistic is defined as the deviation of an individual (observed) value from the mean value of the reference population divided by the value of the standard deviation (SD) of the reference population (de Onis and Blössner, 1997). The z-score system is used to calculate the number of SDs above or below the mean reference value of the anthropometric measure under consideration. For ENNyS2 (2018-19), the z-scores were calculated in a similar fashion by the Ministry of Health.

The cut-off points or thresholds used are as follows (WHO, 2006): Height-for-age (HAZ) < -2 SD will classify as short for age (stunting or chronic malnutrition). Weight-for-height (WHZ) >2 SD will classify as (overweight). Since (WHZ) >3 SD classifies as obesity, the cutoff point for overweight includes cases of obesity.

4.2.2. Variables of Interest

4.2.2.1. Wealth Index

We construct a summary measure of a household's economic well-being using information on housing characteristics and physical assets. Filmer and Pritchett (1999) have

shown that such asset indexes are robust, reliable, and provide good estimates of long run wealth since they are less sensitive to transitory fluctuations than consumption expenditures.

The Wealth Index was computed separately for ENNyS1 and ENNyS2 using principal components of dwelling characteristics and household assets that were collected in both surveys[4] for children aged 6-24 months.

The variables analyzed were housing type, flooring material, number of people per room (excluding kitchen and bathroom), water supply, type of sanitary service and if the dwelling has electricity service, refrigerator, and landline telephone. The principal components analysis was used to assign weights to the different components resulting in an index with a mean of 0 and a SD of 1. However, to facilitate its interpretation, it was re-scaled by adding 5 units so that its values are all positive. For the statistical analysis, quartiles of the Wealth Index distribution were used. Accordingly, four segments were defined[5]: the fourth segment represents the group of households with the highest economic well-being and the first segment represents the group of households with the lowest economic well-being.

Although the sample only included dwellings in urban areas, some of them were in precarious settlements with little or no access to standard city services. Therefore, this indicator, although broad, captures reasonably well the variation in household economic well-being in the sample.

4.2.2.2 Head of Household Educational Attainment

We use the educational level of the household head because, unlike ENNyS2, ENNyS1 does not identify the child's mother. Therefore, the educational level of the reference person was taken as a proxy for the educational level of the person making consumption decisions that may significantly affect the entire household. Three categories were considered: incomplete or complete primary level, incomplete secondary level, and complete secondary level or higher.

4.2.2.3 Statistical Regions

Due to the heterogeneity and inequality of territorial development, which has been registered in all historical periods (Cao and Vaca, 2006), it was decided to consider the

[4] The principal components analysis is a mathematical algorithm used to reduce the dimensionality of the data, in this case the number of variables used to construct the index, without losing the variability of the data.

[5] These segments are not perfectly balanced due to the high number of repeated values, which has made it difficult to determine the cut-off points.

statistical regions determined by the Instituto Nacional de Estadística y Censos [National Institute of Statistics and Census] (Ministerio de Hacienda [Ministry of Finance], 2017): Cuyo, Greater Buenos Aires, Northeast, Northwest, Pampa, and Patagonia.[6]

4.2.3. Statistical Analysis

Descriptive analyses were used to examine the composition of both samples, ENNyS1 and ENNyS2. Z-tests were used to determine whether there are significant differences between samples in the proportion of a given characteristic, operationalized as a dichotomous variable. To determine whether there are significant differences between surveys in the mean ages of the children studied, the t-test was used.

We use multivariate logit models to estimate the likelihood of the occurrence of stunting and overweight in Argentinian children aged 24 to 60 months. We use logistic regressions to investigate how individual-level factors (age and sex of children), family-level factors (educational level of the head of household and household economic well-being) and societal-level factors (region of residence) affect child nutritional status.

In all cases, p-values < 0.05 were considered statistically significant. All statistical analyses were performed using Stata, version 17 (StataCorp LLC, College Station, Texas).

