ARTÍCULO ORIGINAL

INVISIBLE CRISIS: PILOT ASSESSMENT REVEALS OVERLAPPING MALNUTRITION IN INDIGENOUS PRESCHOOLERS OF RURAL PERU

CRISIS INVISIBLE: UNA EVALUACIÓN PILOTO REVELA LA COEXISTENCIA DE MÚLTIPLES FORMAS DE MALNUTRICIÓN EN PREESCOLARES INDÍGENAS DEL PERÚ RURAL

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SUMMARY

Introduction: This pilot case study addresses a knowledge gap in the comprehensive nutritional assessment of children in remote indigenous communities of Peru – communities where existing nutritional surveillance programs seldom reach and where evidence on the coexistence of multiple forms of malnutrition remains scarce. **Objectives:** The objective of this study is to assess the nutritional status (including anemia and anthropometry), feeding practices, and food sourcing among children (n=12) aged 3-6 years attending a pre-kindergarten program in the high-altitude Maras district of Cusco, Peru. **Methods:** Our protocol included altitude-adjusted hemoglobin assessment, anthropometric measurements (weight and height), 24-hour dietary recalls, direct observation of food preparation, and food source mapping. Traditional surveillance programs rarely reach geographically isolated indigenous communities, and even less frequently apply multidimensional assessments capable of capturing the coexistence of undernutrition and overnutrition – both of which were documented in this study. **Results:** Findings reveal multiple coexisting forms of malnutrition: 58% of the participants presented anemia, one third showed stunting, and another third were overweight. Notably, 25% presented with simultaneous anemia and stunting, and 14% with concurrent anemia and excess weight, prevalence rates higher than the national average. Although caloric intake was adequate (122.6% of requirements), the dietary pattern showed qualitative deficiencies, characterized by low iron bioavailability and limited consumption of animal-source foods. **Conclusions:** This study documents the coexistence of stunting, anemia, and excess weight among preschool children in a remote indigenous community of the high-altitude Maras district, while demonstrating the necessity of multidimensional nutritional assessments in remote indigenous communities.

Key words (MeSH): Indigenous population; nutritional status; malnutrition; child, preschool; Peru.

RESUMEN

Introducción*: Este estudio de caso piloto descriptivo aborda la brecha de conocimiento en la evaluación nutricional integral de niños en comunidades indígenas remotas del Perú, donde rara vez llegan los programas tradicionales de vigilancia nutricional y donde existe evidencia limitada sobre la coexistencia de múltiples formas de desnutrición.* ***Objetivos:*** *El objetivo de este estudio es evaluar el estado nutricional (incluida la anemia y la antropometría), las prácticas alimentarias y el origen de los alimentos en niños (n=12) de entre 3 y 6 años que asisten a un programa de educación preescolar en el distrito de Maras, en las alturas de Cusco.* ***Métodos:*** *Nuestro trabajo incluía la evaluación de la hemoglobina ajustada a la altitud, la evaluación antropométrica (peso y altura), el recuerdo de la dieta durante 24 horas, la observación directa de la preparación de los alimentos y la cartografía de las fuentes de alimentos. Esta metodología es importante porque los programas tradicionales de vigilancia rara vez llegan a las comunidades indígenas geográficamente aisladas, en particular con la evaluación multidimensional de los indicadores nutricionales necesarios para caracterizar la compleja interacción de las condiciones de deficiencia y exceso documentadas en este estudio.* ***Resultados:*** *Los resultados evidencian múltiples formas de malnutrición coexistentes: el 58% de los participantes presentó anemia, un tercio mostró talla baja para la edad (retraso de crecimiento lineal), y otro tercio exhibió sobrepeso. Se observó que el 25% manifestó simultáneamente anemia y retraso de crecimiento lineal, mientras que el 14% presentó anemia y sobrepeso de forma concurrente, prevalencias superiores al promedio nacional. Aunque la ingesta calórica fue adecuada (122.6% de los requerimientos), el patrón alimentario mostró deficiencias cualitativas, caracterizado por baja biodisponibilidad de hierro y limitado consumo de alimentos de origen animal.* ***Conclusiones:*** *Este estudio demuestra la factibilidad de evaluar integralmente el estado nutricional en comunidades indígenas remotas, y documenta la presencia simultánea de tres problemáticas nutricionales en niños preescolares.*

