



INDIVIDUAL AND CONTEXTUAL FACTORS OF MALNUTRITION IN MOROCCAN CHILDREN UNDER FIVE



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ABSTRACT

This study investigates the multifaceted determinants of malnutrition among Moroccan children under five, focusing on individual, household, and community influences. Utilizing data from the 2018 Population and Family Health Survey, the study analyzes 5,983 children aged 0–59 months. This study employs a multilevel modelling methodology to consider the data's hierarchical structure. The results reveal that 18% of Moroccan children suffer from undernutrition, while 10% experience overnutrition. Factors influencing malnutrition include child sex, age, birth weight, parental education, breastfeeding practices, household size, and poverty. Male children and those with a low birth weight are also at increased risk, with ORs of 1.49 and 1.93, respectively. Parental education, especially maternal education, protects against undernutrition (OR = 1.45). Breastfeeding practices impact child nutrition, with children not breastfed having higher odds of undernutrition (OR = 2.03). Children from poorer households are more likely to suffer from undernutrition (OR = 2.40). Conversely, children from wealthier households are at a higher risk of overnutrition (OR = 1.78). Community-level factors, such as poverty and regional disparities, influence undernutrition outcomes, with notable differences in regions like Beni Mellal-Khenifra (OR = 6.15). Children living in rural areas are more likely to experience undernutrition than their urban counterparts (OR = 1.87). The findings of this study conclude that addressing child malnutrition in Morocco requires multi-level interventions, focusing on parental education, breastfeeding promotion, support for low-birth-weight infants, and targeted strategies for socio-economic and geographic disparities.

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INTRODUCTION

Being interested in children's health also means being interested in the health of adults of the next generation, and the challenge is to lead these children to adult life in the best possible conditions. Malnutrition, a critical public health issue, has devastating effects: it kills children, impedes their intellectual development, and causes significant economic losses (UNICEF, 2021). This phenomenon, manifesting as undernutrition and overnutrition, remains a critical public health challenge with important implications for child development and overall health. Undernutrition can lead to severe health consequences, including stunted growth, weakened immunity, and cognitive impairments (UNICEF, 2023). Overnutrition, often resulting from diets high in calories but low in nutritional value, contributes to childhood obesity and associated health issues such as diabetes and cardiovascular diseases (WHO, 2024). This dual burden of malnutrition presents a complex problem that hinders efforts to improve child health globally and a complex challenge that varies across different regions and socio-economic contexts (Alaba et al., 2023; Davis et al., 2020; Menon & Peñalvo, 2020). In 2011, researchers reported that chronic malnutrition stunted 18.1% of Moroccan children under five, while acute malnutrition affected 9.3% (Moroccan Ministry of Health, 2012). Despite some progress in reducing stunting to 15.1% by 2018, the issue of overnutrition has escalated, with 10.8% of children under five classified as overweight (Moroccan Ministry of Health, 2019). As the world progresses towards the 2030 Sustainable Development Goals, the fight against child malnutrition remains a central challenge, demanding concerted action from governments and international organizations (Heidkamp et al., 2021). This study aims to identify the multifaceted factors of undernutrition and overnutrition in Moroccan children under five, focusing on individual and contextual influences. Our analysis employs a multilevel modeling approach, which allows us to uncover the interconnections among children, their families, and communities through hierarchical data (Andriani et al., 2023). This approach is critical because traditional logistic regression models, which frequently violate the assumption of data independence in hierarchical data, may yield biased estimates.

The paper's outline is as follows: The literature review examines the various determinants of child malnutrition.

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The materials and methods section details the data sources, population sample, and multilevel modeling techniques. The results section presents key findings from the multilevel analyses, highlighting factors associated with undernutrition and overnutrition. In the discussion section, this research is compared to previous works in the field. The last section provides a concise overview of the main arguments and suggests policies to help reduce child malnutrition in Morocco.

LITERATURE REVIEW

We adopted a structured approach to gathering literature, using keywords such as "multi-level regression techniques," "malnutrition", "determinants or risk factors", and "child under five". We searched for relevant articles in electronic databases like Scopus, Google Scholar, and PubMed via the "Publish or Perish" platform, employing Boolean operators "AND/OR."