5. Results

5.1. Descriptive Statistics

As mentioned above ENNyS1 and ENNyS2 are very different in terms of sample size. Considering only the cases with complete information on each variable of interest, the analytical samples for ENNyS1 and ENNyS2 are composed of 14,306 and 1,646 children aged 2 to 5 years, 92.2 and 94.7% of the original samples, respectively. Table 1 shows that children in the ENNyS2 analytical sample are somehow younger than in the ENNyS1. However, the proportion of males and females is similar in both samples. There are differences in the proportion of children in the six regions, except for the Northeast and Pampa regions, being higher for ENNyS2 than for ENNyS1 in the regions of Greater Buenos Aires and Cuyo. However, is smaller for the regions of Northwest and Patagonia. As expected, there are differences in the maximum educational level attained by the household heads, with a lower proportion of heads of household in ENNyS2 than in ENNyS1 with primary education or

[6] Cuyo (Mendoza, San Juan, and San Luis), Great Buenos Aires (Autonomous City of Buenos Aires, and Greater Buenos Aires), Northeast (Corrientes, Chaco, Formosa, and Misiones), Northwest (Catamarca, Jujuy, La Rioja, Salta, Santiago del Estero, and Tucumán), Pampa (Buenos Aires, Córdoba, Entre Ríos, La Pampa, and Santa Fe), and Patagonia (Río Negro, Neuquén, Chubut, Santa Cruz, Tierra del Fuego, Antártida and South Atlantic islands).

less. In contrast, there is a higher proportion of heads of household with at least some secondary education in ENNyS2 than in ENNyS1. Regarding the Wealth Index, our results show that there are no differences in the proportion of households in the first and fourth quartiles of the Wealth Index distribution. However, compared with ENNyS1, ENNyS2 shows a 2.8% increase in the proportion of households in the second quartiles of the Wealth Index distribution and a 2.5% decrease in the proportion of households in the third quartile (Table 1).

Table 1. Descriptive Analysis – Analytical Sample ENNyS1 y ENNyS2 Children 2 to 5 Years of Age

Variables	ENNyS1 (n =14,306)	ENNyS2 (n = 1,646)	p-value
Age in Month (Mean, SD)	**42.23 (10.48)**	**41.62 (10.52)**	**0.018**
Sex			
Males (%)	50.22	48.66	0.199
Females (%)	49.78	51.34	0.199
Region of Residence			
Greater Buenos Aires (%)	**6.65**	**15.55**	**<0.001**
Cuyo (%)	**12.06**	**16.34**	**<0.001**
Northeast (%)	17.31	16.10	0.217
Northwest (%)	**25.06**	**18.83**	**<0.001**
Pampa (%)	15.47	17.31	0.052
Patagonia (%)	**23.45**	**15.87**	**<0.001**
Educational Attainment of the Reference Person			
Primary Incomplete or Complete (%)	**42.61**	**33.05**	**<0.001**
Secondary Incomplete (%)	**40.08**	**46.11**	**<0.001**
Secondary Complete or Over (%)	**17.31**	**20.84**	**<0.001**
Wealth Index			
1st Quartile (Worst)	25.02	24.60	0.716
2nd Quartile	**25.19**	**27.95**	**0.015**
3rd Quartile	**29.14**	**26.67**	**0.036**
4th Quartile (Best)	20.65	20.78	0.902
Stunting			
Yes (%)	7.19	6.93	0.698
No (%)	92.81	93.07	0.698
Overweight			
Yes (%)	**9.24**	**13.49**	**<0.001**
No (%)	**90.76**	**86.51**	**<0.001**

Note: p-value: t-test for the difference in mean ages between ENNyS1 and ENNyS2; z-test for the difference in percentages between ENNyS1 and ENNyS2; SD: Standard deviation.
Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

Our results show that the prevalence of stunting at the national level in 2005 and 2019 is similar (7.2% and 7.0%, for ENNyS1 and ENNyS2 respectively). However, there is a 4.2% increase in the prevalence of overweight between ENNyS editions. While the prevalence of overweight among children aged 2 to 5 years is 9.2% according to ENNyS1 in 2005, around 14 years later this figure is 13.50% for children in the same age range, according to ENNyS2 (Table 1).

Analyzing by region our findings are as follows. In five of the six regions, the results show no difference in the prevalence of stunting between waves for the regions of Greater

Buenos Aires and Patagonia (around 6.0%[7]), the regions of Pampa and Northwest (around 7.0%[6]), and the Northeast region (8.4%[6]). On the contrary, for the Cuyo region there is a 3.4% increase in the prevalence of stunting (from 6.3%, in 2005, to 9.7%, in 2018). Regarding the prevalence of overweight, there are no differences between surveys in three regions: the Greater Buenos Aires, Cuyo, and Pampa regions (11.0%[8]). However, while the Northwest and Northeast regions show that the prevalence of overweight increased by 5.6% and 4.5%, respectively, in the Patagonia region the prevalence of overweight among children aged between 2 and 5 years doubled, reaching around 20.0% (Table 2).