Palabras claves (DeCS): *Población indígena; estado nutricional; malnutrición; niño preescolar; Perú.*

Main Messages

- ***Message 1. Study context:*** *This descriptive pilot study examined nutritional status in a small sample (n=12) of indigenous preschool children in Peru's Maras district. Our aim was to test a multi-method assessment approach in a setting where traditional surveillance programs rarely reach.*
- ***Message 2. Key observations:*** *We observed multiple forms of malnutrition: 58% of children had anemia, one-third showed stunting, and another third had excess weight. Some children presented with conditions simultaneously.*
- ***Message 3. Potential implications:*** *The observed patterns point to the need for further research on similar populations and contexts to analyze overlapping nutritional challenges and develop more targeted interventions.*

INTRODUCTION

Despite international commitments to end childhood malnutrition, profound disparities persist—hidden beneath national averages in data(1,2). In Latin America, these inequities are pronounced among indigenous and rural communities, where childhood anemia can exceed 70%. These levels compare to sub-Saharan Africa and South Asia, which carry the world's highest anemia burden(3-5). Yet, these Latin American communities remain underrepresented in global health research and policy(6).

This neglect is particularly concerning given the irreversible impact of poor nutrition during early childhood. At the neural level, over one million synaptic connections are formed every second in early childhood—laying the foundation for future cognitive, emotional, and physical health–growth that cannot be replicated later in life(7). Nutritional deficiencies during this period can have irreversible consequences, including long-term impairments in educational attainment and economic productivity(8,9).

Peru exemplifies how national statistics can mask severe regional inequities. While it reports a national childhood anemia rate of approximately 33% that has stagnated for decades(10), rural Peruvian communities experience rates between 60% and 76%(11,12). However, these figures are likely underestimated due to a reliance on data from more accessible urban areas. Research focusing on remote, high-altitude communities is particularly scarce, with few studies addressing the 6- to 59-month age range in isolated Andean contexts(11). This geographic and economic marginalization perpetuates cycles of health inequity that extend beyond anemia to multiple forms of malnutrition(13,14).

Compounding these challenges is the evolving nature of malnutrition itself. Children in low-resource settings now experience overlapping forms of malnutrition, with stunting and excess weight often coexisting within the same individual(15,16). This double burden demands interventions that are both nutritionally sophisticated and context-specific. Globally, nearly half of children under five experience at least one form of malnutrition(17-19), and those with multiple conditions face significantly higher mortality risk(20).

These complex nutritional challenges are further complicated in high-altitude settings, where standard diagnostic frameworks often prove inadequate. Anthropometric measurements and hemoglobin cutoffs require adjustments to account for altitude effects(21,22).

The underlying drivers of malnutrition in these communities reflect broader socioeconomic transformations. Traditional Andean diets based on staple crops contain compounds that inhibit micronutrient absorption—phytates and polyphenols prevalent in plant-based staples reduce iron and zinc bioavailability(23,24). Simultaneously, communities are transitioning to an increased consumption of processed foods alongside persistent limited access to diverse, nutrient-dense alternatives(25, 26).

In the rural highlands of Peru, what children eat is shaped as much by geography and tradition as by economics. Many families grow their own food, but limited market access and seasonal shifts mean fresh fruits, vegetables, and animal products aren't always available. To help support families in these settings, public programs like Programas no Escolarizados de Educación Inicial (PRONOEI) were created in the late 1960s. Designed for children without access to formal preschool, these programs typically run five days a week for about four hours a day(27). Beyond early education, they also provide opportunities for parental involvement and, in some cases, nutrition-related support.

Our case study centers on children aged 3–6 attending a PRONOEI pre-kindergarten in Maras, a high-altitude district in Cusco, Peru. Through examining nutritional status (including anemia and anthropometry), feeding practices, and food sourcing, we seek to understand how these factors collectively shape the nutritional well-being of children in this high-altitude indigenous community.

AIM

The present study aims to assess the nutritional status (including anemia and anthropometry), feeding practices, and food sourcing of children between the ages of 3 and 6 attending the PRONOEI pre-kindergarten program in the Maras District, Cusco region, Peru. Through examining these factors, we hope to highlight the nutritional challenges faced by rural underrepresented children in Peru and potentially other similar contexts in Latin America.