Across various studies, individual-level factors such as age, gender, birth characteristics, health conditions, breastfeeding practices, and maternal factors significantly influence child malnutrition. A child's age plays a crucial role, as stunting is more common in children older than 11 months, especially those between 12 and 24 months. Additionally, the risk of undernutrition increases for children aged 12-36 months. Conversely, children aged 2-3 years have a lower risk of obesity or overweight compared to those younger than two years, highlighting different vulnerabilities across age groups (Adekanmbi et al., 2013; Aman & Kawo, 2020; Amegbor et al., 2020; Ayele et al., 2022; Chikako et al., 2021; Dabale & Sharma, 2014). However, in some contexts, female children are more frequently malnourished due to gender inequalities, while other studies found no significant gender difference in malnutrition rates (Adekanmbi et al., 2013; Aman & Kawo, 2020; Amegbor et al., 2020; Bhowmik & Das, 2019). Multiple births present higher malnutrition risks due to increased competition for nutrition among siblings, leading to a higher risk of being stunted and underweight compared to single births. This is due to higher demands on maternal resources, as well as lower individual care and nutrition (Adekanmbi et al., 2013; Aman & Kawo, 2020; Amegbor et al., 2020; Asmare & Agmas, 2022; Tamir et al., 2022). Birth order and birth interval are also significant determinants. A higher birth order and shorter birth intervals increase the risk of malnutrition. Later-born children face higher malnutrition risks, potentially due to resource constraints, while shorter birth intervals can lead to maternal nutritional depletion, impacting the health of subsequent children (Haile et al., 2016; Muche & Dewau, 2021; Tamir et al., 2022).

Parental education and healthy practices are critical determinants of child nutrition. Higher maternal education levels are consistently associated with lower rates of child stunting and underweight. Mothers' levels of education positively impact maternal health, child nutrition, and access to healthcare. Mother's Proper health practices, such as health-seeking behaviors, antenatal care visits, vaccinations, breastfeeding, and maintaining a healthy BMI, significantly impact child nutrition. Children of mothers with regular health check-ups and proper feeding practices are less likely to be malnourished. Studies indicate that maternal and health-seeking behaviors reduce the likelihood of child malnutrition, while poor health practices exacerbate these risks. Numerous studies (Al-Sadeeq et al., 2018; Amegbor et al., 2020; Aman & Kawo, 2020; Asmare & Agmas, 2022; Ayele et al., 2022; Begashaw & Moges, 2020; Hanandita & Tampubolon, 2015; Rajaram et al., 2007; Roobiati et al., 2019; Tesfaw & Dessie, 2022) emphasize these protective effects. Paternal education contributes to better child nutritional outcomes, although its impact is generally less pronounced than maternal education. Fathers with higher education levels are likely to support health and nutritional practices that benefit children (Amegbor et al., 2020; Haile et al., 2016).

Proper breastfeeding practices are essential for child nutrition. Inconsistent or nonexistent breastfeeding increases the risk of stunting. Researchers have linked the timely introduction of complementary foods to lower odds of malnutrition, underscoring the importance of early and appropriate nutritional interventions (Begashaw & Moges, 2020). Furthermore, children of empowered mothers who make decisions about their health, purchases, and visits to health institutions are less likely to experience concurrent wasting and stunting. This empowerment positively impacts child nutrition, as these mothers are more likely to seek timely healthcare, adopt better nutritional practices, and overcome cultural barriers that might otherwise hinder their children's nutritional status. Consequently, empowered mothers contribute significantly to reducing malnutrition among their children (Roba & Başdaş, 2023).

Household wealth, sanitation, water access, and area of residence are critical determinants of child nutrition. Across various studies, children from poorer households have significantly higher odds of being malnourished compared to those from wealthier households. Economic constraints in poorer households limit access to nutritious food and healthcare, exacerbating malnutrition risks. Moreover, access to safe drinking water and proper sanitation is crucial for preventing malnutrition. Poor sanitation and a lack of clean water led to higher rates of infections like diarrhoea, exacerbating nutritional deficiencies. Furthermore, whether children live in urban or rural areas plays a role in determining nutritional outcomes. Children residing in rural areas are more likely to be malnourished compared to those in urban areas. Urban areas generally provide better infrastructure and services that support child nutrition. Studies across various contexts emphasize the importance of these factors in reducing malnutrition and promoting better health outcomes (Ayele et al., 2022; Dabale & Sharma, 2014; Das & Gulshan, 2017; Aheto et al., 2015; Kalinda et al., 2023; Kumar et al., 2019; Muche & Dewau, 2021; Mulyaningsih et al., 2021; Kaid et al., 2022; Sahiledengle et al., 2022; Sk et al., 2021; Smith & Shively, 2019; Yunus & Rahman, 2019).

