SECTION: HEALTH PROMOTION AND DISEASE PREVENTION
DOI: 10.22267/rus.262801.356
RESEARCH ARTICLE
REVISTA UNIVERSIDAD Y SALUD

# Prevalence of zinc-rich food consumption and associated factors in children at a children's home in Pamplona, Colombia

## Prevalencia de consumo de alimentos fuente de zinc y factores asociados en niños de un hogar infantil de Pamplona, Colombia

## Prevalência do consumo de alimentos ricos em zinco e fatores associados em crianças de um orfanato em Pamplona, Colômbia

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## ABSTRACT

**Introduction:**Zinc is an important mineral for the organism given its structural function and its importance in cell growth, therefore, a good intake of this mineral prevents infant mortality. **Objective:** to determine the prevalence of consumption of food sources of zinc and associated factors in children aged 1 to 4 years. **Materials and methods:** a descriptive observational study was carried out with an analytical, prospective, cross-sectional approach; the sample studied corresponded to 95 parents of children in a children's home in Pamplona, Norte de Santander; a structured questionnaire was used for data collection, which was applied by personal interview. **Results:** The food groups with the highest prevalence of consumption were meats and meat products, cereals and cereal products, legumes, tubers, nuts and seeds; the average frequency of consumption per day was 1.1, per week between 1.2 and 5.0, and the average per month ranged from 1.8 to 6.6; statistically significant differences were found with some demographic and socioeconomic characteristics assessed **Conclusion:** Factors such as sex, nationality, origin, marital status, socio-economic status, number of family members, income, money spent on food are related to the consumption of foods from the meat, cereals, fruits, vegetables, legumes and miscellaneous groups.

**Keywords:** Zinc; eating; prevalence; nutritional status. (Source: DeCS, Bireme).

**Sustainable development goals:** Zero hunger; good health and well-being. (Source: SDG, WHO).

## RESUMEN

**Introducción:** El zinc es un mineral importante para el organismo dada su función en la estructura y crecimiento celular, que previene la mortalidad infantil. **Objetivo:** Determinar la prevalencia de consumo de alimentos fuente de zinc y los factores asociados en niños de 1 a 4 años de edad. **Materiales y métodos:** Estudio observacional descriptivo con enfoque analítico, prospectivo, transversal; la muestra estudiada correspondió a 95 padres de familia de niños de un hogar infantil de Pamplona, Norte de Santander; para la recolección de datos se empleó un cuestionario estructurado aplicado por entrevista personal. **Resultados:** Los grupos de alimentos con mayor prevalencia de consumo fueron carnes y derivados, cereales y derivados, leguminosas, tubérculos, nueces y semillas; la frecuencia promedio de consumo al día fue de 1,1, a la semana entre 1,2 a 5,0 y el promedio al mes osciló entre 1,8 a 6,6; se encontraron diferencias estadísticamente significativas con algunas características demográficas y socioeconómicas evaluadas. **Conclusión:** Factores como el sexo, nacionalidad, procedencia, estado civil, estrato socioeconómico, número de integrantes de la familia, ingreso económico, dinero destinado para la compra de alimentos, se relacionan con el consumo de alimentos de los grupos de carnes, cereales, frutas, verduras, leguminosas y misceláneos.

**Palabras clave:** Zinc; consumo de alimentos; prevalencia; estado nutricional. (Fuente: DeCS, Bireme).

**Objetivos de desarrollo sostenible:** Hambre cero; salud y bienestar. (Fuente: ODS, ONU).

Citation:
Carvajal-Suárez L, Espinel-Villamizar NM, Rojas-Cárdenas MS.Prevalence of zinc-rich food consumption and associated factors in children at a children's home in Pamplona, Colombia. Univ Salud [Internet]. 2026; 28(1):e9210. DOI: 10.22267/rus.262801.356

| | | |
|---|---|---|
| Received: | November | 29 - 2024 |
| Revised: | June | 27 - 2025 |
| Accepted: | September | 12 - 2025 |
| Published: | January | 01 - 2026 |

ISSN: 0124-7107 - ISSN (Online): 2389-7066
Univ. Salud 2026 Vol 28 No 1
https://doi.org/10.22267/rus

https://revistas.udenar.edu.co/index.php/usalud

**Acknowledgments:**
To the seventh-semester students of the Nutrition and Dietetics program for their participation in collecting the information. To the parents, guardians, and caregivers of the children at the Children's Home who participated in this study.

**Funding sources:**
This research was funded by the University of Pamplona and the researchers' own resources.

**Author contributions:**
Formal analysis: Lennys Carvajal, Natalia Espinel, and Melissa Rojas.
Research: Lennys Carvajal, Natalia Espinel, and Melissa Rojas.
Writing - Original draft: Lennys Carvajal and Natalia Espinel.
Writing - Review and editing: Lennys Carvajal and Natalia Espinel.

**Ethics approval and consent to participate:**
Minutes No. 05 of May 17, 2023, approved by the Ethics and Environmental Impact in Research Committee of the University of Pamplona in Pamplona, Colombia.