Considering the Wealth Index, our results show that there are no differences between surveys in the proportion of stunted children in households belonging to the second and fourth quartiles of the distribution, 6.4%[9] and 4.6%[8], respectively. While in households in the first quartile the proportion of stunted children decreases by 4.0%, in households in the third quartile of the distribution the proportion of stunted children increases by 2.5% (Table 3). ENNyS1 shows a decreasing gradient in the prevalence of stunting, which disappears in ENNyS2 (Table 3). However, although the prevalence of stunting among children living in households in the first quartile of the Wealth Index distribution decreased by about four percentage points, it is still the highest (9.1%). Regarding overweight, except for households in the upper quartile of the distribution, with a prevalence of 12.0%[10], all households show an increase, ranging between 4.1 and 6.5 percentage points, in the prevalence of overweight children aged 2 to 5 (Table 3). ENNyS1 shows an increasing gradient in the prevalence of overweight, which also disappears in ENNyS2 (Table 3).

[7] Simple average between ENNyS1 and ENNyS2 in the prevalence of stunting for each region.

[8] Simple average between ENNyS1 and ENNyS2 in the prevalence of overweight for each region.

[9] Simple average between ENNyS1 and ENNyS2 in the prevalence of stunting for each category of the Wealth Index.

[10] Simple average between ENNyS1 and ENNyS2 in the prevalence of overweight for each category of the Wealth Index.

Table 2. Descriptive Analysis – Region of Residence: Analytical Samples ENNyS1 y ENNSy2 Children 2 to 5 Years of Age, by Stunting and Overweight

Region of Residence		Stunting			Overweight		
		ENNyS1	ENNyS2	p-value	ENNyS1	ENNyS2	p-value
Greater Buenos Aires							
	N	952	256		952	256	
	%	6.62	5.08	0.481	11.03	11.33	0.892
Cuyo							
	N	1,725	269		1,725	269	
	%	**6.26**	**9.67**	**0.038**	9.33	11.90	0.184
Northeast							
	N	2,477	265		2,477	265	
	%	9.16	7.55	0.384	**6.82**	**12.45**	**<0.001**
Northwest							
	N	3,585	310		3,585	310	
	%	7.22	7.74	0.735	**9.18**	**13.55**	**0.012**
Pampa							
	N	2,213	285		2,213	285	
	%	7.59	5.96	0.323	9.76	12.28	0.183
Patagonia							
	N	3,354	261		3,354	261	
	%	6.08	5.36	0.638	**10.20**	**19.54**	**<0.001**

Note: p-value: z-test for the difference in percentages between ENNyS1 and ENNyS2.
Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

Table 3. Descriptive Analysis – Wealth Index: Analytical Samples ENNyS1 y ENNSy2 Children 2 to 5 Years of Age, by Stunting and Overweight

Wealth Index	Stunting			Overweight		
	ENNyS1	ENNyS2	p-value	ENNyS1	ENNyS2	p-value
1st Quartile (Worst)						
N	3,579	405		3,579	405	
%	**13.08**	**9.14**	**0.024**	**6.99**	**11.60**	**<0.001**
2nd Quartile						
N	3,604	460		3,604	460	
%	7.05	5.65	0.264	**8.74**	**15.22**	**<0.001**
3rd Quartile						
N	4,169	439		4,169	439	
%	**4.77**	**7.29**	**0.021**	**10.05**	**14.12**	**0.008**
4th Quartile (Best)						
N	2,954	342		2,954	342	
%	3.66	5.56	0.084	11.44	12.57	0.536

Note: p-value: z-test for the difference in percentages between ENNyS1 and ENNyS2.
Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

Our results show that there are no differences between ENNyS1 and ENNyS2 in the proportion of stunted children in households where the educational attainment of the person of reference is primary incomplete/complete or at least secondary complete, 8.6%[11] and 4.6%[10], respectively. However, the prevalence of stunting among children in households where the educational attainment of the person of reference is secondary incomplete is around two percentage points higher in 2019 than it was in 2005 (Table 4). ENNyS1 shows a decreasing gradient in the prevalence of stunting while the educational level of the reference person increases. This gradient disappears in ENNyS2 (Table 4). All households, regardless of the educational level of the reference person, show an increase in the prevalence of overweight in preschool children (5.0, 3.9, and 3.5 percentage points among children living in households where the educational level of the person of reference is primary incomplete/complete, secondary incomplete, and secondary complete or over, respectively (Table 4). In ENNyS1 the highest prevalence of overweight was among those children living in a household where the educational level of the reference person is at least secondary complete. However, differences in overweight prevalence disappear in ENNyS2 (Table 4).

