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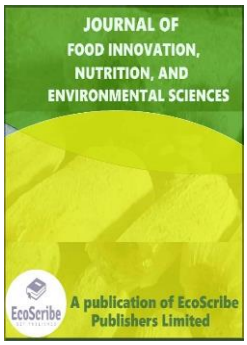

ORIGINAL ARTICLE

Nutritional Status and Morbidity of Children Aged 12 to 59 Months in the Peri-urban Area of Kisangani, Democratic Republic of Congo

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ABSTRACT

This study describes the nutritional status and prevalence of common childhood illnesses of children aged 12 to 59 months in the peri-urban area of Kisangani, DRC. A descriptive cross-sectional study was conducted from June 15 to July 15, 2024, involving 850 children and their mothers. A multi-stage cluster sampling method was used to select households. Data were collected via face-to-face interviews, anthropometric measurements (weight, height, mid-upper arm circumference), and recorded in Kobotoolbox. Anthropometric data were converted into indices using WHO AnthroPlus software, with Z-scores for weight-for-height (WHZ), height-for-age (HAZ), and weight-for-age (WAZ) calculated based on the WHO Multicentre Growth Reference Standards. Nutritional status was classified using Z-scores, with values below −2 standard deviations indicating wasting (WHZ), stunting (HAZ), or underweight (WAZ). Statistical analyses were conducted using Stata version 13 software. Among the 850 children, 8.1% had wasting, 40.2% stunted growth, and 19.2% were underweight. Mothers under 30 years old accounted for 63.5%, and 58.9% had at least a secondary education. Unsafe drinking water affected 55.9% of households, and 75.8% had unimproved sanitation. The prevalence of measles, ARI, diarrhea, and fever was 23.2%, 26.7%, 19.5%, and 48.1%, respectively. Malnutrition was significantly associated ($p<0.05$) with male gender, lack of income, unsafe water, unimproved sanitation, measles, diarrhea, and vaccination status. The results emphasize the importance of improving access to clean water, vaccination, and sanitation infrastructure for reducing childhood malnutrition and limiting waterborne and infectious diseases.

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1. INTRODUCTION

Child malnutrition has been recognized as a major global public health issue, significantly contributing to infant morbidity and mortality (Akilimali et al., 2022). In low-income countries, malnutrition remains a concern, as reflected in various reports from the World Health Organization (WHO) (Akilimali et al., 2022). The three main indicators defining children's nutritional status—stunted growth, wasting, and underweight are assessed using the height-for-age, weight-for-height, and weight-for-age indices, respectively (Zoleko-Manego et al., 2021)(Cruz et al., 2017). Overall, the prevalence of stunted growth in children under five has declined from 26.3% in 2012 to 22.3% in 2022. However, projections indicate that by 2030, 19.5% of children will still suffer from stunting. Wasting has slightly decreased from 7.5% in 2012 to 6.8% in 2022 but remains above the global target of 3%, with a projected prevalence of 6.2% in 2030 (FAO et al., 2024).

Africa is the only region where the number of children suffering from stunted growth has increased, reaching 26% of children across 31 sub-Saharan African countries, with 6% experiencing wasting and 21% being underweight (Adedokun & Yaya, 2021). Several factors influence children's poor nutritional status, including maternal age, education level, household living conditions, access to prenatal care, media exposure, as well as the child's gender and birth size (Adedokun & Yaya, 2021). Malnutrition leads to delayed physical and motor development, weakened immune defenses, increased child mortality, and reduced cognitive capacity (Adedokun & Yaya, 2021; Akilimali et al., 2022). It is an underlying cause of nearly half of all child deaths in developing countries, exacerbated by socioeconomic and demographic factors in Africa (Bavurhe et al., 2024). Additional risk factors include the child's gender, recurrent diarrheal diseases, and limited access to healthcare services (Dires & Mareg, 2021). Improving household socioeconomic conditions is essential for promoting children's well-being (Abajobir et al., 2025). Studies have shown a correlation between vaccination coverage and a lower prevalence of stunted growth (Sato, 2021). Moreover, access to improved latrines is associated with better child nutrition, reducing malnutrition among those living in households with adequate sanitation facilities (Bountogo et al., 2021). The key determinants of child malnutrition include parental employment and education levels, household size, birth spacing, vaccination status, recurrent diarrhea, and exclusive breastfeeding practices (Danso & Appiah, 2023). Reducing stunted growth requires a multisectoral approach, improving healthcare services, maternal education, access to safe drinking water, and poverty reduction (Brar et al., 2020).