**Conflict of interest:**
The authors declare that there is no conflict of interest..

**Declaration of responsibility:**
The authors are responsible for the content and its accuracy.

**Consent to publish:**
All authors reviewed and approved

## RESUMO

**Introdução:** O zinco é um mineral importante para o organismo dada a sua função estrutural e a sua importância no crescimento celular, pelo que uma boa ingestão deste mineral previne a mortalidade infantil. **Objetivo:** determinar a prevalência de consumo de alimentos fontes de zinco e factores associados em crianças de 1 a 4 anos. **Materiais e métodos:** foi realizado um estudo observacional descritivo com uma abordagem analítica, prospetiva e transversal; a amostra estudada corresponde a 95 pais de crianças num lar de Pamplona, Norte de Santander; foi utilizado um questionário estruturado para a recolha de dados, que foi aplicado por entrevista pessoal. **Resultados:** Os grupos de alimentos com maior prevalência de consumo foram carnes e derivados, cereais e derivados, leguminosas, tubérculos, frutos secos e sementes; a frequência média de consumo por dia foi de 1,1, por semana entre 1,2 e 5,0 e a média por mês variou entre 1,8 e 6,6; foram encontradas diferenças estatisticamente significativas com algumas caraterísticas demográficas e socioeconómicas avaliadas. **Conclusão:** Factores como o sexo, a nacionalidade, a origem, o estado civil, o estatuto socioeconómico, o número de membros da família, o rendimento e o dinheiro gasto em alimentação estão relacionados com o consumo de alimentos dos grupos das carnes, dos cereais, das frutas, das hortaliças, das leguminosas e dos diversos.

**Palavras chave:** Zinco; ingestão de alimentos; prevalência; estado nutricional. (Fonte: DeCS, Bireme)

**Metas de desenvolvimento sustentável:** Fome zero; saúde e bem-estar. (Fonte: MDS, ONU).

https://doi.org/10.22267/rus.262801.356

## INTRODUCTION

Zinc is an essential micronutrient that plays a key role in human nutrition and overall health. It is of great importance given its role in the proper functioning of various enzyme complexes involved in a variety of biological processes, such as immune response, protein synthesis, sensory perception, and maintenance of the structural integrity of cell membranes[1]. Particularly in early childhood, zinc is directly involved in cognitive development and linear growth; therefore, adequate intake is essential to promote healthy growth and development and strengthen the immune system at this stage of life[2].

In this approach, considering the perspective of the Social Determinants of Nutrition allows us to understand that nutritional status is influenced by different factors such as availability, access to food, and structural factors that affect both the quality and biological utilization of nutrients. Social determinants include poverty, food insecurity, and inequalities in access to health services, basic sanitation, drinking water, and education. This perspective recognizes zinc deficiency as a complex phenomenon, conditioned by social and economic factors that differentially affect vulnerable population groups such as young children[3].

Zinc deficiency is a public health problem, mainly affecting children under five and pregnant women; It is estimated that in developing countries approximately 25% of the population is zinc deficient, while in industrialized countries it affects approximately 15% of the population[4]. In Colombia, the results of the National Nutritional Status Survey show a prevalence of 43% of this micronutrient deficiency in children aged 1 to 4 years(5). In the first years of life, zinc deficiency is commonly associated with stunted growth and a weakened immune system, increasing vulnerability to prevalent infections such as diarrheal diseases and acute respiratory infections[6]. Likewise, it has been documented that zinc deficiency has a negative impact on neurodevelopment and cognitive function, generating long-term repercussions on learning and school performance[7].

In the national context, the Colombian Institute for Family Welfare (ICBF) has established a solid policy and strategic framework for comprehensive care for vulnerable young children, prioritizing actions aimed at addressing the social determinants of nutrition in order to promote the right to adequate food, nutrition, and health[8]. Thus, identifying the challenges that persist in ensuring adequate zinc intake in the institutional context is essential, given that the available literature shows strengths in the study of this micronutrient in general or specific clinical contexts, reflecting the need to identify relevant patterns of consumption of zinc-rich foods and associated factors in children who are beneficiaries of comprehensive early childhood care programs.

The objective of this study was to determine the prevalence of zinc-rich food consumption and associated factors in children aged 1 to 4 years in a children's home in Pamplona, Norte de Santander. The aim was to develop a study focused on a specific population group and a specific geographical environment, from which it is hoped to provide recent scientific evidence on the dynamics that determine the intake of zinc- rich foods in children who are beneficiaries of an institutional model of comprehensive early childhood care, which will guide the design and implementation of strategic and operational actions aimed at promoting the health and nutritional well-being of children.

## MATERIALS AND METHODS

A descriptive observational study with an analytical, prospective, cross-sectional approach was conducted. The population consisted of 125 children aged 1 to 4 years from the Niño Jesús de Praga Children's Home in Pamplona, Norte de Santander. The sample size was determined using the formula for finite populations, considering the following statistical parameters: 95% confidence level, 5% margin of error, and estimated prevalence of 43.3%. Thus, the sample consisted of 95 parents of the children who agreed to participate in the study by signing the informed consent form. Parents whose children had a special diet or a diagnosed condition that involved specific dietary restrictions, which could interfere with the analysis of habitual consumption of zinc-rich foods, were excluded.