Community-level factors such as illiteracy rates, geographic and environmental conditions, religion, maternal employment, and poverty significantly influence child nutritional outcomes. Poverty at the community level exacerbates malnutrition by limiting access to essential resources. Effective interventions must consider these community-level factors (Aman & Kawo, 2020; Amegbor et al., 2020; Chikako et al., 2021; Enbeyle et al., 2022; Gebru et al., 2019; Haile et al., 2016; Aheto et al., 2015; Kumar et al., 2019; Roba & Başdaş, 2023). The availability and quality of public health infrastructure, including healthcare facilities and services, are critical to addressing malnutrition. Communities with robust

health infrastructure can better prevent and manage malnutrition (Fotso, 2007). Community-wide education programs on nutrition and health can significantly reduce malnutrition. Educating whole communities can ensure widespread knowledge and improve practices across the board (Sahiledengle et al., 2022).

In summary, this literature review has analyzed the determinants of child malnutrition, highlighting its complexity and multifactorial nature, influenced by socio-economic, environmental, and cultural factors. This study aims to investigate the determinants of undernutrition and overnutrition among Moroccan children under five, focusing on individual, household, and community influences using a multilevel modeling methodology. Despite extensive research, unresolved issues remain, including contradictions about gender influence and maternal employment's impact on malnutrition. The role of cultural factors and the effectiveness of community-wide interventions also need further exploration. This study will address these gaps by analyzing multi-level factors contributing to child malnutrition in Morocco and proposing strategies for reducing malnutrition rates.

This research aims to bridge the gap in understanding how global determinants of malnutrition manifest in the Moroccan context. Based on the literature review, we propose nine hypotheses to investigate the multifaceted determinants of malnutrition among Moroccan children under five. The following are the hypotheses that this study takes into account.

Hypothesis H1: Child-specific factors, including being a twin, age, gender, birth sequence, and low birth weight, significantly influence the risk of malnutrition among children.

Hypothesis H2: Lower levels of parental education and younger maternal age are associated with children's malnutrition rates (both undernutrition and overnutrition).

Hypothesis H3: Maternal behaviors, such as place of delivery, previous breastfeeding practices, and the ability to provide quality nutrition, are crucial factors of malnutrition among children under five.

Hypothesis H4: The composition of the household family, whether nuclear or extended, significantly impacts the two phenomena.

Hypothesis H5: Because of resource constraints, larger household sizes are associated with higher malnutrition rates among this population.

Hypothesis H6: According to the wealth quintile, household wealth is a strong indicator of undernourishment in children.

Hypothesis H7: Communities with a higher proportion of poor households have higher rates of undernourishment in children due to limited access to healthcare and proper nutrition.

Hypothesis H8: The proportion of educated women in the community significantly influences malnutrition rates among children under five, with higher education levels within the community associated with lower malnutrition rates.

Hypothesis H9: Urbanization is associated with a dual burden of malnutrition among children under five, with urban areas experiencing both undernutrition and overnutrition due to lifestyle and dietary shifts.

MATERIALS AND METHODS

Source of Data

We utilized data from the 2018 Population and Family Health Survey (PFHS) for this research. The survey collected detailed responses from 9,969 women aged 15 to 49 and interviewed 15,022 households. Our study analyzes a subset of the data, encompassing 5,983 children aged 0 to 59 months. This sample includes 3,120 males and 2,863 females, offering a balanced gender perspective. We employ multilevel modeling techniques to dissect the complex interplay of determinants at three levels (individual, household, and community). Multilevel modeling techniques are exceptionally well suited to our dataset's level composition. This structure embeds children in households, integrating them into broader community settings.

Outcome Variables

This study uses a dual-index approach to assess nutritional status, classifying children with a score of 1 for any form of malnutrition (stunting, underweight, wasting, overweight, or obesity) and 0 otherwise. We constructed these variables based on WHO standards (Moroccan Ministry of Health, 2019; WHO, 2006). This dual-index approach, integrating all five components of malnutrition, offers a more precise evaluation of the nutritional challenges in the child population. In response to the complex nature of child malnutrition, we will construct two separate dependent variables. We derive the first variable, undernutrition, from its three key components and formulate the second variable, overnutrition, from its two distinct elements. Utilizing this methodology enhances precision in evaluating the nutritional issues encountered by the child population (Nandy & Svedberg, 2012).

Explanatory Variables

Building upon the literature review presented above, which explores a range of determinants from socio-economic to contextual factors, we develop a detailed understanding of the explanatory variables pertinent to child malnutrition in Morocco. We will adopt the UNICEF conceptual framework, which classifies the factors affecting child malnutrition into three levels: individual, meso, and macro. "Child characteristics" refers to a child's various attributes and conditions that may influence health outcomes. It considers the presence of twins in addition to commonly analyzed variables such as the child's age, gender, birth sequence, and weight at birth. Parental characteristics refer to various attributes of the parents that can impact the health and nutrition of the child. These include parental education level and the mother's age. Maternal behaviors are the mother's various actions and practices that can impact the child's health and nutrition. Key variables include the place of delivery, previous breastfeeding practices, and the ability to provide quality nutrition to the child. At the meso level, we will consider household family composition, family size, and the well-being quintile. Household family composition: This includes parents, siblings, grandparents, and other extended family members living within the household.

