

Association between dietary diversity and socioeconomic factors with overweight and obesity in adolescents

Asociación entre diversidad dietética y nivel socioeconómico con sobrepeso y obesidad en adolescentes

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What do we know about the subject matter of this study?

Dietary diversity is crucial to preventing overweight and obesity and can be assessed with the Dietary Diversity Score. Most of the studies that analyzed the relationship between diversity and overweight and obesity have included children under 5 years of age or adults, with mixed results.

What does this study contribute to what is already known?

Our study included adolescents, in whom no association between dietary diversity and overweight and obesity was demonstrated. The risk factors for overweight and obesity were being female, higher educational level of the mother, maternal overweight, and belonging to the third wealth quintile.

Abstract

In recent years, childhood overweight and obesity have increased, being genetics, lack of physical activity, and unhealthy dietary habits the main risk factors. **Objective:** To evaluate the association between dietary diversity and socioeconomic factors with overweight and obesity in adolescents. **Patients and Method:** Cross-sectional evaluation of the fifth round of the younger cohort of the Young Lives study in Peru. Overweight, obesity, dietary diversity at home, socioeconomic factors, birth weight, breastfeeding history, and maternal anthropometry were evaluated. A multivariate logistic regression analysis was performed to identify the crude and adjusted association between the variables of interest, with their odds ratios and their respective 95% confidence intervals. **Results:** 1,860 adolescents (50.5% male) were included, with a median age of 14.9 years. 25.5% were overweight or obese and 61.5% had adequate dietary diversity. Protective factors for overweight and obesity were male sex (OR = 0.75; 95% CI: 0.59-0.95) and larger family size (OR = 0.91; 95% CI: 0.85-0.98), while risk factors were higher maternal educational level (OR = 1.43; 95% CI: 1.02-2.02), maternal overweight (OR = 1.90; 95% CI: 1.48-2.46), and belonging to the third wealth quintile (OR = 1.51; 95% CI: 1.01-2.26). No association was found between dietary diversity and overweight or obesity (OR = 0.89; 95% CI: 0.70-1.14). **Conclusions:** No association was found between dietary diversity and overweight and obesity in the participating adolescents. Risk factors included a higher maternal educational level, maternal overweight, and belonging to the third wealth quintile, while male sex and larger family size were protective factors.

Keywords:

Overweight;
Obesity;
Dietary Diversity;
Socioeconomic Factors;
Physical Activity

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Introduction

Obesity is a chronic disease caused by excessive adiposity and with a high risk of causing major complications¹. Since 1970, the global prevalence in adults has increased, with the highest level of obesity reported in the Americas at 28.6% in 2016². Additionally, childhood obesity constitutes a major public health challenge in the 21st century due to its potential to persist into adulthood, increasing the risk of developing non-communicable diseases, premature death, and disability^{2,3}.

The global age-standardized prevalence of obesity between the ages of 5 and 19 years increased dramatically from 0.7% in 1975 to 5.6% in 2016 in females and from 0.9% in 1975 to 7.8% in 2016 in males⁴. In Peru, the prevalence of overweight and obesity between 12 and 17 years of age is 19.3% and 5.5%, respectively. However, what is most worrying is that, according to projections, by 2030 more than 1 million Peruvians aged 5 to 19 years could be living with obesity⁵, underscoring the urgent need for effective strategies in its prevention and control, especially in the pediatric population.

Although genetics, lack of physical activity, unhealthy dietary habits, and the interactions between these factors increase the risk of developing overweight and obesity in children and adolescents, improving the quality of the diet constitutes one of the pillars for the control and prevention of obesity⁶. Considering that different food groups are associated with weight disorders and that there are interactions between food compounds and nutrients, the assessment of the overall diet is better than the assessment of a single dietary component⁷. Therefore, the Dietary Diversity Score (DDS) is the best indicator to assess overall diet quality, although mixed results have been published on the association between it and weight gain⁸⁻¹¹.

Additionally, socioeconomic factors associated with a higher prevalence of overweight and obesity in adolescents have been identified, such as parental education, family income level, poverty, urban residence, and sex¹². However, the existing literature has focused mainly on obesity in children under 5 years of age and adults, leaving an important gap regarding the adolescent population, especially in specific contexts such as Peru.

The objective of this study was to evaluate the association between dietary diversity and socioeconomic factors with overweight and obesity among adolescents participating in the Young Lives Cohort in Peru.