The sampling frame consisted of an updated list of parents of children aged 1 to 4 who were beneficiaries of the children's home. This database was provided by the institution's administrative coordination and contained the personal and contact information necessary to uniquely identify each unit of analysis. The selection was made using simple random probability sampling to ensure the representativeness of the study population and minimize possible selection biases. Randomization was performed using the random number generation function in Microsoft Excel, which allowed participants to be selected in a transparent, equitable, and reproducible manner.

A structured questionnaire consisting of 4 sections and 15 questions was used, relating to the demographic characteristics of the parent and child, the composition of the family unit, and the daily, weekly, and monthly consumption frequency of 83 zinc-rich foods corresponding to nine food groups. The variables included in the study were operationalized based on conceptual and empirical references previously validated in the scientific literature. The independent variables were collected using closed- ended questions with predefined categories, for which appropriate measurement scales (nominal, ordinal, or ratio) were used according to the nature of each variable, which facilitated their coding and statistical analysis.

The dependent variable, prevalence of consumption of zinc-rich foods, was operationalized as the proportion of children who, according to their parents' reports, consume zinc-rich foods with a certain frequency during a specific term. Each response was coded numerically for statistical analysis and then transformed into a dichotomous variable for the calculation of prevalence (regular consumption: yes/no).

To minimize possible measurement bias, each item in the instrument was designed in a clear and neutral manner, avoiding ambiguous questions. The interviewers were previously trained in the application of the questionnaire, which reduced observer bias and ensured uniformity in the collection of information. The instrument was subject to a validation process by experts, which strengthened the conceptual relevance and clarity of the indicators. A pilot test was conducted to assess its internal reliability. These measures contributed to improving the accuracy of the measurements and reducing systematic errors that could affect the validity of the results. Data collection was carried out between September and November 2023.

Data processing was carried out by means of the Jamovi v.2.3.28 statistical program. Descriptive statistics were used, calculating frequencies and percentages for qualitative variables. Prevalence was calculated with a 95% confidence level and a significance level of $p < 0.05$. For the bivariate analysis, Pearson's chi- square test and Fisher's exact test were used, depending on the nature of the categorical data and the fulfillment of the statistical assumptions: independence of observations, random sampling, and expected frequencies. The Chi-square test was used in cases where the expected frequencies were greater than 5, while Fisher's exact test was applied when they were equal to or less than 5. In cases with statistical significance ($p$-value $< 0.05$), the magnitude of the association was estimated by calculating the Odds Ratio (OR), reporting those values greater than 1.0 whose 95% confidence interval did not include the null value, strengthening the accuracy and validity of the results presented.

The research was conducted with strict confidentiality and anonymity. Participation was voluntary, based on informed consent, in accordance with the regulations established in the 2013 Declaration of Helsinki regarding ethical principles for research involving human subjects and Article 11 of Resolution No. 8430 of 1993 of the Colombian Ministry of Health and Social Protection. Institutional consent was obtained, endorsed by the Parents' Association of the Children's Home, and approval was granted by the Ethics and Environmental Impact Committee of the Pamplona Higher Education Institution, according to certificate No. 05 dated May 17th, 2023.

## RESULTS

Most of the children's parents and/or guardians (N = 95) were women, from urban areas, of Colombian nationality, with a Secondary School

https://doi.org/10.22267/rus.262801.356

education level and Marital Status in a common-law union. The household is mostly made up of 3 to 5 people belonging to socioeconomic strata 1 and 2, with a family income of 1 to 2 times the current legal minimum monthly wage, of which USD 49.91 to USD 99.83 is spent on food, i.e., between 192,852.89 COP and 385,744.42 COP (Table 1).

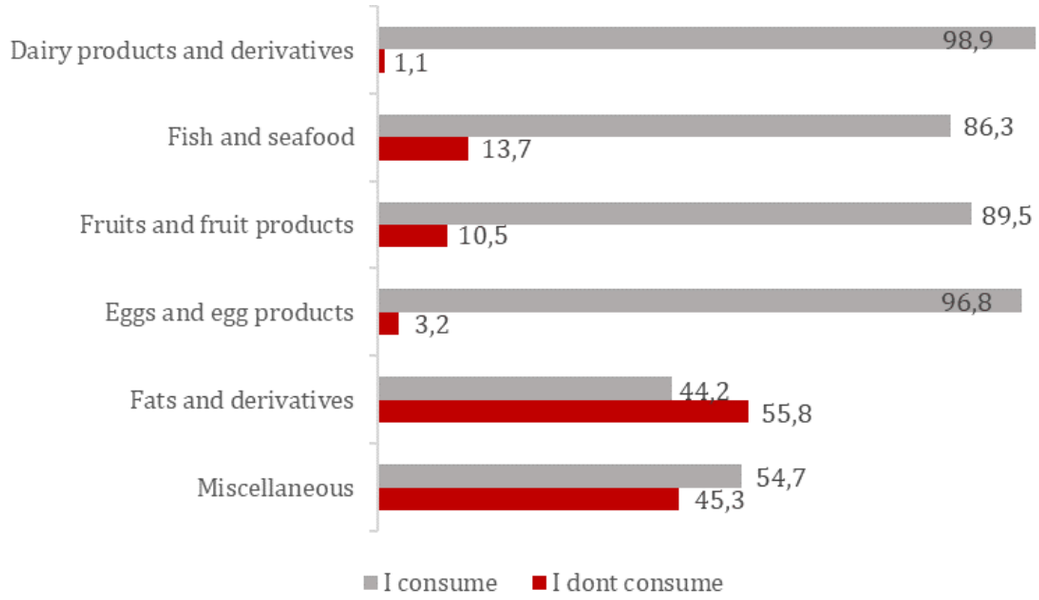
**Table 1.**
Demographic characteristics of parents, children, and family unit