Size of the Household: This refers to the total number of household members. Quintile of well-being: This refers to dividing the population into five equal parts based on economic status. We classify these values as "poor" for the first and second quintiles, "middle" for the third quintile, and "rich" for the fourth and fifth quintiles. For the contextual level, we constructed two other variables besides the area and region of residence variables. Thus, we have synthesised two variables by aggregating household characteristics at the cluster level, the primary unit of analysis in the 2018 PFHS. We divide the proportion of educated women in the community into low, high, and very high levels. Finally, we consider the area of residence, differentiating between rural and urban modalities.

Statistical Analysis

This study employs multi-level modeling. Given that the dependent variables are dichotomous and taking the data's hierarchical structure into account, there is a potential for correlation among observations at the same level. This correlation challenges the assumption of independence fundamental to most single-level analysis models (Snijders & Bosker, 1999). We estimated two models for each dependent variable to evaluate the impact of independent variables on children's malnutrition across the three analysis levels we considered.

Null model (M₀): This model yields the intra-class correlation coefficient (ICC) as a key statistic. A significant deviation of this coefficient from zero indicates the presence of multiple unseen factors associated with children in the same community or household, which are likely to impact the incidence of child malnutrition. The greater the variance, the more pronounced the difference between groups. We can express the Null model as follows:

$$\text{logit}(Y_{ijk}) = \log P\left(\frac{Y_{ijk} = 1}{1 - P(Y_{ijk} = 1)}\right) = \beta_0 + v_k + u_{jk} + e_{ijk}$$

i stands for individual-level observations, j for household-level observations, and k for community-level observations. In this model, the symbol Y_{ijk} represents the undernutrition or overnutrition of the child on three levels. Expression $v_k + u_{jk} + e_{ijk}$ constitutes the random component of the model, and β_0 represents its fixed part. Here, v_k , u_{jk} , and e_{ijk} are unobserved random variables, each following a normal distribution with variances σ_v^2 , σ_u^2 , and $\sigma_e^2/3$, respectively, and mean 0. The full model (M₁) incorporates all explanatory variables. The full model (M₁) incorporates all explanatory variables.

$$\text{logit}(Y_{ijk}) = \beta_0 + \beta_1 x_{ijk} + \beta_2 x_{jk} + \beta_3 x_k + v_k + u_{jk} + e_{ijk}$$

We use Stata, version 17 software, to analyze the data.

RESULTS

In 2018, 18.4% of Moroccan children (0–59 months) suffered from undernutrition, which includes stunting, underweight, or wasting, as shown in Table 1. Additionally, 10.8% of children in this age group experienced overnutrition, which manifested as overweight or obesity.

Table 1. Undernutrition and overnutrition status of children

Child victims of malnutrition	Undernutrition	Overnutrition
Yes	18.4	10.8
Non	81.6	89.2
Total	100.0	100.0

Tables 2 and 3 comprehensively summarise the multi-level modeling results for undernutrition and overnutrition based on various explanatory variables. These tables present the odds ratios (OR) for different factors across the two models (M₀ and M₁), highlighting how individual, household, and contextual factors affect children's nutrition. The empty model's findings (M₀) highlight significant contributions across different levels of child undernutrition. With intra-class correlation coefficients at 56% for the meso level and 12% at the community level, it is evident that unobserved factors at both household and community levels drive disparities in undernutrition. On the other hand, when we look at overnutrition, we see that meso- and community-level factors (with intra-class correlation coefficients of 57% at the meso level and 7% at the community level) have a significant effect. This shows that we cannot see household and community factors influence these nutritional outcomes.

