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TRENDS OF MALNUTRITION AND CONTRIBUTING FACTORS AMONG CHILDREN UNDER FIVE YEARS IN CAMEROON: LESSONS FROM FOUR ROUNDS OF DHS DATA

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Abstract. Introduction: Malnutrition among children under five remains a pressing public health issue in Cameroon, contributing to high rates of morbidity and mortality. Understanding the factors influencing malnutrition over time is essential for designing effective, targeted interventions. Methods: This study uses data from four rounds of the Cameroon Demographic and Health Survey (CDHS) conducted in 2004, 2011, 2018, and 2022. Anthropometric indicators were used to assess nutritional outcomes, specifically stunting, wasting, and underweight. Bivariate analyses (Chi-square tests) and multivariate logistic regression models were employed to identify significant socioeconomic, demographic, and environmental predictors of malnutrition. Results: The prevalence of stunting declined from 35% in 2004 to 23% in 2022, reflecting gradual improvements in child nutrition. Despite this positive trend, malnutrition remains a significant concern. Key determinants of poor nutritional outcomes

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include low household wealth, limited maternal education, short birth intervals, lack of antenatal care, and rural residence. Conclusion: While there has been notable progress in reducing child malnutrition, it continues to pose a serious public health challenge in Cameroon. The study highlights the need for integrated, multisectoral strategies that address both direct child-related factors and broader household and maternal conditions. Policies aiming to improve maternal education, access to healthcare, and living standards are critical for further reducing malnutrition rates and enhancing child well-being.

Keywords: malnutrition prevalence; logistic regression; anthropometric measurement; stunting.

2020 AMS Subject Classification: 62P25.

1. INTRODUCTION

Malnutrition continues to be a major cause of child mortality and long-term developmental issues, particularly in low- and middle-income countries such as Cameroon. Despite public health interventions, its prevalence remains high in sub-Saharan Africa, with over 45 million children affected by wasting and nearly 150 million stunted globally, largely due to food insecurity, poor maternal care, and inadequate health systems [1]. In Cameroon, structural challenges such as economic instability and limited healthcare access further worsen child nutrition outcomes.

Although data from national surveys like the Demographic and Health Surveys (DHS) provide useful insights into malnutrition, they are often affected by measurement errors in anthropometric data. Inaccuracies such as recall bias or improper recording can misrepresent true malnutrition prevalence, leading to flawed policy decisions [2]. Addressing such limitations through more robust statistical approaches is essential for accurate and actionable insights.

This study analyzes malnutrition trends in Cameroon using pooled DHS data from 2004, 2011, 2018, and 2022, with a specific focus on stunting as the primary outcome. The objective is to identify how socioeconomic, demographic, environmental, and maternal health factors have shaped child nutritional outcomes over time. In addition, the study applies logistic regression while considering measurement error, advocating for more refined modeling techniques to enhance data reliability [3, 4].

Previous studies support the multifactorial nature of child malnutrition. Determinants such as maternal education, income level, birth intervals, and sanitation consistently emerge as key predictors [5]. For example, [6] linked poor dietary diversity with increased malnutrition risk, while [7] highlighted the positive effect of maternal education on child nutrition. These findings

emphasize that both individual and contextual factors must be considered in designing effective interventions.

The main aim of this study is to examine malnutrition trends among children under five in Cameroon using four rounds of DHS data. It seeks to identify key factors influencing malnutrition over time and evaluate the effects of socioeconomic, demographic, and environmental determinants. Thus, the specific objectives of this study are as follows:

- To describe the differentials in malnutrition among children under five years in Cameroon across four rounds of DHS data.;
- To identify the significant socioeconomic, demographic, and environmental determinants of malnutrition among children under five years and analyze their impact over time.

The paper is organised as follows: section 2 presents the data used , the nutritional status of the children and the methods. In section 3, the various results are presented. section 4 present the discussion and a conclusion.