| Variable | Category | Frequency | % |
|---|---|---|---|
| **Demographic characteristics of parents and/or guardians** | | | |
| Gender | Female | 83 | 87.37 |
| | Male | 12 | 12.63 |
| Area of origin | Urban | 88 | 92.63 |
| | Rural | 7 | 7.37 |
| Nationality | Colombian | 88 | 92.63 |
| | Venezuelan | 7 | 7.37 |
| Educational level | None | 1 | 1.05 |
| | Primary | 5 | 5.26 |
| | Preschool | 1 | 1.05 |
| | Secondary School | 31 | 32.63 |
| | Middle | 6 | 6.32 |
| | Vocational | 18 | 18.95 |
| | Technology | 11 | 11.58 |
| | Undergraduate | 22 | 23.16 |
| Marital status | Single | 32 | 33.68 |
| | Married | 10 | 10.53 |
| | Common-law union | 51 | 53.68 |
| | Divorced | 1 | 1.05 |
| | Widowed | 1 | 1.05 |
| **Demographic characteristics of the child** | | | |
| Gender | Female | 45 | 44.37 |
| | Male | 50 | 52.63 |
| Nationality | Colombian | 94 | 98.95 |
| | Venezuelan | 1 | 1.05 |
| Age | 1 year to 1 year and 11 months | 3 | 3.16 |
| | 2 years to 2 years and 11 months | 39 | 41.05 |
| | 3 years to 3 years and 11 months | 53 | 55.79 |
| **Characteristics of the family unit** | | | |
| Number of household members | 2 | 6 | 6.32 |
| | 3 | 24 | 25.26 |
| | 4 | 28 | 29.47 |
| | 5 | 25 | 26.32 |
| | ≥ 6 | 12 | 12.63 |
| Family income | < 1 current legal minimum monthly wage | 37 | 38.95 |
| | 1 to 2 current legal minimum monthly wage | 55 | 57.89 |
| | 2 to 3 current legal minimum monthly wage | 3 | 3.16 |
| Family income allocated to the purchase of food | < USD 49.91 | 8 | 8.42 |
| | 49.91 USD to USD 99.83 | 54 | 56.84 |
| | > USD 99.83 | 33 | 34.74 |
| Socioeconomic stratum | 1 | 41 | 43.16 |
| | 2 | 42 | 44.21 |
| | 3 | 10 | 10.53 |
| | 4 | 2 | 2.11 |

The food groups with the highest prevalence of consumption were meat and meat products (100%), cereals and cereal products (100%), legumes, tubers, nuts, and seeds (100%). The dairy and dairy

products group stood out, with the consumption of foods such as yogurt with sugar (91.6%) and pasteurized whole cow's milk (71.6%) predominating, as well as eggs and derivatives, fruits and derivatives, in which passion fruit had the highest consumption rate (84.2%), as did trout for the fish and seafood group (72.6%) (Figure 1).

**Figure 1.**
Prevalence of consumption by food groups




For the food groups evaluated, the average frequency per day was 1.1; while the average frequency per week ranged from 1.2 to 5.0, showing that the foods consumed most often during the week were eggs, sweetened yogurt, pasteurized whole cow's milk, white rice, unenriched pasta, yellow corn flour, fortified wheat flour for baking, and crackers. The average frequency per month ranged from 1.8 to 6.6, showing the same behavior with respect to the frequency of consumption per week of foods in the eggs and derivatives, dairy and derivatives, and cereals and derivatives groups, for which it was identified that the foods consumed most often per month were crackers, rolled oats, fortified wheat flour for baking, pasta, and white rice (Table 2).