Table 2. Null model results (M₀)

Characteristics	Undernutrition	Overnutrition
Constant	0.08***	0.04***
Random effects		
Community var(constant)	0.90***	0.52***
Community>HH var(constant)	3.32***	3.90***
ICC Community	0.12***	0.07***
ICC HH>Community	0.56***	0.57***
χ ² de Wald	385***	170***

***p-value < 0.001; ** p-value < 0.01; * p-value < 0.05

Model 1 integrates individual, household, and contextual factors, offering a comprehensive perspective on the diverse influences on nutritional outcomes. The youngest children, particularly those under six months, show significantly higher odds of undernutrition (OR = 2.32, $p < 0.001$) and overnutrition (OR = 6.80, $p < 0.001$) compared to the reference group of 48–59 months. Furthermore, the analysis for this complete model reveals a notable gender disparity, with male children facing higher odds of both undernutrition (OR = 1.48, $p < 0.001$) and overnutrition (OR = 1.42, $p < 0.01$). Moreover, birth weight is another critical factor influencing undernutrition among children. The results indicate that children with a low birth weight have significantly higher odds of undernutrition (OR = 1.93, $p < 0.01$) than those with a high birth weight. This demonstrates that low birth weight is a substantial risk factor for undernutrition, highlighting the necessity for targeted nutritional support and monitoring for infants born with low or average birth weight to mitigate these risks. Thus, the results partially verify hypothesis H1, which suggests that child-specific factors like being a twin, age, gender, birth sequence, and low birth weight significantly influence the likelihood of malnutrition among children under five. Hypothesis H2, which links lower levels of parental education and younger maternal age to higher rates of malnutrition (both undernutrition and overnutrition) among children under five, only partially supports parental traits. It turns out that the level of parental education is the most critical factor, especially when both parents lack education, which has a significant effect on undernutrition (OR = 1.45, $p < 0.01$). This highlights the importance of educational interventions targeting parents to improve child nutrition and health knowledge and practices. Maternal behaviors are also crucial determinants of malnutrition. We also partially confirm hypothesis H3 that maternal behaviors, including place of delivery, previous breastfeeding practices, and the ability to provide quality nutrition, are crucial determinants of malnutrition among children under five. Model 4 sheds light on the importance of breastfeeding practices and the place of birth, which, while not significantly influential in the overnutrition model, show relevance to undernutrition outcomes.

The Meso-level analysis does not directly test hypothesis H4, that the type of family in a household, including whether the family is nuclear or extended, significantly affects the nutritional status of children under five, with extended families being better at helping with child nutrition. The analysis does not explicitly differentiate between nuclear and extended family impacts on child nutrition, focusing instead on household size and wealth. However, the model's result confirms hypothesis H5, that resource constraints associated with larger household sizes lead to higher malnutrition rates among children under five. The model brings to light the challenges faced by larger households. Specifically, those with seven or more members are associated with an increased risk of undernutrition (OR = 1.42, $p < 0.05$), pointing towards the dilution of resources or inadequate food distribution within these families. This finding calls for policies that support families effectively managing their nutritional needs, regardless of size.

Furthermore, the wealth quintile confirms hypothesis H6, that household wealth significantly predicts child malnutrition, with children from poorer households more likely to suffer from malnutrition. The stark contrast in nutritional outcomes based on household wealth is evident, as children from poorer households exhibit significantly higher odds of undernutrition (OR = 2.40, $p < 0.001$). This correlation underscores the critical link between economic status and nutritional health, highlighting poverty as a root cause of nutritional disparities. The macro level confirms H7's hypothesis that communities with a higher proportion of poor households have higher rates of malnutrition among children under five due to limited access to healthcare and proper nutrition.

Additionally, the broader socio-economic environment, reflected in the community's poverty level, shows a pronounced impact on nutritional health, with communities experiencing higher rates of poverty associated with increased odds of undernutrition (OR = 1.61, $p < 0.01$). This analysis aspect further illustrates the complex interplay between socioeconomic factors and child nutrition. Our findings do not support hypothesis H8, which posits that higher education levels within the community are associated with lower malnutrition rates. The focus is more on the immediate educational status of parents than the broader community. Lastly, we partially confirm hypothesis H9 that urbanization is associated with a dual burden of malnutrition among children under five, with urban areas experiencing undernutrition and overnutrition due to lifestyle and dietary shifts. The influence of living in rural areas emerges as a significant factor, with children in these settings showing higher odds of undernutrition (OR = 1.73, $p < 0.01$). Model 1 further emphasizes geographic disparities by shedding light on the significant regional variations affecting nutritional outcomes among Moroccan children under five. Notably, while Beni Mellal Khenifra emerges as a region with a markedly higher risk of undernutrition (OR = 6.15, $p < 0.001$), it is not the only area facing such challenges. The results uncover similar disparities in other regions, indicating a broader pattern of regional influence on nutritional health. In short, the findings highlight the multifaceted nature of child malnutrition, which is influenced by the three-level factors. Tackling these problems calls for focused, multi-level interventions considering parental education, child-specific characteristics, maternal behaviors, household composition, economic status, and geographic disparities. The insights from this analysis underscore the importance of comprehensive policies and programs that address these diverse determinants to improve child nutritional outcomes.