2. METHOD AND MATERIALS

This study uses data from the Cameroon Demographic and Health Surveys (CDHS) conducted in 2004, 2011, 2018, and 2022. Each survey collected anthropometric measurements from children under five and women aged 15 to 49 to assess nutritional status. After excluding observations with missing values, the final analytic sample included 2,132 children in 2004, 2,973 in 2011, 2,924 in 2018, and 4,506 in 2022.

To examine variations in malnutrition and its determinants, several explanatory variables were considered, including place of residence, mother's education and occupation, water source, regional location, type of toilet facility, entries in maternity table, entries in health table, and household wealth index. These variables were selected based on their relevance in prior malnutrition research and their availability across all survey years.

Child nutritional status was assessed using three standard anthropometric indices: height-for-age, weight-for-height, and weight-for-age. These correspond to stunting, wasting, and underweight, respectively. Stunting reflects chronic malnutrition, wasting indicates acute nutritional

stress, and underweight is a composite of both conditions. These indicators are widely used to monitor child growth and assess nutritional interventions. The methodology aligns with that used in other national assessments such as the Bangladesh DHS [8].

The Z-scores for these indices were calculated using the World Health Organization (WHO) Child Growth Standards, which are based on a diverse international reference population living under optimal health and nutrition conditions [9]. The Z-score is computed by comparing an individual's measurement to the median and standard deviation of the reference population [10].

2.1. Classification of Malnutrition.

Child malnutrition is typically assessed using anthropometric indices standardized by the World Health Organization (WHO), expressed as Z-scores. These scores measure the deviation of a child's physical measurements from the median of a reference population [11]. A Z-score below -2 SD indicates malnutrition, while below -3 SD signifies severe malnutrition. The main indicators used are: height-for-age (HAZ) for stunting, reflecting chronic undernutrition; weight-for-height (WHZ) for wasting, indicating acute undernutrition; and weight-for-age (WAZ) for underweight, a combined indicator of both chronic and acute malnutrition. Recent research underscores the continued relevance of these metrics. [12] validated HAZ as an early indicator of growth failure, while [13] highlighted WHZ's role in predicting mortality. [14] emphasized the high risk posed by co-occurrence of stunting and wasting. This study focuses on stunting (HAZ \leq -2 SD), a reliable indicator of long-term deprivation. It reflects not only nutritional deficits but also broader social and health inequalities [15].

2.2. Statistical Analyses.

To explore the relationships between various explanatory variables and child nutritional outcomes, several statistical techniques were employed. Initially, bivariate analysis was conducted to examine the distribution and basic association between individual predictors and nutritional status. This approach helps in identifying patterns and potential risk factors and is frequently used in nutritional epidemiology to screen variables before multivariate modeling [16]. Following this, the Chi-square test of independence was applied to assess whether there is a statistically significant association between categorical variables—such as highest education level, wealth index, or place of residence—and child malnutrition status. This test is commonly applied in

large survey datasets such as DHS and has proven effective for identifying key demographic risk factors in low-resource settings [17]. To identify the key determinants and quantify the strength of association between risk factors and malnutrition, binary logistic regression analysis was used. This method is particularly suitable for modeling binary outcomes, such as whether a child is stunted or not. Logistic regression is widely used in public health studies due to its interpretability, flexibility, and suitability for non-normally distributed outcomes. Recent studies have demonstrated its robustness in identifying malnutrition predictors across multiple countries and over time [18]. All analyses were performed using R version 4.4.0 and IBM SPSS Statistics version 25.0, both of which are widely used in health data analysis. R provides powerful tools for data manipulation, modeling, and visualization, while SPSS is valued for its user-friendly interface and capabilities in descriptive and inferential statistics, particularly in applied health research.