Patient and Method

Study design

Observational, analytic, cross-sectional study with secondary data from the younger cohort of the Young Lives Study, a longitudinal study conducted in Ethiopia, India, Peru, and Vietnam that started in 2002 with two randomly selected baseline groups: infants aged 6-18 months (younger cohort) and children aged 7-8 years (larger cohort). Follow-ups have now been conducted for almost 15 years, 2006-2007 (second round), 2009-2010 (third round), 2012-2013 (fourth round), and 2016-2017 (fifth round) for the two cohorts.

Population and sample

The study included 2000 infants in the younger cohort and 1000 children in the older cohort, with a public domain database available on the website <https://beta.ukdataservice.ac.uk/myaccount/credential>¹². The original study was carried out in three stages: in the first, using a sampling frame of 1818 districts of Peru, the country was divided into equal geographic regions, considering the poverty map of Peru prepared in 2000 by the Peru Social Development and Compensation Fund (FONCODES), excluding 5% of the districts with the highest socioeconomic level to over-represent the poorest areas. In the second stage, 20 sentinel sites were selected, and in each of them, one area was randomly selected; within each selected area, a random sample of blocks was obtained. Finally, in the third stage, infants aged between 6 and 18 months living in the selected blocks were selected.

This investigation included 1860 adolescents from the fifth round of 2016 of the younger cohort of the Young Lives study, aged 14-15 years, chosen from 20 districts in the regions of Lima, Piura, La Libertad, Tumbes, Amazonas, San Martín, Cajamarca, Ancash, Puno, Huánuco, Junín, Arequipa, Ayacucho, and Apurímac. The household questionnaire was answered by the person responsible for the family and included questions on household composition, characteristics of the participating population, socioeconomic level, health (including household food consumption), anthropometry, etc.

Definition of variables

Overweight and obesity were defined using the z-score of the body mass index for age (zBMI), considering the reference tables and software established by the WHO, establishing as overweight a zBMI > 1 and ≤ 2 standard deviations (SD) and obesity with zBMI > 2 SD (13). For this study, we considered overweight and obesity as a single variable, defined with a zBMI > 1.

Dietary diversity was measured with the household dietary diversity score (HDDS), which measures dietary diversity from the perspective of the household's ability to access food¹⁴. For the construction of the HDDS, the food groups were adapted to include the following: (i) cereals, (ii) roots and tubers, (iii) vegetables, (iv) fruits, (v) meat, poultry, and others, (vi) eggs, (vii) fish and seafood, (viii) legumes (including pulses) and nuts, (ix) milk and dairy products, (x) oils and fats, (xi) sugar and honey, and (xii) miscellaneous foods. Considering the above, the HDDS can score values between 0 and 12.

To construct the indicator, data on food consumption reported by the children's caregiver were used and organized into 15 food groups in Round 5. The HDDS was calculated by considering the total number of food groups consumed in the previous 24 hours, and this value was then divided by the total number of households to obtain the average HDDS. In order to use this indicator in a performance monitoring context, the HDDS obtained must be compared with a significant expected level of dietary diversity.

For this study, the target to be compared was established by dividing the population into tertiles according to the wealth index and then finding the average dietary diversity in the 33% of households with the highest economic well-being, thus determining the expected or appropriate level of dietary diversity to be compared with the other households¹⁴. In this way, an HDDS ≥ 7.96 points was considered adequate, while a score below that threshold was considered inadequate.

For the calculation of HDDS, the 12-food group methodology was chosen, including "sugar and honey" as a group, since its inclusion in the diet of a household, as well as other foods whose acquisition requires greater economic resources, such as condiments, sugar and sugary foods, and beverages, may be associated with a change in socioeconomic level^{14,15}.

The socioeconomic level of the household was assessed through a wealth index, constructed by the Young Lives study considering three measures: quality of housing, access to services, and possession of household goods. These were obtained from household surveys, based on questions answered by the person responsible for the family. The housing quality indicator was obtained by considering the simple average of the quality of the roof, floor, and wall materials, also including housing density. Access to basic services was estimated with the simple average of availability of electricity, water, sanitation, and cooking fuel; while, for the calculation of the patrimony index, the simple average of the list of household items in the home was considered. Finally, for the calculation of the wealth index, the simple average of the three indexes was used, obtaining a value between

0 and 1, where one represents the highest socioeconomic level. For analysis purposes, this variable was divided into tertiles, with tercile 1 being the poorest and tercile 3 the richest.

Additionally, other variables were considered to evaluate the association of interest such as age, sex (male/female), place of residence (urban/rural), family size, maternal educational level (< 7 years, 7-11 years, and ≥ 12 years), paternal educational level (< 7 years, 7-11 years, and ≥ 12 years), birth weight, history of breastfeeding (yes/no), and presence of maternal overweight according to maternal BMI (yes/no).