**Table 2.**
Average frequency of daily/weekly/monthly consumption by food group

| Food group | Average frequency | | |
|---|---|---|---|
| | Day | Week | Month |
| Dairy products and derivatives | 1.4 | 3.7 | 5.6 |
| Meat and meat products | 1.1 | 2.3 | 3.9 |
| Cereales y derivados | 1.3 | 3.4 | 5.1 |
| Fish and seafood | 1.0 | 1.2 | 1.9 |
| Fruit and fruit products | 1.0 | 2.3 | 3.8 |
| Eggs and egg products | 1.3 | 5.0 | 6.6 |
| Fats and fat products | 1.0 | 1.3 | 1.8 |
| Miscellaneous | 1.0 | 2.2 | 2.8 |
| Legumes, tubers, nuts, and seeds | 1.1 | 2.6 | 4.2 |

The highest percentage of compliance with the standard portion size was identified in the egg group (75%), dairy products and derivatives (75.4%), with sugar-sweetened yogurt (75.9%) being the most relevant for this group. For the cereals and derivatives group, it was 55.9%, with yellow corn flour (58%) being the most relevant.

https://doi.org/10.22267/rus.262801.356

Statistically significant differences were found between food consumption and some of the demographic and socioeconomic variables evaluated, among which characteristics such as female gender, more than three family members, married or common-law marital status, income greater than 1 current legal minimum monthly wage, educational level of parents or guardians, area of origin, age, and spending USD 49.91 or more on food purchases were found to be related to the consumption of foods from the meat, cereal, fruit, legume, and miscellaneous groups. These differences were determined using the Chi-square test in cases where the expected frequencies were greater than 5 (Table 3) and Fisher's exact test when they were equal to or less than 5 (Table 4); in cases with statistical significance ($p$-value $< 0.05$), the magnitude of the association was estimated by calculating the Odds Ratio (OR), reporting those values greater than 1.0 whose 95% confidence interval did not include the null value, strengthening the accuracy and validity of the results presented below in Table 3.

**Table 3.**
Relationship between demographic and socioeconomic variables and food consumption

| Variable | Category | Consume | | Do not consume | | Total | Pearson's Chi-square | *p*-value | *OR* | 95% CI | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *n* | % | *n* | % | *n* | | | | Lower limit | Upper limit |
| **Lean pork** | | | | | | | | | | | |
| Gender | Female | 32 | 71.1 | 13 | 28.9 | 45 | 4.40 | 0.036 | 2.46 | 1.05 | 5.76 |
| | Male | 25 | 50 | 25 | 50 | 50 | | | | | |
| **Beef, liver** | | | | | | | | | | | |
| Number of household members | > 3 | 39 | 60 | 26 | 40 | 65 | 4.48 | 0.034 | 2.59 | 1.06 | 6.33 |
| | ≤ 3 | 11 | 36.7 | 19 | 63.3 | 30 | | | | | |
| ***Mojarra*** | | | | | | | | | | | |
| Marital status | Married/Common-law union | 29 | 47.5 | 32 | 52.5 | 61 | 4.04 | 0.044 | 2.52 | 1.01 | 6.27 |
| | Single | 9 | 26.5 | 25 | 73.5 | 34 | | | | | |
| **Pork ham** | | | | | | | | | | | |
| Family income | > 1 current legal minimum monthly wage | 22 | 37.9 | 36 | 62.1 | 58 | 5.12 | 0.024 | 3.16 | 1.14 | 8.78 |
| | < 1 current legal minimum monthly wage | 6 | 16.2 | 31 | 83.8 | 37 | | | | | |
| **Pork and beef ham** | | | | | | | | | | | |
| Number of household members | > 3 | 37 | 56.9 | 28 | 43.1 | 65 | 5.96 | 0.015 | 3.08 | 1.23 | 7.76 |
| | ≤ 3 | 9 | 30 | 21 | 70 | 30 | | | | | |
| **Pork and beef *chorizo*** | | | | | | | | | | | |
| Family income | > 1 current legal minimum monthly wage | 24 | 41.4 | 34 | 58.6 | 58 | 5.18 | 0.023 | 3.03 | 1.14 | 8.02 |
| | < 1 current legal minimum monthly wage | 7 | 18.9 | 30 | 81.1 | 37 | | | | | |
| **Pira corn** | | | | | | | | | | | |
| Number of household members | > 3 | 56 | 86.2 | 9 | 13.8 | 65 | 4.87 | 0.027 | 3.11 | 1.10 | 8,76 |
| | ≤ 3 | 20 | 66.7 | 10 | 33.3 | 30 | | | | | |
| **Roasted and ground coffee powde** | | | | | | | | | | | |
| Educational level of parent/guardian | Primaria/Secundaria | 24 | 55.8 | 19 | 44.2 | 43 | 6.70 | 0.010 | 3.03 | 1.29 | 7.10 |
| | Técnica/Superior | 15 | 29.4 | 36 | 70.6 | 51 | | | | | |
| Number of household members | > 3 | 32 | 49.2 | 33 | 50.8 | 65 | 5.69 | 0.017 | 3.19 | 1.20 | 8.45 |
| | ≤ 3 | 7 | 23.3 | 23 | 76.7 | 30 | | | | | |
| **Dried peas** | | | | | | | | | | | |
| Number of household members | > a 3 | 27 | 41.5 | 38 | 58.5 | 65 | 4.20 | 0.040 | 2.84 | 1.02 | 7.89 |
| | ≤ 3 | 6 | 20 | 24 | 80 | 30 | | | | | |
| ***Garbanzo*** | | | | | | | | | | | |
| Number of household members | > 3 | 39 | 60 | 26 | 40 | 65 | 4.48 | 0.034 | 2.59 | 1.06 | 6.33 |
| | ≤ 3 | 11 | 36.7 | 19 | 63.3 | 30 | | | | | |