[11] Simple average between ENNyS1 and ENNyS2 in the prevalence of stunting for each educational level of the person of reference.

Table 4. Descriptive Analysis – Educational Attainment of the Reference Person: Analytical Samples ENNyS1 y ENNSy2 Children 2 to 5 Years of Age, by Stunted and Overweight

Educational Attainment of the Reference Person		Stunting			Overweight		
		ENNyS1	ENNyS2	p-value	ENNyS1	ENNyS2	p-value
Primary Incomplete or Complete							
	N	6,096	544		6,096	544	
	%	9.71	7.54	0.099	**8.83**	**13.79**	**<0.001**
Secondary Incomplete							
	N	5,734	759		5,734	759	
	%	**5.69**	**7.51**	**0.046**	9.03	12.91	**<0.001**
Secondary Complete or Over							
	N	2,476	343		2,476	343	
	%	4.48	4.66	0.880	10.74	14.29	0.050

Note: p-value: z-test for the difference in percentages between ENNyS1 and ENNyS2.
Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

Table 5. **Multivariate Analysis – Logistic Regression Children 2 to 5 Years of Age, Dependent Variable Stunting and Overweight - ENNyS1 and ENNyS2 (n=15,952)**

Variables	Stunting				Overweight			
	ENNyS1 (n=14,306)		ENNyS2 (n=1,646)		ENNyS1 (n=14,306)		ENNyS2 (n=1,646)	
	OR (SE)	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Age in Months	1.00 (0.00)	[0.99,1.00]	**0.97** ** **(0.01)**	**[0.96,0.99]**	1.00 (0.00)	[1.00,1.01]	1.00 (0.00)	[0.99,1.02]
Sex								
Ref. Male	1.00		1.00		1.00			
Female	1.01 (0.07)	[0.89,1.15]	1.03 (0.21)	[0.76,1.52]	**0.85** ** **(0.05)**	**[0.76,0.95]**	1.09 (0.16)	[0.82,1.45]
Educational Attainment of the Reference Person								
Ref. Secondary or More	1.00		1.00		1.00		1.00	
Secondary Incomplete	0.93 (0.11)	[0.74,1.17]	1.50 (0.45)	[0.83,2.70]	0.93 (0.08)	[0.79,1.10]	0.89 (0.17)	[0.60,1.30]
Primary Incomplete/Complete	1.26† (0.15)	[1.00,1.60]	1.44 (0.45)	[0.76,2.71]	1.03 (0.09)	[0.86,1.22]	1.00 (0.21)	[0.66,1.52]
Wealth Index								
Ref. 4th Quartile (Best)	1.00		1.00		1.00		1.00	
3rd Quartile	**1.26*** **(0.16)**	[1.01,1.65]	1.23 (0.37)	[0.68,2.24]	0.86† (0.07)	[0.73,1.00]	1.13 (0.24)	[0.74,1.73]
2rd Quartile	**1.91*** **(0.24)**	[1.49,2.45]	0.86 (0.27)	[0.46,1.61]	**0.74** ** **(0.07)**	**[0.62,0.88]**	1.26 (0.27)	[0.82,1.93]
1st Quartile (Worst)	**3.61*** **(0.45)**	[2.83,4.60]	1.44 (0.45)	[0.78,2.67]	**0.60*** **(0.06)**	**[0.49,0.73]**	0.98 (0.24)	[0.61,1.58]
Region of residence								
Ref. Greater Buenos Aires	1.00		1.00		1.00		1.00	
Cuyo	0.82 (0.14)	[0.59,1.14]	**2.12*** **(0.70)**	**[1.05,4.28]**	0.87 (0.11)	[0.67,1.13]	1.02 (0.28)	[0.59,1.75]
Northeast	0.96 (0.15)	[0.72,1.30]	1.44 (0.42)	[0.69,2.98]	**0.65** ** **(0.09)**	**[0.50,0.85]**	1.11 (0.30)	[0.65,1.90]
Northwest	0.80 (0.12)	[0.60,1.07]	1.59 (0.47)	[0.79,3.20]	0.90 (0.11)	[0.71,1.14]	1.21 (0.31)	[0.73,2.01]
Pampa	1.05 (0.16)	[0.77,1.42]	1.23 (0.40)	[0.58,2.61]	0.89 (0.11)	[0.70,1.14]	1.09 (0.29)	[0.64,1.85]
Patagonia	0.96 (0.15)	[0.71,1.29]	1.18 (0.44)	[0.54,2.61]	0.91 (0.11)	[0.72,1.15]	**1.83*** **(0.47)**	**[1.11,3.02]**
Constant	0.05*** (0.01)	[0.03,0.07]	0.09***(0.05)	[0.03,0.27]	0.14***(0.02)	[0.10,0.20]	0.10***(0.04)	[0.05,0.23]