METHODS

Study design and population

This descriptive, observational, pilot cross-sectional study was conducted at a PRONOEI pre-kindergarten program near Urubamba in the Maras district, Cusco region, Peru. The Maras district was selected as a representative high-altitude indigenous community with limited access to healthcare services and nutritional surveillance programs. Data collection took place between June 4-6, 2024. Inclusion criteria: Children aged 3-6 years whose families were associated with the PRONOEI program (either as enrolled students or siblings of enrolled students), with parental informed consent. Exclusion criteria: Children with acute illness on the day of assessment. This case study used census sampling, including all 12 children (aged 3-6 years) enrolled in the PRONOEI program whose mothers consented to participate, and 2 siblings not enrolled in the program. Given the case study design and small population size, formal sample size calculations and power analyses were not applicable.

Instruments and procedures

- **Anthropometry**
  The weight and height of the children were assessed following the anthropometric measurement standards established by CENAN[28]. A Seca Model 803 scale with a capacity of 150 kg and a precision of 100 grams was used to measure weight. A Seca Model 213 portable stadiometer with a capacity of 205 cm and a precision of 1 mm was used to measure height. The results were used to calculate the Height-for-Age Z-score and the BMI-for-age using WHO Anthro version 3.2.2 software[29].

- **Hemoglobin to determine anemia**
  For anemia assessment, we collected capillary blood samples from the fingertip using a portable Hemocue Model 201 hemoglobinometer, following the standardized protocols described by Fernández Tinco et al.[30]. Given the study's location at high altitude, hemoglobin values were adjusted according to WHO guidelines[22] using the Stevens et al.[31] formula:
  ◊ Adjusted Hgb = Unadjusted Hgb + 0.32 × (altitude in meters × .0033) - 0.22 × (altitude in meters × .0033)^2.

  Anemia was defined as hemoglobin levels below 11.0 g/dL, with severity categorized as mild (10.0-10.9 g/dL), moderate (7.0-9.9 g/dL), or severe (<7.0 g/dL) based on WHO criteria. Children identified with anemia were referred to local healthcare facilities for clinical evaluation, as our measurements served as screening rather than definitive diagnosis.

- **Dietary Assessment Methods**
  Multiple complementary techniques were employed to evaluate children's food consumption patterns. A 24-hour semi-quantitative recall was conducted with mothers (in one case, an aunt) to document home food consumption. For foods consumed at PRONOEI, information was collected from teachers and staff for each child. During interviews, we documented the previous day's food intake with approximate quantities. Dietary intake data were converted to energy and micronutrient values using the Tablas Peruanas de Composición de Alimentos. Micronutrient consumption (including iron, calcium, zinc, and other key nutrients) was calculated from both home and PRONOEI consumption and compared against age-appropriate Dietary Reference Intakes[32,33] and WHO indicators for infant and young child feeding practices[34]. Instruments are openly available at: DOI 10.17605/OSF.IO/XBDAV

- **Food Sourcing Assessment**
  The food system evaluation included documentation of household food production, mapping of available food purchase locations, and identification of food assistance programs operating in the area. We also examined alternative food acquisition methods including food donations, bartering, and exchange practices. Some socioeconomic data was collected including: household structure, education level, and employment status. Sociodemographic data were also recorded, such as origin and family composition, educational level, occupation, mother tongue, housing characteristics and access to health care.

- **Ethical considerations**
  This study received ethical approval from the Institutional Ethics Committee of the Institute of Nutritional Investigation (IIN) (approval number: 424-2024/CIEI-IIN). Recruitment and data collection took place between April to June 6, 2024. Prior to data collection, all mothers or caregivers were informed about the study objectives and provided written informed consent for the participation of their children. Participants were advised of their right to withdraw from the study at any point without consequence. All collected data were anonymized, with participants identified only through coded identifiers throughout the research process.

RESULTS

Nutritional status and coexistence of multiple nutritional challenges

12 children were evaluated (5 girls and 7 boys, mean age 5.0 years), anemia emerged as the predominant nutritional concern, affecting 58.3% of children (table 1). Anemia was more prevalent among boys (71.4%) compared to girls (40.0%). Both stunting and excess weight were observed in one-third of the children (33.3%), with slightly higher rates

among girls (40.0%) than boys (28.6%, p=0.679). However, given the small sample size and case study design, with most cells containing fewer than 5 subjects, statistical comparisons have limited validity and should be interpreted with caution.