**Note:**
Report of results with statistical significance according to the Chi-Square test.

**Table 4.**
Relationship between demographic and socioeconomic variables and food consumption

| Variable | Category | Consume | | Do not consume | | Total | Fisher's exact test *p*-value | *OR* | 95% CI | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *n* | % | *n* | % | *n* | | | Lower limit | Upper limit |
| **Pork, medium-fat meat** | | | | | | | | | | |
| Area of origin | Rural | 3 | 42.9 | 4 | 57.1 | 7 | 0.017 | 10.3 | 1.85 | 56.7 |
| | Urban | 6 | 6.8 | 82 | 93.2 | 88 | | | | |
| **Pork, ham** | | | | | | | | | | |
| Number of household members | > 3 | 21 | 32.3 | 44 | 67.7 | 65 | 0.023 | 4.30 | 1.17 | 15.8 |
| | ≤ 3 | 3 | 10 | 27 | 90 | 30 | | | | |
| **Beef, ground beef, medium fat** | | | | | | | | | | |
| Money for buying food | ≥ USD 49.91 | 67 | 77 | 20 | 23 | 87 | 0.028 | 5.58 | 1.23 | 25.4 |
| | < USD 49.91 | 3 | 37.5 | 5 | 62.5 | 8 | | | | |
| **Beef, leg** | | | | | | | | | | |
| Number of household members | > 3 | 27 | 41.5 | 38 | 58.5 | 65 | 0.009 | 4.62 | 1.44 | 14.8 |
| | ≤ 3 | 4 | 13.3 | 26 | 86.7 | 30 | | | | |
| **Chicken *Mortadella*** | | | | | | | | | | |
| Age of child | 1 year to 1 year and 11 months | 2 | 66.7 | 1 | 33.3 | 3 | 0.041 | 16.4 | 1.36 | 1.8 |
| | 2 years to 3 years and 11 months | 10 | 10.9 | 82 | 89.1 | 92 | | | | |
| **Wheat flour, fortified, for baking** | | | | | | | | | | |
| Number of household members | > 3 | 62 | 95.4 | 3 | 4.6 | 65 | <0.001 | 10.3 | 2.59 | 41.3 |
| | ≤ 3 | 20 | 66.7 | 10 | 33.3 | 30 | | | | |
| ***Granadilla*** | | | | | | | | | | |
| Gender | Female | 42 | 93.3 | 3 | 6.7 | 45 | 0.025 | 4.42 | 1.16 | 16.9 |
| | Male | 38 | 76 | 12 | 24 | 50 | | | | |
| **Roasted and ground coffee powder** | | | | | | | | | | |
| Number of household members | > 3 | 32 | 49.2 | 33 | 50.8 | 65 | 0.017 | 3.19 | 1.20 | 8.45 |
| | ≤ 3 | 7 | 23.3 | 23 | 76.7 | 30 | | | | |
| **Green beans** | | | | | | | | | | |
| Area of origin | Rural | 5 | 71.4 | 2 | 28.6 | 7 | 0.015 | 7.98 | 1.44 | 44.2 |
| | Urban | 21 | 23.9 | 67 | 76.1 | 88 | | | | |
| **Lentil** | | | | | | | | | | |
| Marital Status | Married/Common-law union | 58 | 95.1 | 3 | 4.9 | 61 | 0.032 | 5.01 | 1.20 | 20.9 |
| | Single | 27 | 79.4 | 7 | 20.6 | 34 | | | | |
| ***Garbanzo*** | | | | | | | | | | |
| Money for buying food | ≥ USD 49.91 | 49 | 56.3 | 38 | 43.7 | 87 | 0.025 | 9.03 | 1.06 | 76.5 |
| | < USD 49.91 | 1 | 12.5 | 7 | 87.5 | 8 | | | | |

**Note:**
Results with statistical significance according to Fisher's exact test.

## DISCUSSION

Zinc is a nutrient of great importance for growth and development in children under five years of age[9]. The main dietary sources of zinc are animal products such as meat, liver, eggs, seafood, and dairy products. In the present study, it was observed that the highest prevalence of consumption corresponded precisely to these foods, recognized for their high zinc content. These findings coincide with those reported by Santana, who identified red meat, milk, and eggs as the main sources of zinc with moderate bioavailability in the diet of the child population evaluated[10].

Likewise, the results showed a similar pattern to that reported in Colombia based on the National Nutritional Status Survey (ENSIN-2015)[5], where the prevalence of consumption of beef, veal, pork, capybara, rabbit, goat, curi, in children aged 3 to 4 years was 90.5%, chicken or hen (93.4%), fish or seafood (63.1%), eggs (97.0%), blood sausage or offal (32.1%), milk (94.2%), cheese and other dairy products (90.4%). Thereof, Rosales *et al.*[9] highlight in their research the consumption of foods of animal origin, which facilitate zinc absorption because zinc is associated with proteins and nucleic acids in food, making it more bioavailable. In addition, during digestion, amino acids and peptides containing lysine are released, forming more soluble complexes with zinc. In fact, Mangia *et al.*[11] reviewed the contribution of dairy products and derivatives to the recommended intake of minerals, highlighting the zinc and iron content in yogurt, which is higher compared to the content of other minerals such as calcium, phosphorus, and sodium.