Statistical analysis

The STATA version 15 software (Stata Corp, College Station, TX, USA) was used. Absolute and relative frequencies were obtained for categorical variables and, for the numerical ones, measures of central tendency (median) and dispersion (interquartile range) were calculated. The association between overweight and obesity with qualitative variables was determined using Pearson's Chi² test of independence, with a significance level of 0.05, while the Wilcoxon rank-sum test was used for quantitative variables. To identify the crude and adjusted association between the dependent variable of overweight and obesity and the independent variables, a multivariate logistic regression analysis was performed, calculating the odds ratio and their respective 95% confidence intervals.

Ethical aspects

The initial study was approved by the Division of Ethics in Social Sciences of the University of Oxford and was subsequently approved in each country where it was carried out. Thus, in Peru, the original study was approved by the ethics committee of the Institute of Nutritional Research. This research protocol was reviewed and approved by the Research Ethics Committee of the Faculty of Medicine of the *Universidad Católica Santo Toribio de Mogrovejo*. The database was used only for this investigation.

Results

1,860 adolescents were included, with a median age of 179 months and a slight predominance of males. Family size had a median of 5 people, and most were from urban areas, with about half of the mothers presenting illiteracy or some primary education and a similar percentage of the fathers having some secondary education.

Approximately 55% of the mothers were overweight and most participants were born with an adequate weight and were breastfed. 25.5% of adolescents

were overweight or obese and 61.5% of participants reported adequate dietary diversity (Table 1).

The bivariate analysis showed that overweight and obesity were associated with female sex, living in an urban area, having mothers with some degree of secondary education or higher and fathers with some degree of higher education, having mothers with excess weight and belonging to the third wealth quintile (p -value < 0.05). Additionally, no statistically significant relationship was found between inadequate dietary diversity and overweight and obesity in the study population (p -value = 0.8) (Table 2).

In the multivariate analysis, considering the model adjusted for the variables sex, family size, maternal educational level, maternal BMI, and wealth index, the protective factors for overweight and obesity were found to be male (OR = 0.75; 95%CI: 0.59-0.95) and larger family size (OR = 0.91; 95%CI: 0.85-0.98) and as risk factors mother with some degree of secondary or higher education (OR 1.43; 95%CI: 1.02-2.02), maternal overweight (OR = 1.90; 95%CI: 1.48-2.46), and belonging to the third wealth quintile (OR = 1.51; 95%CI: 1.01-2.26). In contrast, adequate dietary diversity was not associated with lower overweight and obesity (OR = 0.89; 95%CI: 0.70-1.14) (Table 3).

Discussion

In our study, a quarter of the adolescents were overweight or obese, a figure similar to that reported in a Technical Report on nutritional status in Peru¹⁶. However, the Demographic and Family Health Survey (ENDES-2022), prepared by the National Institute of Statistics and Information (INEI) reported a 33.8% prevalence, probably related to social isolation during the COVID-19 pandemic¹⁷, a situation also observed in Chilean adolescents¹⁸.

Dietary diversity was adequate in 61% of the included population. However, contrary to what we expected to demonstrate, there was no statistically significant association between dietary diversity and overweight and obesity, as other authors have also published^{19,20}. This contrasts with the findings in Iranian adolescents reported by Golpour S²¹, with an increased risk of overweight and obesity according to the increase in the DDS and by Heidari M⁶, with the association between higher DDS and higher anthropometric indexes in females. This positive association was also evidenced in American children aged 7 to 39 months²², Chinese children aged 3 to 12 years²³, and in the adult population²⁴. One possible explanation for our finding has to do with the complex and multifactorial nature of the determinants of nutritional status, which involves not only the participation of cultural, ethnic, and religious

factors but also factors at the household and community levels¹⁹.

Although the analysis of dietary patterns and diet quality has been key in the investigation of the risk of overweight or obesity in the pediatric population, the assessment of the diet as a whole, rather than focusing on individual nutrients, is more effective²⁵. In that sense, the DDS is useful for assessing diet quality, but it has limitations, such as not considering portion size, which may explain the contradictory results in the

Table 1. Sociodemographic characteristics of adolescents aged 14–15 years from the fifth round of the Young Lives study in 2016 (n=1,851)

Variables	%
Male/Female (%)	50.5/49.5
Age (years)	14.9 (14.6-15.1)*
Urban residence (%)	74.9
Maternal education (%)	
< 7	44.9
7-11	36.5
≥ 12	18.6
Paternal education (%)	
< 7	33.8
7-11	44.3
≥ 12	21.9
Family size (no. of persons)	5 (4-6)*
Birth weight (%)	
Low birth weight	7.2
Normal	85.9
Macrosomic	6.9
Breastfed (%)	99.1
Maternal nutritional status (%)	
Underweight	1.1
Normal	43.4
Overweight	40.5
Obesity	15
Socioeconomic level (tertile)	(%)
First	33.4
Second	33.2
Third	33.4
Overweight/obesity (%)	22.5
Adequate dietary diversity (%)	