Table 3. Multi-level undernutrition and overnutrition modeling results (M₁)

Characteristics	Undernutrition	Overnutrition	Characteristics	Undernutrition	Overnutrition	Characteristics	Undernutrition	Overnutrition
Constant	0.006***	0.02***	Under 25 years	1.05	0.82	Percentage of poor in the community		
INDIVIDUAL FACTORS			25-29 years	0.98	0.67	Low ^R	1.00	1.00
Child age			30-34 years	1.04	0.66	High	1.61**	1.16
months						% of educated women in the community		
48-59 months ^R	1.00	1.00	35-39 years	1.14	0.65**			
Under 6 months	2.32***	6.80***	Place birth of a child			Very high ^R	1.00	1.00

6-11 months	1.90**	5.06***	Health	1.00	1.00	Low	0.71	0.79
12-23 months	2.20***	8.15***	Home	1.01	0.98	High	0.89	1.03
24-35 months	2.70***	4.02***	Breastfeeding			Place of residence		
36-47 months	1.63**	1.90**	Yes ^R	1.00	1.00	Urban ^R	1.00	1.00
Sex of children			No	1.35*	0.86	Rural	1.73**	0.92
Female^R	1.00	1.00	Quality of food			Region of residence		
Male	1.48***	1.42**	Yes ^R	1.00	1.00	Casablanca Settat ^R	1.00	1.00
Child rank			No	1.04	1.05	Tanger Tetouan Al Hoceima	1.51	1.11
4 or over^R	1.00	1.00	HOUSEHOLD FACTORS			Oriental	3.03***	1.47
1	0.98	0.95	Family composition of the household			Fes Meknes	1.26	0.69
2-3	1.27	1.44	Nuclear ^R	1.00	1.00	Rabat Sale Kenitra	1.66	0.98
Birth weight			Extended ascendants	1.03	1.36	Beni Mellal Khenifra	6.15***	2.82***
High^R	1.00	1.00	Extended siblings	1.19	1.47	Marrakech Safi	2.36***	0.50**
Low	1.93**	0.63	Extended others	0.85	0.93	Draa Tafilalet	3.02***	0.83
Normal	1.46*	0.79	HH and children	0.44	0.80	Souss Massa	1.32	0.62
Twin child^R			HH, children, and others	1.07	0.90	Guelmim Oued Noun	4.67***	1.15
No^R	1.00	1.00	Others	0.73	1.06	Laayoune Sakia El Hamra	5.67***	2.54*
Yes	1.13	0.42	Household size			Ed Dakhla Oued Ed Dahab	3.93**	0.38
Parents education level			2-4 ^R	1.00	1.00	Random effects		
Parents with secondary or higher education^R	1.00	1.00	5-6	1.16	0.95	Community var(constant)	0.35***	0.43***
Parents without education	1.45**	0.76	7 or over	1.42*	0.67	Community>HH var(constant)	3.73***	3.94***
Parents with primary education	1.40**	1.18	Household wealth quintile			ICC Community	0.05***	0.06
Mother more educated than father	0.83	0.91	Rich ^R	1.00	1.00	ICC HH> Community	0.55***	0.57
Mother less educated than father	0.96	0.87	Poor	1.46*	0.81	χ^2 de Wald	269***	150***
Maternal age 40 years or over^R	1.00	1.00	Middle	1.40*	0.76			
			CONTEXTUAL LEVEL FACTORS					

***p-value < 0.001; ** p-value < 0.01; * p-value < 0.05. ^R Reference category; ICC: intraclass correlation coefficient.

DISCUSSIONS

This study used 2018 PFHS data to investigate the factors influencing under and over-nutrition among Moroccan children under five. The multi-level analyses revealed that various factors determine these two phenomena at different levels of analysis. According to our results, undernutrition affects two out of eleven (18%) Moroccan children under five, while overnutrition affects one out of ten (10%).

The findings of this study underscore the multifaceted nature of malnutrition among Moroccan children under five, influenced by individual, household, and community-level factors. Our results reveal concordances and discordances with existing literature, emphasizing the need for tailored interventions. So, our study confirms children under six months' critical vulnerability to undernutrition and overnutrition, with odds ratios (OR) of 2.25 and 6.49, respectively, compared to children aged 48-59 months. This aligns with previous research indicating that infancy is a high-risk period for malnutrition due to significant nutritional needs during early development (Adekanmbi et al., 2013; Aman & Kawo, 2020; Amegbor et al., 2020). However, our findings contradict some studies that suggest older children are more prone to certain forms of malnutrition (Chikako et al., 2021). This discrepancy might be due to differences in feeding practices and healthcare access in different contexts.