The Democratic Republic of Congo (DRC) is one of the most affected countries by malnutrition, with severe socio-economic inequalities impacting the nutritional status of children under five (Qi et al., 2022). The adoption of maternal and child health awareness programs could enhance household nutritional practices (Sackou Kouakou et al., 2016). Currently, in the DRC, 45% of children under five suffer from chronic malnutrition, 7% experience wasting, and 25% are underweight, according to the 2023–2024 Demographic and Health Survey. (*RDC-EDS-III, 2024*). In the peri-urban areas of Kisangani, a transitional zone, malnutrition and childhood diseases remain major public health challenges, with limited data available on children in this region. The objective of this study was to assess the nutritional status and its association with common childhood illnesses (measles, diarrhea, fever, and ARI) among children aged 12 to 59 months in peri-urban Kisangani, DRC.

2. METHODOLOGY

2.1 Study site and population

This study was conducted in the peri-urban environment of the City of Kisangani, in the Tshopo Province, located in the northeastern part of the DRC. This environment is characterized by a transition between dense urban areas and the surrounding rural areas. These spaces are often marked by rapid and unplanned urbanization, leading to infrastructure challenges, limited access to basic services due to the fact that water and electricity networks are poorly developed, and residents often rely on wells and natural water sources. Residents of these environments rely mainly on subsistence agriculture, small-scale trade and the informal sector to survive. Livestock farming, market gardening and the sale of agricultural products are common economic activities. The study population consisted of children aged 12 to 59 months coupled with their mothers/caregivers.

2.2 Study design

This was a community-based descriptive cross-sectional study that was conducted during the period from June 15 to July 15, 2024, corresponding to the data collection.

2.3 Sample size and sampling techniques

The sample size was calculated using the Daniel de Schwartz formula, suitable for community-based cross-sectional surveys.

$$n = \frac{Z^2.p(1-p)}{d^2}$$

Assuming a 50% prevalence of malnutrition, a 95% confidence level, a 5% margin of error,

$$n = \frac{(1{,}96x1{,}96).0{,}50(1-0{,}50)}{(0{,}05)^2} = \frac{0{,}9604}{0{,}0025} = 384 \text{ x } 2$$

a 10% contingency, and a cluster effect of 2, the minimum sample size required was 845 subjects, adjusted to 850 mother-child pairs.

Multi-stage cluster sampling was used: (i) Three health zones (HZ) including Kabondo, Makiso -Kisangani and Tshopo were randomly selected. (ii) Nine peri-urban health areas (HAs) were then randomly selected. (iii) Thirty clusters (villages/avenues) were selected proportionally to the demographic weight of the HAs. (iv) Finally, eligible households were chosen by systematic random sampling after a census. The sampling interval (k = N/n) was calculated, and the first household visited was determined by throwing a pen to choose a direction. In case of absence, the neighboring household was included. The interview was conducted with the mother or guardian of a child aged 12 to 59 months, after the agreement of the head of household. When several eligible children were present, the youngest was retained to minimize recall bias.

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2.4 Data collection and organization

The data were collected using face-to-face interviews and a structured questionnaire administered to the participants (or the children's caregivers) during the survey period. The Sociodemographic data included variables such as the mother's age, educational level, marital status, number of children, socioeconomic status, as well as child-related characteristics (age and sex). Prior to data collection, enumerators were trained in the use of the questionnaire and the ethical approach to be adopted. A pilot test was conducted on a similar sample to adapt the questions to the local context.

To ensure mutual understanding of the main objectives and the data collection instrument, a pre-test was conducted with 43 mothers/caregivers of children aged 12 to 59 months, which corresponded to a 5% sample, in an urban health area (as in the city of Kisangani), not involved in the study, in order to ensure precision and accuracy during data collection. The Kobotoolbox / Kobocollect application, installed on smartphones, was used to record the participants' responses in order to generate the database directly in Excel format. The completeness and consistency of the collected questionnaires were checked daily during the data collection period. concerning the anthropometric data of children, weight was measured with an accuracy of 0.1 kg using the SECA electronic battery-powered personal scale. This weight was taken with light clothing and without shoes. The scale was calibrated before weighing each child. For children who did not want to go up alone, a double weighing was applied with the mother. The height was measured using a short measuring rod placed vertically for children aged 12 to 23 months and horizontally for those aged 24 to 59 months. The graduation was read in centimeters, with an accuracy of 0.1 cm, including the child's head, shoulder, buttocks, knees and heels touch the vertical board. The brachial perimeter (BP) was measured on the left arm using a MUAC (Middle Upper Arm Circumference) bracelet, halfway between the tip of the shoulder and the tip of the elbow to the nearest 0.1 cm.