Note: Ref.: Reference category; † p < .1; * p < .05; ** p < .01; *** p < .001.

Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

5.2. Multivariate Analysis

Analyzing the determinants of stunting, as it was expected, in 2005, living in a household belonging to any of the three lower quartiles, compared with living in a household belonging to the fourth quartile, increased the odds of being stunted (Table 5). However, in 2019 there were no differences in the odds of being stunted between living in a household belonging to any of the three lower quartiles, compared with living in a household belonging to the fourth quartile of the Wealth Index distribution (Table 5). In contrast, ENNyS2 shows that any month increase in age decreases the odds of being stunted and that, compared with living in Greater Buenos Aires, living in the Cuyo region increases the odds of being stunted (Table 5).

Table 5 also shows that in 2005 being female decreases the odds of being overweight, on the contrary in 2019 there were no differences between males and females in the odds of being overweight. Also in 2005, compared with living in a household belonging to the fourth quartile of the Wealth Index distribution, living in a household belonging to any of the lower quartiles decreased the odds of being overweight. The same was true among those children living in the Northeast region, compared with those living in the Greater Buenos Aires region. In 2019, living in the Patagonia region, compared with living in Greater Buenos Aires almost doubled the odds of being overweight. In general, these results show that variables used in the present analysis fail to explain in any meaningful proportion the likelihood of being stunted or overweight. However, the analysis shows a period effect particularly in the increment in the prevalence of overweight preschool children.

To analyze the presence of this period effect, we include in the analysis a variable to consider the year in which the surveys were conducted. As expected, Table 6 shows that there is a period effect in the odds of being overweight among preschool children. In 2019, the odds of being overweight were 55% higher than in 2005. There is no period effect in the odds of being stunted (Table 6). These results were obtained adjusting the models for the other covariates.

Table 6. Multivariate Analysis – Logistic Regression Children 2 to 5 Years of Age, Dependent Variable Stunted - Combined ENNyS1 y ENNyS2 (n=15,952)

Variables	Stunting		Overweight	
	OR (SE)	[95% CI]	OR	[95% CI]
Survey				
Ref. ENNyS1	1.00		1.00	
ENNyS2	0.98 (0.10)	[0.80,1.20]	**1.55*** (0.12)**	**[1.33,1.81]**
Constant	0.05*** (0.01)	[0.03,0.07]	0.12*** (0.01)	[0.09,0.17]

Note: Ref.: Reference category. Models adjusted for sex, age, educational attainment of the reference person, Wealth Index, and region of residence.

† p < .1; * p < .05; ** p < .01; *** p < .001.

Source: National Survey of Nutrition and Health 2004-05 and 2018-19 (ENNyS1 and ENNyS2).

6. Discussion

This study has two strengths: (i) To the best of our knowledge this is the first study comparing the nutritional status of children aged 2 to 5 years using two national representative surveys, and (ii) these surveys allowed us to use the WHO standards to compute the prevalence of stunting and overweight, instead of other growth charts. The WHO standards have shown to be a reliable tool to diagnose nutritional impairments and are the only ones developed with information gathered from infants fed according to the WHO recommendations (Padula et al., 2012).

Our results show that the prevalence of overweight among Argentine preschoolers has increased significantly between 2005 and 2019, from just below 10%, still a medium prevalence level, to more than 13%, a high prevalence level, according to de Onis and colleagues' (2019) thresholds. The prevalence of overweight increased between 2005 and 2019 at all socioeconomic levels, regardless of how it was measured, using a wealth index or the educational level of the reference person. Although children in lower socioeconomic segments had significantly lower odds of being overweight in 2005 compared with children in the highest socioeconomic segment, this effect disappears in 2019.