*Median and IQR.

literature. Some authors found a positive association between DDS and obesity due to higher fat and total energy intake^{6,22}, whereas others reported a negative association with healthy foods^{26,27}. Despite the correlation between DDS and energy intake reported by Torheim²⁸, a meta-analysis found no significant relationship with obesity²⁹. These discrepancies could be due to differences in the methods and criteria used in the different studies, which highlights the importance of avoiding excessive energy intake when using DDS.

Regarding sociodemographic variables, studies have shown a variable relationship between sex and overweight and obesity. Wang VH reported male sex

as a risk factor in Chinese adolescents³⁰, as did other authors in schoolchildren aged 5 to 13 years, both in Malaysia³¹ and Peru^{31,32}. This could be explained by the influence of sociocultural differences in these countries, such as the beliefs and behaviors related to weight among children and their parents in China³⁰, the greater caution and restriction of adolescent girls in Malaysia in their diet³¹, or the maternal custom of assigning a greater amount of food to male children to develop physical activities with greater energy expenditure³². In contrast, in our study, male sex was associated with a lower risk of overweight and obesity, similar to that reported by Gonzales-Casanova in Colombian students³³

Table 2. Association between sociodemographic factors, dietary diversity, and overweight/obesity in adolescents aged 14–15 years (fifth round of the Young Lives study, 2016)

Variables	Overweight and obesity		p value*
	No (n = 1.372)	Yes (n = 470)	
Male/Female (%)	52.8/47.2	43.6/56.4	< 0.001
Urban residence (%)	72.2	84.0	< 0.001
Maternal education (%)			< 0.001
< 7 años	49.2	31.7	
7 a 11 años	34.8	41.5	
≥ 12 años	16.0	26.8	
Paternal education (%)			< 0.001
< 7 años	39.5	25.8	
7 a 11 años	47.0	46.7	
≥ 12 años	13.5	27.5	
Birth weight (%)			0.2
Low birth weight	7.5	6.2	
Normal	86.3	83.8	
Macrosomic	6.2	10.0	
Breastfed (%)	99.4	98.3	0.038
Maternal nutritional status (%)			< 0.001
Underweight/normal	49.1	31.9	
Overweight/obese	50.9	68.1	
Family size	5 (4-6)	4 (3-5)	< 0.004
Socioeconomic level (%)			0.001
First tertile	36.9	22.5	
Second tertile	33.9	31.4	
Third tertile	29.2	43.1	
Adequate dietary diversity (%)		61.8	0.8

*Pearson's chi-square test; Wilcoxon rank-sum test.

Table 3. Strength of association between socioeconomic factors, dietary diversity, and overweight/obesity in adolescents aged 14–15 years (fifth round of the Young Lives study, 2016)

Variables	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Sex ¹				
Female	Ref	< 0.001	Ref	0.015
Male	0.69 (0.56-0.85)		0.75 (0.59-0.95)	
Area of residence ¹				
Urban	Ref	< 0.001	Ref	0.8
Rural	0.49 (0.37-0.64)		0.96 (0.65-1.43)	
Family size ¹	0.93 (0.88-0.99)	0.016	0.91 (0.85-0.98)	0.011
Maternal education ¹				
<7 años	Ref		Ref	
7 a 11 años	1.01 (0.81-1.25)	> 0.9	0.78 (0.56-1.08)	> 0.9
≥ 12 años	1.63 (1.27-2.10)	0.002	1.43 (1.02-2.02)	0.039
Paternal education ¹				
< 7 años	Ref		Ref	
7 a 11 años	1.01 (0.81-1.26)	> 0.9	0.86 (0.75-1.50)	0.3
≥ 12 años	1.3 (1.00-1.69)	<0.001	1.06 (0.75-1.50)	0.7
Maternal nutritional status				
Underweight/normal	Ref	< 0.001	Ref	< 0.001
Overweight/obese	2.16 (1.73-2.72)		1.90 (1.48-2.46)	
Socioeconomic level ¹				
Tertile 1	Ref	< 0.001	Ref	0.043
Tertile 2	1.54 (1.16-2.05)		1.10 (0.75-1.62)	
Tertile 3	2.64 (2.02-3.47)		1.51 (1.01-2.26)	
Dietary diversity ²				
Adequate	1.02 (0.82-1.27)	0.8	0.89 (0.70-1.14)	0.4
Inadequate	Ref		Ref	