3. MAIN RESULTS

3.1. Keys results.

Table 1: Percentage of Children Stunted in Cameroon by Four Consecutive Demographic and Health Surveys

| Survey | Reference Period | Children Stunted (%) |
|-----------|------------------|----------------------|
| CDHS 2004 | 1999–2003 | 35 |
| CDHS 2011 | 2005–2010 | 33 |
| CDHS 2018 | 2012–2018 | 29 |
| CDHS 2022 | 2019–2021 | 23 |

Data from four rounds of the Cameroon Demographic and Health Surveys (CDHS) show a consistent decline in the prevalence of stunting among children under five years of age over the last two decades (Table 1). In 2004, 35% of children were classified as stunted, a proportion that decreased slightly to 33% in 2011, then to 29% in 2018, and finally to 23% in 2022. This downward trend reflects notable improvements in child nutritional status over time. This

improvement is likely driven by a combination of factors including increased public health interventions, greater awareness of child nutrition, improvements in maternal education, enhanced sanitation, and better access to healthcare services. Nonetheless, the 2022 figure still exceeds the World Health Organization's (WHO) threshold of 20% for public health concern, indicating that child malnutrition remains a persistent issue in Cameroon.

Table 2: Demographic and socio-economic differentials of malnutrition among the under-five children, Cameroon 2004
($N = 2132$)

| Variables | Frequency ($N = 2132$) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|------------------------------------|------------------------------------|--------------------------|--------------------|--|
| Sex of child | | | | |
| Female | 980 | 46.0 | 36(5%) | 1.02 |
| Male | 941 | 44.1 | 43(5%) | |
| Missing | 211 | 9.9 | 0(0%) | |
| Place of residence | | | | |
| Urban | 851 | 39.9 | 43(7%) | 8.31* |
| Rural | 1281 | 60.1 | 36(4%) | |
| Highest education level | | | | |
| No education | 600 | 28.1 | 16(3%) | 5.29 |
| Primary | 944 | 44.3 | 34(5%) | |
| Secondary | 557 | 26.1 | 27(6%) | |
| Higher | 31 | 1.5 | 2(1%) | |

Table 3: Demographic and socio-economic differentials of malnutrition among under-five children, Cameroon 2004
($N = 2132$)

| Variables | Frequency | Percentage (%) | Stunted (%) | χ^2 value and significance |
|-----------------------------------|------------------|-----------------------|--------------------|---|
| Partner's occupation | | | | |
| Did not work | 734 | 34.4 | 12(3%) | |
| Prof., Tech., Manag. | 738 | 34.6 | 4(22%) | |
| Clerical | 420 | 19.7 | 1(6.25%) | |
| Sales | 73 | 3.4 | 0(0%) | |
| Agric-self employed | 11 | 0.5 | 22(4.26%) | |
| Agric-employed | 113 | 5.3 | 11(4%) | |
| Household Services | 43 | 2.0 | 0(0%) | 27.4** |
| Skilled manual | 233 | 10.5 | 6(16.21%) | |
| Unskilled manual | 178 | 8.5 | 3(6.12%) | |
| 314 | 14.5 | 20(7%) | | |
| Type of Toilet facility | | | | |
| Flush toilet | 115 | 5.5 | 12(13.48%) | |
| Rudimentary pit toilet latrine | 1294 | 60.8 | 39(4%) | |
| Improved pit latrine | 507 | 23.8 | 26(7%) | |
| No facility | 1 | 1 | 169(7.9%) | |
| Other | 1 | 0.0 | 1(4%) | |

| Variables | Frequency | Percentage (%) | Stunted (%) | χ^2 value and significance |
|---------------------------------|------------------|-----------------------|--------------------|---|
| Non resident | 41 | 2.1 | 79(5%) | 23.42*** |
| Source of drinking water | | | | |
| In the house | 121 | 5.7 | 14(14.43%) | |
| In the courtyard | 74 | 3.5 | 5(9%) | |
| Of a neighbor | 86 | 4.0 | 3(4.47%) | |
| Along the road | 397 | 18.6 | 23(8%) | |
| Well with pump | 265 | 12.4 | 5(2.46%) | |
| No protected well | 276 | 12.6 | 5(2.46%) | |
| Protected with pump | 178 | 8.3 | 4(3%) | |
| River | 542 | 25.4 | 15(4%) | |
| Protected source | 129 | 6.1 | 15(4%) | 33.82*** |
| Age groups | | | | |
| 0–14 | – | – | – | |
| 15–19 | 221 | 10.4 | 0(0%) | |
| 20–24 | 473 | 22.2 | 0(0%) | |
| 25–29 | 456 | 21.4 | 11(3%) | |
| 30–34 | 367 | 17.2 | 9(3%) | |
| 35–39 | 271 | 12.7 | 12(6%) | |
| 40–44 | 200 | 9.4 | 21(16.15%) | |
| 45–49 | 144 | 6.5 | 26(32.5%) | 196.236*** |
| 50–59 | – | – | – | |
| Region | | | | |
| Adamaoua | 205 | 9.6 | 5(3.25%) | |
| Centre | 156 | 7.3 | 5(4.54%) | |