Despite this, in the study by Rivera *et al.*[12] showed that among the preschoolers studied, fish consumption was 57.1%, 48.78% did not like offal because of its unpleasant appearance, family aversion, and because they did not know how to prepare

https://doi.org/10.22267/rus.262801.356

it, while 22.2% of children preferred chicken meat. The United Nations Children's Fund[13] highlights, that children between 6- and 23-months old benefit especially from animal-based foods such as meat, fish, eggs and dairy products, which provide essential nutrients such as vitamin A, iron, zinc, and calcium, which are important for growth, physical activity, and cognitive performance.

However, Monroy *et al.*[14] state that in developing countries, the main sources of zinc are roots, tubers, vegetables, rice, and corn, which have a high phytate: zinc molar ratio, resulting in lower bioavailability. In this regard, this research obtained similar results to the study conducted by Santana[10], in which cereals were the main source of dietary zinc ingested by children in the provinces surveyed. Given their plant origin, these foods provide zinc with low bioavailability. Other sources of dietary zinc with low bioavailability were fruits other than those providing vitamin A and legumes.

The results of the National Nutritional Status Survey (ENSIN-2015)[5] showed that, in children aged 3 to 4 years, the prevalence of consumption of dry grains or legumes was 94.8%, rice or pasta at 99.8%, and tubers and bananas at 94.6%. This behavior is similar to that observed in this study, which highlighted the consumption of cereals and derivatives, legumes, tubers, seeds, fruits, and derivatives. In this regard, Rosales *et al.*[9] report that phytates and dietary fiber such as cellulose and lignin present in fruits and vegetables form compounds with low solubility with zinc, inhibiting its absorption.

This study found statistically significant differences between the consumption of certain foods among different groups based on family income, a result similar to that reported in the study by Cordoba *et al.*[15], in which families earning more than the current legal minimum monthly wage purchase a large amount of food, which allows them to extend the frequency of purchasing the required products and, therefore, consumption among children. Likewise, the results show that families with greater economic capacity tend to consume zinc-rich foods more frequently. This result coincides with that reported by Rocha *et al.*[16], who identified that population groups with a higher socioeconomic status consume more foods such as dairy products, pasteurized cheese, fruits, and vegetables. In turn, it is noteworthy that families who allocate a monthly expenditure of at least 200,000 COP (USD 49.91) to the purchase of food have a higher consumption of food; This amount is in line with the cost of the basic food basket (CBA) in San José de Cúcuta, which averages 245,791.33 COP (USD 61.51).

With regard to socioeconomic status, this coincides with the findings of Aguirre and Montealegre[17], who assert that this aspect influences nutritional status, with children under 5 being the most vulnerable. However, they also note that there is no homogeneity in food consumption across social classes, given that intake cannot be standardized by socioeconomic status. The United Nations Children's Fund (UNICEF)[18] points out that the quality of food varies according to the purchasing power of the family and the area of residence (urban or rural), a situation that coincides with the relationship found in this study for this variable. Thereof, Acosta[19] highlights that the number of family members is one of the characteristics related to malnutrition in children under five, since larger families have greater difficulty in ensuring sufficient and adequate access to food for all their members.

Additionally, statistically significant differences were identified with Marital Status, coinciding with the study by Rios *et al.*[20], which identified that structural conditions in the home, including single-parent households, are linked to higher levels of food insecurity, which can have a direct impact on the type, frequency, and quality of food consumed by children. A relationship with the sex of the children was evident, a result that differs from the study by Risco *et al.*[21], which found no differences related to sex in eating habits. However, other studies, such as that by Nankinga *et al.*[22], identified that gender can be a relevant factor in the nutritional status of children under five years of age, suggesting that in certain contexts, this variable may influence diet and, consequently, the intake of key nutrients such as zinc.

In Colombia, based on the results of the Nutritional Status Survey (ENSIN-2015)[5], among children aged 3 to 4 years, the highest average frequency per day was for rice or pasta, at 1.7 times per day, followed by tubers and plantains

(0.9), bread (0.9), and cookies (0.8). The frequency was 1.4 for milk and 0.6 for cheese and other dairy products. For beef, veal, pork, chiguiro, rabbit, goat, and curi, it was 0.4; chicken or hen (0.4); fish or seafood (0.1); eggs (0.8); and dry beans or legumes 0.5. This behavior was similarly evident in this study for the food groups of dairy and dairy products and cereals and cereal products. However, it differs from the behavior identified for the group of eggs, legumes, meat and meat products, fish, and seafood, in which case the average frequency was equal to or greater than once a day. The average weekly frequency of zinc-rich food groups observed in this study was higher than that reported in the study by Monroy et al.[14], in which eggs, chicken, beef/pork sausage, powdered cow's milk, fresh/layered cheese, chicken, beef, and offal are consumed between one and two times a week.