Ref: Reference value. ¹Adjusted for all socioeconomic factors in the table. ²Adjusted for significant variables: child's sex, family size, maternal education, maternal BMI, and wealth index.

and by Nouayti H³⁴ and Aryteetey R³⁵ in Morocco and Ghana, respectively, the latter finding that girls were twice as likely to be overweight or obese. This can be explained by sociocultural differences, such as greater parental control over girls, with restrictions on going out alone outside school hours, decreasing the time for outdoor physical activity³⁴, and by physiological changes in adolescence, with an increase in fat mass in girls and a decrease in boys due to the development of muscle and bone mass^{33,36}.

Within the household characteristics, it was observed that belonging to the third tertile of wealth increased the risk of presenting overweight and obesity.

This is consistent with several studies that have reported a positive association between family income and the risk of overweight and obesity^{31,34,35,37}. However, the literature is contradictory, since there are publications that report a higher prevalence of obesity in children with a low socioeconomic level^{38,39}, demonstrating that the direction of the association between obesity and socioeconomic status varies, being positive in poorer countries and negative in richer societies³⁵. To explain this, several hypotheses have been proposed. In developing countries, the low prevalence of obesity in low socioeconomic status groups is related to energy-intensive work activities, food shortages, and the

greater ability of wealthier families to consume a more adequate amount of food⁴⁰. The negative association reported in some studies could be related to economic growth, with better access to food, and higher energy expenditure in poorer social groups, difficulty in acquiring foods with lower caloric content, usually more expensive, and less free time with less opportunity for physical activity³⁷.

Additionally, household size was a protective factor for overweight and obesity, which has also been reported by Gonzales-Casanova in Colombia³³ and Ahmad in Malaysia³¹. This phenomenon could be explained by the fact that smaller household size is associated with greater purchasing power and greater accessibility to food^{31,41}.

Regarding maternal characteristics, maternal overweight was significantly associated with overweight and obesity in children, similar to that reported by Preston⁴² and in a meta-analysis that included 37 studies with data from a cohort in Europe, North America, and Australia in 2019, which reported that higher maternal pregestational BMI was associated with higher risk of overweight or obesity in the offspring, especially in adolescents⁴³. This relationship could be explained by socio-environmental factors, such as dietary habits and the practice of physical activity shared by mother and child, and by genetic factors with the influence of the mother's nutritional status in the intrauterine environment⁴⁴. However, in recent years, epidemiological studies and murine models have provided abundant evidence linking maternal obesity with excess weight in offspring and the development of cardiometabolic complications in adulthood, suggesting a transgenerational inheritance of susceptibility through epigenetic mechanisms that could potentially persist across generations⁴⁵. This finding underscores the importance of assessing maternal nutritional status and its factors in designing strategies to reduce the prevalence of childhood overweight and obesity.

Studies on the relationship between maternal educational level and childhood overweight and obesity have found variable results, reporting positive^{32,35,37}, negative^{47,48}, or null association³⁴. In our study, having a mother with some secondary education or higher increased the risk of overweight and obesity. Although a high level of maternal education can improve the acquisition and application of knowledge about nutrition with better dietary practices³⁵, it is also linked to greater job opportunities, more time away from home, and better purchasing power with negative effects on dietary habits^{32,49}. The greater time away from home conditions less participation in food choice, and the formation of children's dietary habits and practices³², while the higher educational and occupational level and, consequently, the higher socioeconomic level

of parents increases children's access to high-calorie foods, increasing the risk of obesity³⁷. All this suggests that the relationship between maternal education and childhood overweight is complex and may be modified by other factors³⁴, so further research is needed to clearly establish the relationship between the two.

Among the limitations of the study are the type of cross-sectional design that did not allow establishing causality but only association between the variables of interest, having a secondary database as a source, with the absence of all the information on some variables, and, finally, the subjective measurements and responses subject to memory bias at the time of collecting the information to establish dietary behavior.

Conclusions

No association was found between dietary diversity and overweight and obesity in adolescents participating in the Young Lives Cohort in Peru. The higher educational level of the mother, maternal overweight, and belonging to the third wealth quintile increased the risk of overweight and obesity in adolescents, while the male sex and larger family size in the household were protective factors.

In order to adequately establish the effect of dietary diversity on nutritional status in the pediatric population, in addition to a standardized methodology for its measurement, prospective studies that can establish causality are required.

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.

Rights to privacy and informed consent: This study was approved by the respective Research Ethics Committee. The authors state that the information has been obtained from secondary data.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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