2.5 Data processing and analysis

All data were visually checked and coded on an Excel sheet before being exported to STATA 13 software for analyses. Anthropometric data (sex, age, height, weight) were converted into indices and indicators using *WHO Anthro software*.
*Wasting***:** An acute weight deficit in relation to height. It is defined by a weight-for-height Z-score (WHZ) below –2 standard deviations (SD) from the WHO growth reference median.
Stunting: A low height-for-age, reflecting chronic malnutrition. It is defined by a height-for-age Z-score (HAZ) below –2 SD.
Underweight: A low weight-for-age, which may result from either acute or chronic malnutrition. It is defined by a weight-for-age Z-score (WAZ) below –2 SD (*WHO,2009*; De Onis et al., 2009).
Sociodemographic variables were summarized using descriptive statistics: frequencies and percentages for qualitative variables, and means (± standard deviation) or medians (with interquartile ranges) for quantitative variables, depending on their distribution. The comparison of proportion between wasting, stunting and underweight with individual independent variables was made using Pearson Chi-square test whose statistically significant difference was set at the threshold of p-value less than 5%.

2.6 Ethical considerations

The study received ethical approval from the Faculty of Medicine and Pharmacy of the University of Kisangani through a research authorization certificate (No. FMP/06/2024) and was authorized by the Provincial Health Division of Tshopo (No. 701/DPS/TSHOPO/IBB/SEC/0336/2024). Verbal informed consent was obtained from all participants (mothers or caregivers) following a clear explanation of the study's objectives, the voluntary nature of participation, and assurances of confidentiality. Children were included in the study only with the permission of the head of household and the mother or legal guardian. Anonymity was strictly maintained throughout the research process.

3. RESULTS

3.1 Sociodemographic and anthropometric characteristics of the respondents

The study involved 850 mother-child pairs aged 12 to 59 months. It was found that the majority of mothers surveyed were under 30 years old, with more than half having a secondary or higher education. Most index children were between 24 and 59 months old, with a slight predominance of boys. Access to drinking water

remains limited, with more than half of households using unsafe sources, and a large majority having unimproved toilets. Anthropometric indicators reveal a prevalence of chronic malnutrition, with marked growth retardation in many children (**Table 1**).

3.2 Curves of standard deviations of Z-Score weight-for-height, height-for-age and weight-for-age of children compared to the WHO reference population

Figure 1 shows that the Weight-for-Height z-score curve of the studied children (red) is shifted to the left compared to the WHO standards (green), indicating an increased prevalence of wasting. **Figure 2** reveals a similar shift for Height-for-Age z-scores, with a peak around -2, highlighting a high proportion of stunting. Finally, **Figure 3** illustrates a Weight-for-Age curve shifted towards -1.5, while the WHO standard is centered on 0, reflecting a high prevalence of underweight among the studied children.

3.3 Community morbidity in children

The results (**Table 2**) indicated that the majority of children were vaccinated against measles, although some still contracted the disease. A significant proportion had received vitamin A supplementation, but deworming with mebendazole remains low. Acute respiratory infections, diarrhea, and fever were common among children. Regarding vaccination, a large proportion of children are partially vaccinated, while a small number have not received any doses. Finally, most households have impregnated mosquito nets, and a majority of children use them for sleeping.

3.4 Prevalence of indicators of malnutrition in children aged 12 to 59 months

Figure 4 shows that the children surveyed presented wasting at 8.1%, stunting at 40.2% and underweight at 19.2%.

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3.5 Indicators of malnutrition, sociodemographic characteristics and morbidity of children aged 12 to 59 months

Analysis of factors associated with wasting, stunting, and underweight in children aged 12 to 59 months highlights several significant elements. As presented in **Table 3**, males are more affected by these forms of malnutrition compared to girls. Age 15 to 30 years is associated with stunting. The use of unsafe water sources and unimproved toilets is associated with a higher risk of wasting and stunting. The mother's education level and marital status do not show a statistically significant association with these nutritional indicators. Finally, the absence of a source of income in the household appears to be a vulnerability factor, particularly for wasting. Children who have contracted measles or suffered from diarrhea are more exposed to wasting and stunting. In addition, incomplete vaccination status or the absence of vaccination is associated with a high risk of malnutrition. On the other hand, attendance at pre-school consultation (PSC) does not show a statistically significant link with these nutritional indicators.