The coexistence of multiple nutritional problems within individual children was particularly notable. Of the seven children with anemia, two (28.6%) also exhibited stunting, while one (14.3%) was classified as overweight.

Table 1. Nutritional Status of Indigenous Preschoolers in Maras, Peru (n=12).

Nutritional Parameter	Total (N=12	Girls (N=5)	Boys (N=7)
Mean age (years)	5	4.6	5.5
Anemia[a]	7 (58.3%)	2 (40.0%)	5 (71.4%)
Mild	3 (25.0%)	1 (20.0%)	2 (28.6%)
Moderate	4 (33.3%)	1 (20.0%)	3 (42.9%)
Anthropometric indicators[b]			
Stunting	4 (33.3%)	2 (40.0%)	2 (28.6%)
Excess weight	4 (33.3%)	2 (40.0%)	2 (28.6%)
Coexistence patterns			
Anemia + stunting	3 (25.0%)	1 (20.0%)	2 (28.6%)
Anemia + excess weight	2 (16.7%)	1 (20.0%)	1 (14.3%)

Note. Excess weight and stunting were assessed using WHO growth reference data for 5-19 years. Anemia was determined according to WHO guidelines.
[a] World Health Organization. (2024). Guideline on haemoglobin cutoffs to define anaemia in individuals and populations. https://www.who.int/publications/i/item/9789240088542
[b] World Health Organization. (2021). Growth reference data for 5-19 years: Application tools. https://www.who.int/tools/growth-reference-data-for-5to19-years/application-tools

Cultural, food production, and economic characteristics by anemia status

Our cultural and socioeconomic assessment revealed several patterns associated with anemia status (though the small sample size precludes statistical inference). Among children whose mothers spoke quechua, 66.7% had anemia, compared to 55.6% among spanish speakers. All five children without anemia came from households that raised guinea pigs, while among the seven children with anemia, five lived in homes with guinea pig breeding and two did not.

Among children from households that purchased food from stores, 50% had anemia, compared to 75% in non-purchasing households. Neither of the two children whose families owned a food stand or small business had anemia, while seven of ten children (70%) from families without such enterprises presented with anemia. All mothers combined household responsibilities with agricultural fieldwork.

Energy and macronutrient intake patterns

Children in our study consumed an average of 1574.1 Kcal daily, representing 122.6% of their recommended intake (Table 2). Among the 12 children, six received the PRONOEI snack (averaging 491 Kcal), with their total daily intake reaching 125.2% of requirements. The remaining six children who did not receive this institutional snack consumed 120.1% of their recommended energy levels. Intake was measured through 24-hour dietary recalls with parents/caregivers, conducted with translator support for quechua-speaking families. Energy consumption values were descriptively higher in children with excess weight (137.1% of requirements) compared to those with normal weight (115.2% of requirements) (p=0.004, Mann-Whittney U test).

Macronutrient distribution analysis revealed that the average protein intake provided 12.1% of total energy, with two children consuming below the recommended range of 10-35%[32]. Approximately half of the protein consumed was derived from animal sources. Fat intake averaged 20.6% of total energy, below the recommended range of 25-35%, with nine children (75%) not meeting the minimum recommendation. Carbohydrates contributed an average of 67.2% of total energy, with seven children (58.3%) exceeding the upper limit of the recommended 45-65% range.

Micronutrient intake and adequacy

Micronutrient consumption generally fell below recommended requirements[33], with notable deficiencies in iron, calcium, and zinc. Total iron intake averaged 91.4% of recommended amounts, though much of this came from plant sources with lower bioavailability. Five children (41.7%) consumed no heme iron sources (meats, fish, or poultry). The average heme iron intake was notably influenced by one child who consumed lamb blood sausage, which elevated the group average.

Our data suggested variation in heme iron consumption across children with different hemoglobin levels. Children without anemia had higher average heme iron intake (1.7 mg) compared to those with mild anemia (0.3 mg) and moderate anemia (0.2 mg) (p=0.0076). For children without anemia, heme iron comprised approximately 11.6% of their total iron intake, compared to just 2.2% in those with mild anemia and 1.6% in those with moderate anemia (p<0.01).

Zinc intake reached 83.8% of recommended levels, with animal sources (which offer superior bioavailability) contributing 33.7% of total dietary zinc. Calcium consumption was particularly inadequate, meeting only 66.4% of recommended intake levels. A substantial proportion of children failed to meet nutritional recommendations: 25.0% consumed insufficient iron, 50.0% fell short of zinc requirements, and 83.3% did not achieve recommended calcium intake levels. Those who met calcium and zinc recommendations primarily did so through cheese consumption.