Our results are consistent with the studies mentioned in the introduction and with surveillance data from a government program targeting uninsured children and adolescents (about 3 million). The latter shows that overweight and obesity prevalence increases with age, and it is more pronounced in certain provinces/regions, Patagonia being the highest (Secretaría de Salud y Desarrollo Social, 2018). Although overweight prevalence from children in the mentioned program is substantially higher than those of the nationally representative surveys like the ones we use in our work, they are consistent with our results

showing a significant increase in overweight prevalence between 2005 and 2019 for all children and, particularly, for those in the lower socioeconomic segments.

Obesity is the result of multiple causes, including environmental, socioeconomic, and cultural factors, as well as dietary factors such as portion size, consumption of fast food, snacks and sugary drinks (Sahoo et al., 2015). There is ample evidence that identifies exposure to unhealthy food (obesogenic environments), characterized by increased access to sugar- and salt-free foods and intense promotion of these products, as one of the main risk factors for obesity in children (UNICEF, 2019). The consumption of ultra-processed foods[12] is associated with disorders in different metabolic traits that may be risk factors for obesity (Handakas et al., 2022). According to the Organización Panamericana de la Salud (OPS, 2019) [Pan American Health Organization], Argentina has the third highest consumption of ultra-processed products, behind Chile and Mexico (OPS, 2019). Analyzing by regions of the country, Zapata and Rovirosa (2021) found that between 2004-05 and 2017-18 the consumption of processed meats increased in five regions, between 16.7% (Patagonia region, from 24 to 28%) and 35.3% (Cuyo region, from 17 to 23%). The exception was Greater Buenos Aires, where consumption of processed meats remained at a level of 22%. Neri and collaborators (2022) studied the contribution of different types of food to the total energy intake of Argentine preschool children. Their analysis shows that 15% corresponds to processed culinary ingredients, 16% are processed foods, and 27% are ultra-processed foods.

As reported by our results, the prevalence of stunting has not significantly changed in 14 years, remaining at around 7%, a low level, according to the thresholds categories defined by de Onis and colleagues (2019). Except for the Cuyo region, which is bordering the medium level, stunting prevalence in all regions remains between 5 and 8%. The strong socioeconomic gradient for stunting in 2005 (children in lower socioeconomic segments had higher odds of stunting, compared with the highest socioeconomic segment), is not present in 2019. Other studies also show that stunting decreases or remains stable among children in the three years recorded: 2014, 2015 and 2016 (Secretaría de Salud y Desarrollo Social, 2018).

Our study has limitations that arise from the databases used. As mentioned in the Methods section, ENNyS1 and ENNyS2 are not fully compatible. Therefore, we were unable to use the full set of variables provided by each survey that would have allowed us to better understand the differences in the determinants of stunting and overweight over time. Our results are at the national level and consequently represent a national average. Since Argentina is a very diverse country with an unequal distribution of wealth, we are not in a

[12] Food substances made from few whole foods that often contain flavorings, colorings, and other enhancing additives (Neri et al., 2022).

position to consider existing differences in malnutrition at a more disaggregated level. Previous studies show the existence of an unequal spatial distribution of malnutrition (linked to poverty) which results in high rates of infant morbidity and mortality (Longhi et al., 2020).

Despite its limitations, this study contributes to the knowledge of the evolution of the nutritional status of preschool children in Argentina according to two dimensions: stunting, which reflects chronic malnutrition, and overweight, malnutrition due to excess caloric intake.

7. Conclusion

Although on average the prevalence of stunting is relatively low in Argentina, it can have long-term effects on different dimensions throughout life. Therefore, the fact that the prevalence of stunting has not declined in 14 years should be a call to address the nutritional needs of children, particularly those in economically disadvantaged households. In contrast, the prevalence of childhood overweight is high and has increased at all socioeconomic levels, indicating changes in dietary patterns that respond to cultural and environmental factors. In fact, our results show a period effect that could not be explained by the available information. Like stunting, childhood overweight, and especially obesity, can also have adverse effects that manifest themselves at different points in the life course. Understanding the determinants and evolution of young children's nutritional status is key to implementing policies aimed at improving childhood nutrition.

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