Furthermore, our analysis indicates that male children are at higher risk for undernutrition (OR = 1.49) and overnutrition (OR = 1.42). This finding is consistent with studies highlighting gender-specific vulnerabilities yet contrasts with others that found no significant gender difference (Bhowmik & Das, 2019). This disparity suggests that cultural and biological factors influencing malnutrition vary significantly across countries. Our results indicate that the rank of the child within the family is not an essential predictor of malnutrition, which contrasts with existing literature that suggests higher birth order is associated with increased risk of malnutrition due to resource dilution (Haile et al., 2016; Muche & Dewau, 2021). This discrepancy might be due to variations in family dynamics, resource allocation, or cultural practices in Morocco that mitigate the negative impacts of higher birth order.

Similarly, low birth weight emerges as a significant determinant of undernutrition (OR = 1.93), corroborating studies associating low birth weight with poor prenatal nutrition and subsequent health complications (Asmare & Agmas, 2022; Haile et al., 2016). However, our findings differ from some research that indicates multiple births as significant predictors of malnutrition (Adekanmbi et al., 2013). In our study, twinning was not considered an important risk factor,

possibly reflecting differences in healthcare practices or support systems available to mothers of twins in Morocco.

In addition, parental education, particularly maternal education, is crucial in reducing malnutrition risks. Our results show that children of uneducated parents are more likely to be undernourished (OR = 1.45), aligning with numerous studies that demonstrate the protective effects of maternal education on child nutritional status (Aheto & Alangea, 2021; Begashaw & Moges, 2020; Kumar et al., 2019). Interestingly, our findings also highlight the significant impact of paternal education, albeit to a lesser degree, which diverges from the predominant focus on maternal education in many studies (Bhusal, 2022; Fotso, 2007). This suggests that in the Moroccan context, both parents' educational levels should be considered in nutritional interventions. Contrary to studies indicating that younger maternal age is associated with malnutrition rates (Aheto & Alangea, 2021; Al-Sadeeq et al., 2018), our results show that maternal age is not a significant predictor of overnutrition. This might suggest that other factors, such as socioeconomic status and maternal education, play a more crucial role in influencing overnutrition in Moroccan children. Our study did not find a significant link between where a child was born (at home vs. a healthcare facility) and malnutrition. This differs from previous research suggesting home births are more likely to lead to malnutrition because of limited access to immediate postnatal care and nutritional guidance (Roba & Başdaş, 2023; Seboka et al., 2021). This discrepancy may be due to improvements in community healthcare support and nutritional education that mitigate the risks traditionally associated with home births in Morocco. Our analysis indicates that breastfeeding practices significantly impact child nutrition. Previous breastfeeding practices show relevance to undernutrition, aligning with studies emphasizing the importance of proper breastfeeding in preventing malnutrition (Begashaw & Moges, 2020; Enbeyle et al., 2022). However, our findings did not significantly impact overnutrition, suggesting that while breastfeeding is crucial for preventing undernutrition, overnutrition may require additional interventions focused on dietary quality and lifestyle.

Additionally, our study did not find a significant impact of food quality on malnutrition outcomes, contrasting with numerous studies emphasizing the importance of dietary quality in preventing undernutrition and overnutrition (Adeyonu et al., 2022; Smith & Shively, 2019). This lack of significance might be due to the challenges in accurately assessing food quality or variations in dietary patterns and food availability in Morocco. It suggests that other factors, such as food security and access to diverse foods, might be more critical in this context.

Furthermore, our study finds no significant impact of family composition on child nutrition, which is in discordance with existing literature. Indeed, previous studies suggest that children living in extended families have better nutritional outcomes than those in nuclear families due to more robust social support systems and resource sharing (Kalinda et al., 2023; Titaley et al., 2019). However, our results did not show a significant difference, which might reflect unique cultural or socioeconomic dynamics in Moroccan households that differ from other contexts. Similarly, household size significantly impacts child nutrition, with larger households facing higher risks of undernutrition (OR = 1.81 for households with seven or more members). This supports existing literature highlighting resource constraints in larger households (Kalinda et al., 2023; Titaley et al., 2019). However, our finding that larger households show a lower risk for overnutrition (OR = 0.72) contrasts with some studies that did not find significant differences based on household size (Roba & Başdaş, 2023). This might indicate varying food distribution dynamics and dietary quality across different contexts. In line with these findings, our results reveal that household wealth significantly predicts child malnutrition. Children from poorer households are more likely to suffer from undernutrition (OR = 2.40), aligning with numerous studies that associate poverty with higher malnutrition rates (Adekanmbi et al., 2013; Aheto & Alangea, 2021; Al-Sadeeq et al., 2018). Conversely, children from wealthier households are more likely to be overnutrition, suggesting a dual burden of malnutrition influenced by economic status. This supports the notion that while poverty exacerbates undernutrition through limited access to nutritious food and healthcare, affluence might increase overnutrition risks due to higher consumption of calorie-dense, low-nutrient foods (Smith & Shively, 2019; Yunus & Rahman, 2019).