| Variables | Frequency | Percentage (%) | Stunted (%) | χ^2 value and significance |
|-----------------------------------|------------------|-----------------------|--------------------|---|
| Douala | 144 | 6.5 | 8(7.47%) | |
| Est | 178 | 8.2 | 3(2.47%) | |
| Far North | 266 | 12.5 | 8(3%) | |
| Littoral | 126 | 5.9 | 8(3%) | |
| North | 309 | 14.5 | 6(2.45%) | |
| North West | 162 | 7.6 | 13(9%) | |
| West | 169 | 7.9 | 6(4.38%) | |
| South | 148 | 6.9 | 9(9%) | |
| South West | 152 | 7.1 | 6(5.40%) | |
| Yaoundé | 131 | 5.7 | 9(11%) | 24.13** |
| Wealth index | | | | |
| Poorest | 532 | 25.0 | 11(3%) | |
| Poorer | 442 | 20.7 | 13(4%) | |
| Middle | 433 | 20.7 | 16(5%) | |
| Richer | 368 | 17.3 | 12(4.56%) | |
| Richest | 357 | 16.7 | 27(10.30%) | 21.67*** |
| Entries in maternity table | | | | |
| No | 699 | 32.8 | 79(26.42%) | |
| 1 | 684 | 32.2 | 0(0%) | |
| 2 | 630 | 29.5 | 0(0%) | |
| 3 | 111 | 5.2 | 0(0%) | |
| 4 | 7 | 0.3 | 0(0%) | |
| 5 | 1 | 0.0 | 0(0%) | 361.59*** |
| Entries in health table | | | | |
| No | 699 | 32.8 | 79(26.42%) | |

| Variables | Frequency | Percentage (%) | Stunted (%) | χ^2 value and significance |
|---------------------------------------|------------------|-----------------------|--------------------|---|
| 1 | 684 | 32.2 | 0(0%) | |
| 2 | 630 | 29.5 | 0(0%) | |
| 3 | 111 | 5.2 | 0(0%) | |
| 4 | 7 | 0.3 | 0(0%) | |
| 5 | 1 | 0.0 | 0(0%) | 361.59*** |
| Entries in height/weight table | | | | |
| No | 699 | 32.8 | 79(26.42%) | |
| 1 | 684 | 32.2 | 0(0%) | |
| 2 | 630 | 29.5 | 0(0%) | |
| 3 | 111 | 5.2 | 0(0%) | |
| 4 | 7 | 0.3 | 0(0%) | |
| 5 | 1 | 0.0 | 0(0%) | 361.59*** |

Table 4: Percentage of Children Stunted in Cameroon by the Demographic and Health Survey 2011 ($N = 2973$)

| Variable | Frequency ($n = 2973$) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------|--|-----------------------|--------------------|--|
| Sex of child | | | | |
| Female | 1379 | 49.6 | 30(2.36%) | |
| Male | 1359 | 55.4 | 27(2%) | 0.09 |
| Place of residence | | | | |
| Urban | 1175 | 39.5 | 31(3%) | |
| Rural | 1798 | 60.5 | 26(2%) | 5.72*** |