For vitamins, most children exceeded recommended intake levels for B vitamins (thiamine, riboflavin, niacin, and folates) and vitamins A and C. However, since B vitamins and vitamin C are thermolabile, further investigation into cooking methods is warranted to understand their actual nutritional contribution.

Table 2. Dietary Intake and Eating Patterns of Indigenous Preschoolers in Maras, Peru (n=12).

Dietary Componen	Mean Value	Adequacy To Recommendations (%)[b]
Energy and Macronutrient Intake[a]		
Energy (kcal)	1574.1	122.6
Macronutrient distribution (% energy)		
Proteins	12.1 (8.8-16.0)	83.3% within range*
Fats	20.6 (11.5-27.0)	25.0% within range*
Carbohydrates	67.2 (59.0-76.0)	41.7% within range*
Micronutrient Intake[b]		
Total iron (mg)	13.7	91.4
Heme iron (mg)	0.8	5.9
Zinc (mg)	6.7	83.8
Calcium (mg)	530.8	66.4
Food Group Consumption[c]	% of children consuming	Average amount (g)
Grains, roots, tubers	100	518.2
Vitamin A-rich vegetables	83.3	42.8
Other fruits and vegetables	100	245.8
Meat, poultry, fish	58.3	48.7
Eggs	75	52.2
Legumes	41.7	20.9
Milk and dairy products	100	89.8

Note. Macronutrient recommendations were based on dietary reference intakes for energy established for this age group. Micronutrient requirements based on Institute of Medicine guidelines. Food groups based on WHO/UNICEF indicators for assessing infant and young child feeding practices.
[a] National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Committee on the Dietary Reference Intakes for Energy. (2023). Dietary Reference Intakes for Energy. National Academies Press. https://www.ncbi.nlm.nih.gov/books/NBK588659/
[b] Institute of Medicine. (2006). Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. The National Academies Press. https://doi.org/10.17226/11537 Daily requirements for children 4-8 years: Energy 1295 kcal, Total iron 15 mg, Zinc 8 mg, Calcium 800 mg, Vitamin C 22 mg, Vitamin A 275 IU.
[c] World Health Organization. (2021). Indicators for assessing infant and young child feeding practices: definitions and measurement methods. https://iris.who.int/handle/10665/34070

Meal patterns and nutrient distribution

Children consumed between 4 and 5 meals daily (mean: 4.3 meals). All children ate three main meals, and six children also had a snack provided by PRONOEI. Breakfast (389.0 kcal) and lunch (401.1 kcal) provided the greatest amounts of energy, with similar patterns observed for total protein (12.5 g and 15.0 g, respectively) and other nutrients. PRONOEI snacks represented significant sources of energy and nutrients, with the exception of animal protein, heme iron, animal zinc, calcium, and niacin.

Breakfast and lunch collectively provided approximately half of daily calories and protein intake. For micronutrients, lunch was the primary source of heme iron (32.6% of daily intake), while breakfast contributed the highest percentage of calcium (30.4% of daily intake). Together, these two meals supplied about two-thirds of the recommended daily calorie intake and exceeded the protein requirement, underscoring their significance in the children's diet.

Dietary diversity and food group consumption

All children in the sample met the criterion for adequate dietary diversity (consumption of more than five food groups), with 41.7% consuming five food groups and 58.3% consuming six food groups. All children consumed grains/roots/tubers, other fruits and vegetables, and milk/dairy products the previous day. Additionally, 83.3% consumed vitamin A-rich vegetables, 75.0% consumed eggs, 58.3% consumed meats, and 41.7% consumed legumes.

Grains, roots, and tubers provided the greatest amount of energy, protein, carbohydrates, and several nutrients, including iron and zinc. However, the iron from these foods is of plant origin, which has lower absorption efficiency. Legumes contributed relatively low amounts of nutrients and energy, primarily due to their smaller consumption quantities. Fruits and vegetables intake among children averaged about 300 grams per day, falling short of the 400 grams daily recommended for their age group[35].