With regard to compliance with the standard reference portion consumed by the children participating in the study, the dairy and dairy products group stands out, which corresponds to the Food-Based Dietary Guidelines for the Colombian population[24], in terms of the established reference measure of 200 cc for the foods evaluated in this group. This behavior was similar to that obtained in the study by Loria *et al.*[24], which establishes a recommended intake of 250 g of milk and 125 g of yogurt for the 3- to 6-year-old age group. Rodriguez *et al.*[25] showed that, in preschool children, the most commonly consumed food group was dairy products, with an intake of approximately 140 g/day or more.

Considering that eggs are an important source of high biological value protein, vitamins, and essential minerals, this study found that a significant proportion of children meet the standard portion, reflecting compliance with the recommendations established in the Food-Based Dietary Guidelines for the Colombian population[23], which promote the daily consumption of one serving of eggs (1 small egg, 50 g), as reported by Loria *et al.*[24], who highlight this same recommendation in terms of the approximate weight of the egg serving for children aged 3 to 6 years. However, in the research carried out by Pineda[26] on children aged 1 to 5 years, regular consumption was observed, although the recommendation for protein intake was not met. This behavior is essential since, as pointed out by Loria *et al.*[24], eggs are an essential food in the diet of children under five years of age due to their high content of quality protein and their richness in micronutrients such as zinc, chlorine, selenium, and vitamins D and B12, which are essential for physical growth, cognitive development, and strengthening of the immune system. Eggs are also valuable as an affordable, versatile, and sustainable food in contexts of malnutrition or low dietary diversity.

In the cereals and derivatives group, the lowest compliance with the standard reference portion intake was observed, which differs from the findings of Deleon *et al.*[27], since, when determining the availability and consumption of food in households with children under five years of age, they found that the group of cereals, tubers, and derivatives was the one with the highest consumption (59.6%).

Supplementation in early childhood with micronutrients such as vitamin D, calcium, iron, and zinc is essential to ensure adequate growth and development[28]. The actions proposed in the national context are in line with the guidelines of the World Health Organization, which establish children under five as one of the priority population groups and recognize that zinc supplementation is an essential factor in improving growth and reducing the incidence of diarrheal diseases and respiratory infections[29]. It is therefore essential to highlight that most supplements given to children provide a significant amount of this micronutrient in relation to the recommended daily intake for this age group (4 mg/day). This aspect is of great importance, given that, as evidenced in the study by Bejarano[30], zinc has a protective effect in the presence of acute diarrheal diseases, identifying that the duration of this clinical condition decreases in patients who receive this type of supplement.

The results of this study show that foods of animal origin, specifically meat, dairy products, and eggs, are the main sources of zinc in the diets of the children evaluated. This consumption trend is consistent with national nutritional recommendations and with cultural patterns and food availability in the local context. From a conceptual perspective, the interpretation of these findings is supported by the framework of social

https://doi.org/10.22267/rus.262801.356

determinants of health and nutrition, considering that access to and selection of foods is mediated by economic, cultural, and educational factors. In this sense, the predominant consumption of animal-based sources of zinc could be linked to inherited eating habits, as well as to existing institutional programs that promote their distribution in community settings[31].

The findings contribute to the study's objectives by identifying the main sources of zinc in children's diets and highlighting the importance of family practices in shaping these habits. This allows for recommendations to be made aimed at strengthening food and nutrition education programs, incorporating participatory approaches that consider the community and family environment as key actors.

### Recommendations

This study provides important public health insights for the planning, implementation, and evaluation of inter-institutional and intersectoral intervention strategies and initiatives aimed at the continuous and permanent strengthening of healthy eating habits among children and their families, thereby positively impacting the health and nutritional status of these communities. In this regard, it is recommended that institutions responsible for early childhood nutrition consider these results in order to adjust and target interventions, integrating the family and community environment in the promotion of healthy and sustainable eating practices.

Likewise, this research constitutes a fundamental input to support the development of future research framed within the importance of zinc-rich food consumption for nutritional status and health in early childhood, considering the influence of particular demographic and socioeconomic characteristics of different groups. However, as this is a cross-sectional study, causal mechanisms were not measured, and therefore further research is suggested.

## CONCLUSIONS

The consumption of zinc-rich foods among children aged 1 to 4 years old cared for at the children's home in Pamplona, Norte de Santander, was characterized by a high prevalence of animal products. A relationship was found between factors such as gender, nationality, origin, Marital Status, socioeconomic status, number of family members, income, and money allocated for food purchases, and the consumption of foods from the meat, cereal, fruit, vegetable, legume, and miscellaneous groups in the children evaluated. The selected population, focused on the 1-4 age group, proved to be relevant given its more defined dietary pattern and its relevance in the nutritional development stage. The operationalization of the variables, the control of measurement biases, and the validation of the instrument strengthened the methodological quality and the findings obtained in the study.

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