4. DISCUSSION

We conducted this study to describe the nutritional status of children aged 12-59 months in the peri-urban area of Kisangani. The prevalence of wasting (8.1%), stunting (40.2%) and underweight (19.4%) highlights significant nutritional deficits in children aged 12-59 months. These prevalences are lower than those found throughout the DRC for stunting (45%) and underweight (25%). The prevalence of wasting is similar to that reported for children under five (7%) (*RDC-EDS-III,2024*.). Although these values are slightly lower than the national average (*RDC-EDS-III,2024*.), they remain above WHO alert thresholds and confirm the extent of child malnutrition in transition zones such as Kisangani. In comparison with other regional studies, such as those carried out in Kenya (Ndemwa et al., 2017) where a higher prevalence of stunting (29.2%), almost similar underweight (20.8%) and a higher prevalence of wasting (19.0%) were found, and in Ethiopia where a higher prevalence of wasting (16.8%) and stunting (53.9%) was found (Roba et al., 2021). while Morris et al found a higher prevalence of stunting (29.2%), almost similar underweight (20.8%) and a higher prevalence of wasting (19.0%). our results are in line with a general trend observed in sub-Saharan Africa. The disparities observed could be explained by the diversity of socio-economic contexts, local health policies, cultural dietary practices and access to basic services. This underlines the importance of adapting nutritional interventions to the specific context of each environment.

Sociodemographic factors and child nutrition

The majority of mothers surveyed were under 30 years of age (75.9%) and had a secondary or higher education (60%). Although these variables did not show statistically significant associations with children's nutritional status in our study ($p>0.05$), it would be premature to conclude that there was no effect.

This situation could theoretically encourage better management of nutrition and child health. On the other hand, Sulaimon et al have shown that the unfavourable nutritional status of children is closely linked to the mother's age and the household's level of education and standard of living (Sackou Kouakou et al., 2016). Other studies have shown that a mother's high level of education was significantly positively associated with children's nutritional status (Adedokun & Yaya, 2021) and that having the first child before the age of 15 was associated with a higher risk of stunting.

Table 1. Distribution of respondents according to the sociodemographic characteristics of mothers and children aged 12 to 59 months

Variables	Frequencies (n=850)	%)
Age of respondent (in completed years)	Mean (SD) 27.2 (±6.57)	
From 15 to 30 years old	645	75.9
31 to 55 years old	24	24.1
Level of education		
None	16	1.9
primary	324	38.1
Secondary	481	56.6
University	29	3.4
Marital status		
Married	639	(75.2)
Unmarried	211	(24.8)
Household size	Mean (SD) 6.9 (±2.6)	
Source of drinking water		
Water from the Regideso	383	45,1
Well water, springs and river/stream	467	55,9
Types of toilets		
Improved	206	24,2
Unimproved	644	75,8
Age of index children (in months)	Median (P25-P75) 36 (24-42)	
12 to 23	642	75.5
24 to 59	208	24.5
Sex of the index child		
Male	457	53.8
Female	393	46.2
Weight (in kg)	Mean (SD) 11.8 ±2.4	
Size (in cm)	Mean (SD) 87.5 ±10.0	
Upper arm circumference (in cm)	Median 14.5 ±9.1	
Weight-Height Z-score	Median -0.3 (-9.6 to 5.6)	
Height-Age Z-score	Median -1.7 (-7.9 to 8.9)	
Weight-Age Z-score	Median -1.1 (-6.5 to 4.2)	

(Fentahun et al., 2016). Samuel A found that maternal age was a significant factor in wasting (Samuel et al., 2022). Even an educated mother may be limited in the application of her nutritional knowledge if the environment is disadvantaged, resources inaccessible, or if the education received is too theoretical and not well adapted to practical health issues.

Males are much more affected by wasting (p=0.046), stunting (p=0.011) and underweight (p=0.001) than females.

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A similar pattern was found by Samuel A, in Ethiopia, where the prevalence of stunting and wasting was significantly higher in boys than in girls, 18.7% versus 10.7% and 7.9 versus 5.4%, respectively (Samuel et al., 2022). Similar results have been observed for stunting in Kenya (Ndemwa et al., 2017). This may reflect gender differences in care according to household observations, although the latter hypothesis requires further qualitative analysis.