Our findings confirm the substantial influence of community-level factors on child nutrition. Communities with higher poverty rates are associated with increased odds of undernutrition (OR = 1.71), emphasizing the impact of socioeconomic status on nutritional health (Adekanmbi et al., 2013; Banu et al., 2023; Aman & Kawo, 2020; Bhusal, 2022). Contrary to several studies that emphasize the importance of community-wide education levels in reducing malnutrition rates (Roba & Başdaş, 2023), our findings do not support the hypothesis that higher community education levels are associated with lower malnutrition rates. Instead, immediate parental education appears to be more influential. This discrepancy may indicate that local interventions focused on improving parental education could be more effective than broader community education initiatives.

Additionally, the higher risk of undernutrition in rural areas (OR = 1.87) reflects geographical disparities in access to nutritional resources and healthcare, consistent with findings from other studies (Ayele et al., 2022). Moreover, while previous research underscores the significant impact of urbanization on malnutrition, leading to both undernutrition and overnutrition due to lifestyle and dietary shifts (Smith & Shively, 2019; Yunus & Rahman, 2019), our results show a more pronounced risk of undernutrition in rural areas. This suggests that rural-urban disparities in access to nutritional resources and healthcare are more critical determinants of undernutrition in Morocco. Our findings also indicate significant regional disparities in malnutrition outcomes among Moroccan children, with regions such as Beni Mellal-Khenifra showing notably higher risks of undernutrition (OR = 6.15). This supports existing literature that emphasizes the impact of geographic and socioeconomic factors on child health (Ayele et al., 2022). However, our results also reveal that certain regions do not follow this pattern, suggesting that local interventions and policies might differ in effectiveness. This regional variability highlights the need for region-specific strategies to address malnutrition effectively.

CONCLUSIONS

This study aimed to identify the multifaceted determinants of undernutrition and overnutrition in Moroccan children under five, using data from the 2018 PFHS. The study used a multilevel modelling methodology to account for the data's hierarchical structure, which embeds children within households and communities. The multi-level analysis revealed that factors at all three levels of analysis contribute significantly to child malnutrition.

Specifically, child sex, age, birth weight, and parental education emerged as critical determinants. Younger children, especially those under six months, are particularly vulnerable to undernutrition and overnutrition. Male children and those with a low birth weight are also at increased risk. Parental education, particularly maternal education, plays a protective role against undernutrition, while larger household sizes increase the risk of undernutrition but decrease the risk of overnutrition. Community-level factors, such as poverty rates and rural residence, significantly influence undernutrition outcomes, with notable regional disparities, particularly in regions like Beni Mellal-Khenifra.

This study's unique contribution lies in its multi-level approach, which provides a nuanced understanding of how individual, household, and community factors influence child nutrition outcomes. Unlike many previous studies, our analysis incorporates a comprehensive set of variables, offering a holistic view of the determinants of malnutrition in Morocco. Theoretically, this study advances the research on child malnutrition by highlighting the importance of considering multiple levels of influence. It supports the notion that addressing malnutrition requires interventions targeting individual behaviors, household dynamics, and community conditions. From a managerial perspective, the findings suggest that policies and programs to improve child nutrition should prioritize maternal education, support for larger households, and targeted regional interventions. Enhancing community healthcare support, particularly in rural areas, and ensuring access to diverse and nutritious foods are critical to mitigating undernutrition and overnutrition. We must strengthen healthcare services, especially in underserved rural regions, to provide timely and adequate nutritional support. Additionally, policies should promote food security and access to a balanced diet, particularly for poorer households.

This study has several limitations. The cross-sectional design of the data makes it difficult to determine causation, and relying on self-reported data may lead to reporting biases. Regional disparities in this study highlight the need for more localized research to understand specific regional dynamics better.

Future research should focus on longitudinal studies to establish causal relationships between the identified determinants and malnutrition outcomes. Investigating the impact of particular interventions over time would provide valuable insights into their effectiveness. Further research is necessary to investigate the mechanisms by which community-level factors impact malnutrition, especially in diverse regional contexts. Addressing child malnutrition in Morocco requires a multifaceted approach considering the factors at three levels. Comprehensive policies and programs targeting these diverse determinants are essential for improving child nutritional outcomes and achieving sustainable health improvements for future generations.

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