Feeding practices and food sourcing

Regarding feeding practices, almost all mothers reported that their main source of food supply was their own production, followed by purchases, and lastly, donations or social programs. Mothers perceived dietary changes over time, mainly due to increased economic access and greater food availability. Most reported that now more food can be purchased in stores because they have greater purchasing power compared to when they were children, when their parents only worked in the fields and consumed only what they produced.

Many mothers demonstrated knowledge about iron sources and foods suitable for children, appropriately identifying foods that are not suitable such as candy, fried foods, junk food, and noodles. Half of the children reported daily consumption of fruit and three-quarters reported daily consumption of vegetables, with vegetables mainly consumed cooked in soups and stews.

For food production, families reported growing a variety of crops including potatoes, beans, corn, barley, wheat, olluco, peas, quinoa, oats, oca, and tarwi. All interviewed families raised sheep and chickens, and the majority raised guinea pigs, donkeys, and pigs. Half of the families had cows, and some raised ducks and rabbits.

Regarding social programs, almost all families were beneficiaries of the Vaso de Leche Program, while all had access to Qali Warma through the school breakfast offered at PRONOEI. We observed that PRONOEI has a kiosk where unhealthy foods are sold, including gelatin, popcorn, biscuits, and cookies. Mothers reported that children who do not bring fruit to the nursery school receive money to purchase snacks at this kiosk.

DISCUSSION

Our findings reveal a complex nutritional profile among children attending the PRONOEI pre-kindergarten program in the Maras district. The pattern of overlapping nutritional challenges–especially the coexistence of anemia (>50%), stunting (33%), and excess weight (33%)–might be termed a “triple burden of malnutrition” and was a key finding of our assessment. The high anemia prevalence parallels previous findings in the Cusco region, where Cabada et al.[12] reported rates of 48.8% across 12 villages. Similarly, our observed stunting rate corresponds with their reported prevalence of 31.3%. The variability in stunting rates between communities within the region, as noted by Cabada[12], suggests localized determinants of nutritional status. As Amerson[11] proposed, this variation may reflect dietary patterns where children consume sufficient calories for weight maintenance but inadequate protein for optimal linear growth. Although catch-up growth remains biologically possible through adolescence, children in resource-constrained environments typically experience persistent growth impairment[36, 37, 38].

Particularly concerning is the concurrent presentation of multiple nutritional deficits within individual children. One in four exhibited both anemia and stunting, while one in seven presented with both anemia and excess weight. This exemplifies the "malnutrition paradox" described by Tzioumis and Adair[39], where undernutrition and overnutrition coexist not only within communities but within individuals. The concurrence of anemia and stunting (25% in our sample) substantially exceeds national estimates for Peruvian children, suggesting particular vulnerability in this rural highland population [40].

Dietary patterns provide insight into these seemingly contradictory nutritional outcomes. Energy intake exceeded recommendations, indicating a shift toward energy-dense foods. However, macronutrient distribution revealed insufficient protein and fat intake, coupled with inadequate micronutrient consumption, especially iron, zinc, and calcium. This pattern of "hidden hunger" amid caloric excess has been increasingly documented in populations undergoing nutrition transition[15,26].

The food sourcing data highlight the central role of home production and local markets in dietary patterns. Maternal reports of improved food access compared to previous generations, concurrent with increased availability of energy-dense, nutrient-poor processed foods, align with the nutrition transition framework described by Popkin and Reardon[25].

Limitations

We acknowledge that this pilot's small convenience sample (n=12) limits generalizability. Our reliance on single-day dietary recalls may not accurately reflect habitual intake patterns.

CONCLUSION

This case study describes a complex nutritional landscape in the Maras district, characterized by the coexistence of deficiency and excess in pre-kindergarteners. Particularly troubling is the substantial proportion of children experiencing multiple nutritional problems simultaneously: 25% with both anemia and stunting, and 14% with both anemia and excess weight.

Dietary analysis found excessive caloric intake, predominantly from carbohydrates, while protein and fat consumption remained within or below recommended levels. Micronutrient inadequacy was pronounced, with substantial deficits in dietary iron, zinc, and calcium. Despite improved food access compared to previous generations reported by mothers, dietary diversity remained limited.

Future research should validate these preliminary findings through larger-scale studies with representative sampling and investigate potential interventions that address both micronutrient deficiencies and excess weight gain simultaneously.

DATA AVAILABILITY

The data that support the findings of this study are openly available at DOI 10.17605/OSF.IO/XBDAV.

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