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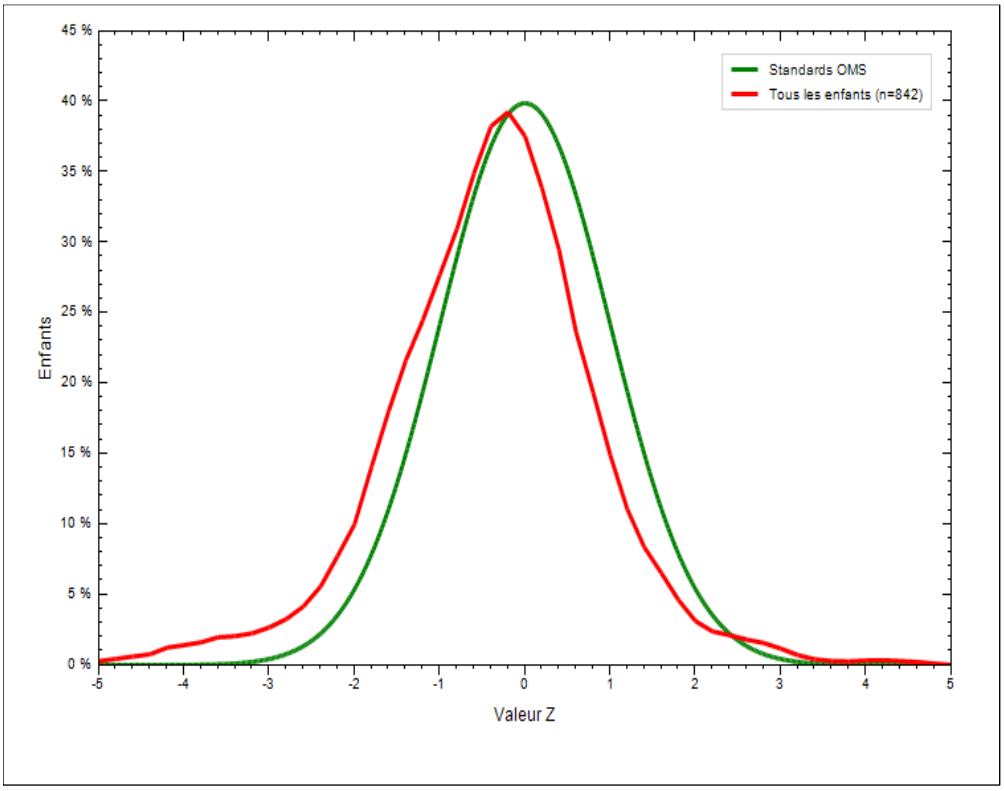

Fig. 1. Curve of standard deviations of children's Z-Score Weight-Height compared with the WHO reference population

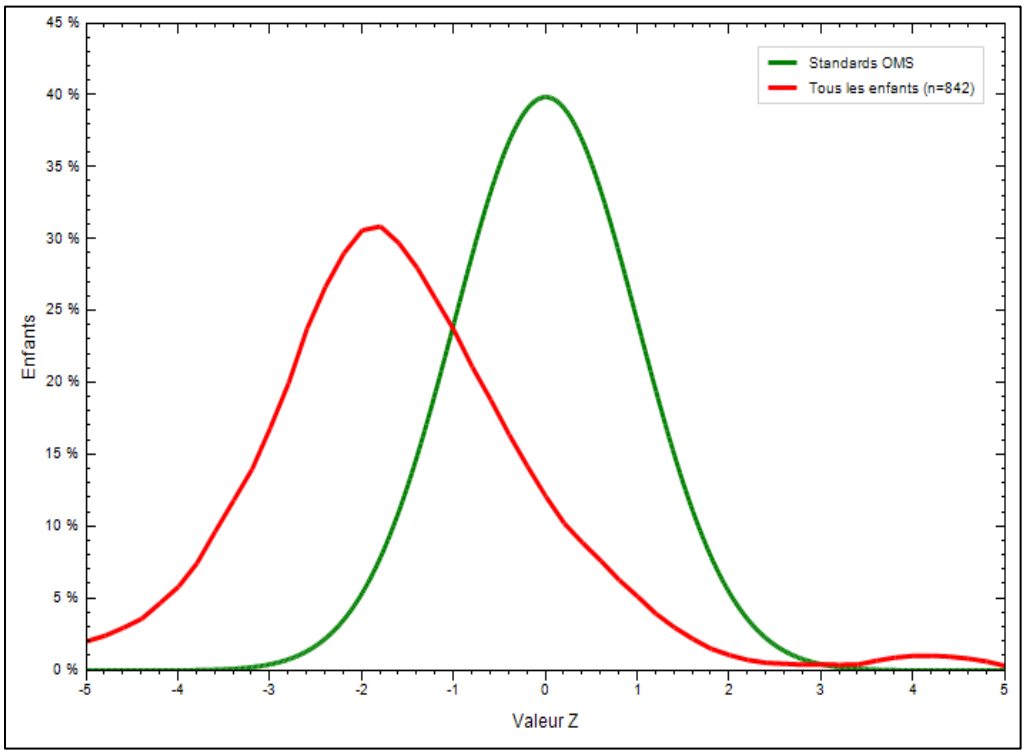

Fig. 2. Curve of standard deviations of children's Z-Score Height-Age in relation to the WHO reference population.

Table 2. Distribution of children according to the frequency of recurring pathologies and prevention practices

Variables	Terms and conditions	frequency (n=850)	%
Measles vaccination	Yes	686	80.7
	No	164	19.3
Having contracted measles	Yes	197	23.2
	No	653	76.8
Supplemented with Vitamin A	Yes	665	78.2
	No	185	21.8
Dewormed with Mebendazole	Yes	72	8.5
	No	778	91.5
Having developed an acute respiratory infection	Yes	298	35.1
	No	627	64.9
Having had diarrhea	Yes	223	26.2
	No	627	73.8
Having had a fever	Yes	338	39.8
	No	512	60.2
Vaccination status	Fully vaccinated	198	23.3
	Partially vaccinated	555	65.3
	Unvaccinated	97	11.4
Availability of long-lasting insecticide-treated mosquito nets (LLINs)	Yes	740	87.1
	No	110	12.9
Child having slept under a LLIN	Yes	724	85.2
	No	126	14.8

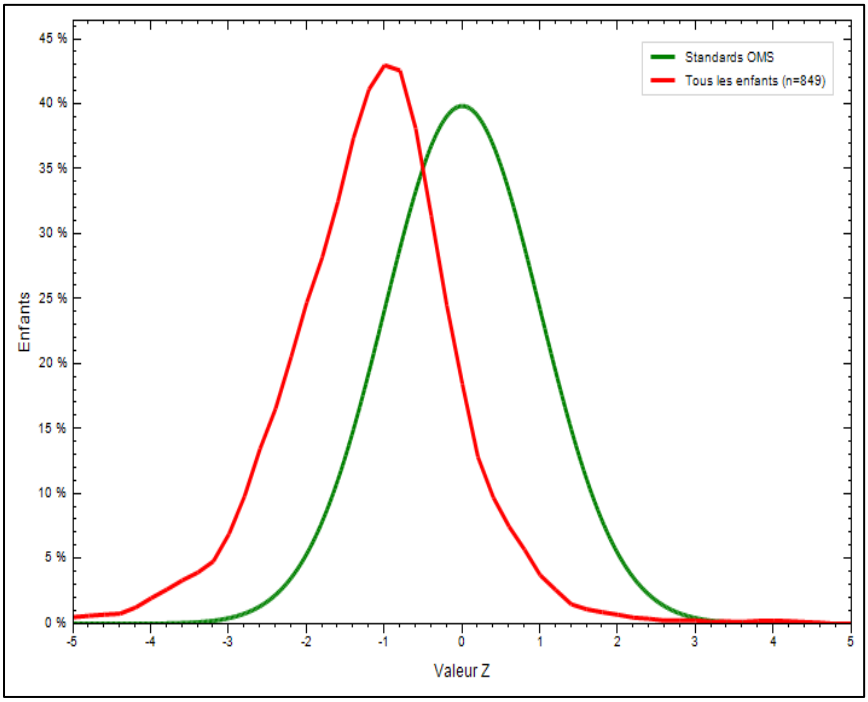

Fig. 3. Standard deviation curve of children's Z-Score Weight-Age compared with the WHO reference population

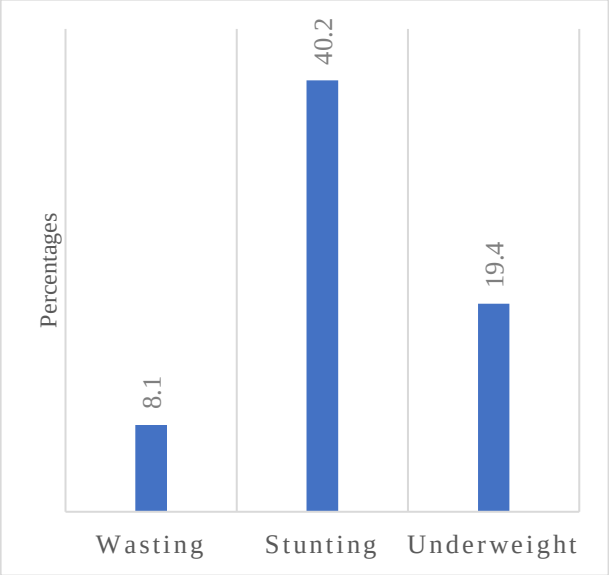

Fig. 4. Summary of the status of malnutrition in children aged 12 to 59 months surveyed

Living conditions and impact on nutrition

The widespread use of unsafe water sources (55.9%) and unimproved sanitation facilities (75.8%) reflects an environment conducive to the transmission of waterborne and parasitic diseases. These conditions are significantly associated with wasting and stunting, confirming the impact of WASH (Water, Sanitation, and Hygiene) infrastructure on child nutrition.(Cooten et al., 2018)(Sinharoy et al., 2016)(Brar et al., 2020). The link between an unsanitary environment and malnutrition is primarily mediated by chronic diarrhoea, which impairs the absorption of essential nutrients in young children.

Childhood illnesses and vaccination

Les résultats révèlent une prévalence élevée de maladies infectieuses : rougeole (23,2 %), IRA (35,1 %), diarrhée (26,2 %) et fièvre (39,8 %). Ces pathologies sont fortement associées à la malnutrition, particulièrement à l'émaciation. Ces observations renforcent l'idée d'un cercle vicieux entre malnutrition et infection, où chaque facteur exacerbe l'autre. Notamment, la rougeole, bien que largement évitable, reste fréquente, probablement en raison d'une couverture vaccinale insuffisante (23,3 % complètement vaccinés). La malnutrition peut compromettre la réponse immunitaire aux vaccins, et inversement, l'absence de vaccination accroît le risque de morbidité et, indirectement, de malnutrition. (Mardya et al., 2023). La faible couverture vaccinale observée reflète des dysfonctionnements dans les programmes de santé préventive, qui méritent une attention urgente dans les politiques publiques.

Economic vulnerability

The absence of a source of income within the household is associated with an increased risk of malnutrition. While Fentahun *et al* concluded that high monthly household income was associated with a low risk of stunting (Fentahun et al., 2016). This situation reflects the direct impact of economic insecurity on access to quality food and appropriate health care. In a context like that of the DRC, where social safety nets are limited, low-income households are particularly vulnerable to food insecurity, compromising children's growth and development.

Study Limitations

This study has certain limitations that may influence the results. The use of mothers' declarations for data such as infant morbidity, vaccination and use of mosquito nets exposes the study to recall bias. The absence of data on feeding practices limits analysis of the immediate causes of malnutrition. In addition, anthropometric measurements, although standardised, may be subject to variability between interviewers. Finally, the restricted geographical scope of the study to the peri-urban areas of Kisangani limits the generalisability of the results to other contexts in the DRC.

CONCLUSION

This study demonstrates that multiple factors of undernutrition in children aged 12 to 59 months are present in the peri-urban environment of Kisangani, including male sex, limited access to drinking water and improved sanitation facilities, the high prevalence of infectious and diarrheal diseases, insufficient vaccination coverage, and the economic precariousness of households. These findings highlight the urgency of strengthening public health interventions, including improving health infrastructure, promoting routine vaccinations and deworming campaigns, and providing economic support to vulnerable households. A multisectoral approach integrating health, nutrition, sanitation, and economic development is essential to effectively combat child malnutrition.

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Table 3. Association between malnutrition indicators, sociodemographic characteristics and morbidity of children aged 12 to 59 months.

Variables	Terms and conditions	Wasting		P-Value	Stunting		p-value	Underweight		p-value
		Yes n (%)	No n (%)		Yes n (%)	No n (%)		Yes n (%)	No n (%)	
Child's age	12 to 23	52 (75.4)	590 (75.5)	0.973	250 (73.0)	392 (77.2)	0.102	123 (74.5)	519 (75.8)	0.762
	24 to 59	17 (24.6)	191 (24.5)		92 (27.0)	116 (22.8)		42 (25.5)	166 (24.2)	
sex of the child	Male	45 (65.2)	412 (52.8)	0.046	202 (59.1)	255 (50.2)	0.011	108 (65.5)	349 (55.9)	0.001
	Female	24 (34.8)	369 (41.2)		140 (40.9)	253 (49.8)		57 (34.5)	336 (49.1)	
Mother's age	From 15 to 30	53 (76.9)	592 (75.8)	0.851	275 (80.4)	370 (72.8)	0.011	127 (75.8)	518 (75.6)	0.716
	31 to 55 years old	16 (27.1)	189 (24.2)		67 (19.6)	138 (27.2)		38 (24.2)	167 (24.4)	
Marital status	Married	55 (79.7)	584 (74.8)	0.363	249 (72.8)	390 (76.8)	0.189	114 (69.0)	525 (76.6)	0.044
	Unmarried	14 (20.3)	197 (25.2)		93 (27.2)	118 (23.2)		51 (31.0)	160 (23.4)	
Level of study	None and primary	24 (34.8)	316 (40.5)	0.373	146 (42.7)	194 (38.2)	0.189	75 (45.5)	265 (38.7)	0.111
	Secondary and higher education	45 (65.2)	465 (59.5)		196 (57.3)	314 (61.8)		90 (54.5)	420 (61.3)	
Source of drinking water	Water from the Regideso	19 (27.5)	364 (46.6)	0.002	173 (50.6)	210 (41.3)	0.008	77 (46.7)	306 (44.7)	0.644
	Well water, springs and river/stream	50 (72.5)	417 (53.4)		169 (49.4)	298 (58.4)		88 (53.3)	379 (55.3)	
Toilet type	Improved	26 (37.7)	180 (23.0)	0.007	67 (19.6)	139 (27.4)	0.012	38 (23.0)	168 (24.5)	0.687
	Unimproved	43 (62.3)	601 (77.3)		275 (80.4)	369 (72.6)		127 (77.0)	517 (75.5)	
Source of income	Yes	39 (56.5)	305 (39.1)	0.005	126 (36.8)	218 (12.9)	0.077	69 (41.8)	275 (40.1)	0.694
	No	30 (43.5)	476 (60.9)		216 (63.2)	290 (57.1)		96 (58.2)	410 (59.9)	
preschool consultation	Yes	18 (26.1)	228 (29.2)	0.585	103 (30.1)	143 (28.1)	0.535	46 (27.9)	200 (29.1)	0.737
	No	51 (73.9)	553 (70.8)		239 (69.9)	365 (71.9)		119 (72.1)	485 (70.8)	
Measles	Yes	26 (37.7)	171 (21.9)	0.003	66 (19.3)	131 (25.8)	0.028	45 (27.3)	152 (22.2)	0.165
	No	43 (62.3)	610 (78.1)		276 (80.7)	377 (74.2)		120 (72.7)	533 (77.8)	
diarrhea	Yes	30 (43.5)	193 (24.7)	0.001	95 (27.8)	128 (25.2)	0.402	50 (30.3)	173 (25.3)	0.186
	No	39 (56.5)	588 (75.3)		247 (72.2)	380 (74.8)		115 (69.7)	512 (74.7)	
vaccination status	Fully vaccinated	9 (13.0)	189 (24.2)	0.031	77 (22.5)	121 (23.8)	0.031	30 (18.2)	168 (24.5)	0.194
	Partially vaccinated	55 (79.7)	500 (64.0)		214 (62.6)	341 (67.1)		113 (68.5)	442 (64.5)	
	Unvaccinated	5 (7.3)	92 (11.8)		51 (14.9)	46 (9.1)		22 (13.3)	75 (11.0)	

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DATA AVAILABILITY STATEMENT

The data used in this study is available upon request from the author.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Boande Losangola Gaston, principal and corresponding author, designed the study, supervised data collection, performed data processing and processing and analysis, and drafted the manuscript. Iseayembele Bosalo Raphael, Basandja Longembe Eugene, Olonga Atike Rachel, Mokoto Lokoni Véronique, Esuka Igabuchia Franc, Tagoto Tepungepame Alliance, and Panda Kitronza John have contributed to the revision of the manuscript. Tebandite Kasai Emmanuel and Losimba Likwela Joris participated in protocol design and validated the final version of the manuscript. All authors have read and approved the final version.

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