| Variable | Frequency (<i>n</i> = 2973) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|--------------------------------|--|--------------------------|-----------------------|--|
| Highest education level | | | | |
| No education | 809 | 27.2 | 8(1%) | 11.26 |
| Primary | 1224 | 41.2 | 25(2.4%) | |
| Secondary | 861 | 29.0 | 23(3%) | |
| Higher | 79 | 2.7 | 1(2%) | |
| Partner's occupation | | | | |
| Did not work | 28 | 0.9 | 2(6.45%) | 10.69 |
| Prof., Tech., Manag. | 174 | 5.9 | 7(5%) | |
| Clerical | 85 | 2.9 | 1(2%) | |
| Sales | 377 | 12.7 | 4(1.31%) | |
| Agric-self employed | 1351 | 45.4 | 25(2%) | |
| Agric-employed | 23 | 0.8 | 0(0%) | |
| Household | 61 | 2.1 | 0(0%) | |
| Services | 139 | 4.5 | 2(2%) | |
| Skilled manual | 649 | 21.8 | 14(2.57%) | |
| Unskilled manual | 73 | 2.5 | 0(0%) | |
| Type of Toilet facility | | | | |
| Flush to piped sewer system | 8 | 0.3 | 0(0%) | 10.69 |
| Flush to septic tank | 196 | 6.6 | 9(5.32%) | |

| Variable | Frequency (<i>n</i> = 2973) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------------------|--|---------------------------|------------------------|--|
| Flush to pit latrine | 19 | 0.6 | 1(8%) | |
| Flush to somewhere else | 1 | 0.0 | 0(0%) | |
| Ventilated improved pit latrine | 24 | 0.8 | 0(0%) | |
| Pit latrine with slab | 1375 | 46.2 | 29(2.48%) | |
| Pit latrine without slab | 1105 | 37.2 | 18(2%) | |
| No facility/brush | 208 | 7.0 | 0(0%) | |
| Hanging toilet/latrine | 7 | 0.2 | 0(0%) | |
| Other | 1 | 0.0 | 0(0%) | |
| Not a de jure resident | 23 | 0.8 | 0(0%) | 15.06 |
| Source of drinking water | | | | |
| Piped into dwelling | 173 | 5.8 | 6(4%) | |
| Piped to yard/plot | 136 | 4.6 | 5(4.23%) | |
| Public tap/standpipe | 588 | 19.8 | 10(2%) | |
| Tube well or borehole | 555 | 18.7 | 6(1.30%) | |

| Variable | Frequency (<i>n</i> = 2973) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------|--|--------------------------|-----------------------|--|
| Protected well | 246 | 8.3 | 2(1%) | |
| Unprotected well | 379 | 12.8 | 1(0.31%) | |
| Protected spring | 158 | 5.3 | 2(1.43%) | |
| Unprotected spring | 379 | 12.8 | 11(3.43%) | |
| River | 286 | 9.6 | 5(2%) | |
| Rainwater | 5 | 0.2 | 0(0%) | |
| Cart with small tank | 10 | 0.3 | 0(0%) | |
| Bottle water | 7 | 0.2 | 0(0%) | |
| Other | 26 | 0.9 | 0(0%) | |
| Not a de jure resident | 23 | 0.8 | 0(0%) | 18.01 |
| Age groups | | | | |
| 0–14 | – | – | – | |
| 15–19 | 229 | 7.7 | 0(0%) | |
| 20–24 | 562 | 18.9 | 0(0%) | |
| 25–29 | 663 | 22.3 | 0(0%) | |
| 30–34 | 522 | 17.6 | 9(2%) | |
| 35–39 | 467 | 15.7 | 10(2.43%) | |
| 40–44 | 291 | 9.8 | 12(5%) | |
| 45–49 | 239 | 8.0 | 26(14%) | 156.13*** |
| 50–59 | – | – | – | |
| Region | | | | |
| Adamaoua | 246 | 8.3 | 1(0.5%) | |
| Centre | 238 | 8.0 | 7(3.41%) | |
| Douala | 222 | 7.5 | 5(3%) | |

| Variable | Frequency (n = 2973) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------------------|---------------------------------|---------------------------|------------------------|--|
| East | 219 | 7.4 | 3(2%) | |
| Far North | 443 | 14.9 | 5(1.33%) | |
| Littoral | 152 | 5.1 | 4(3%) | |
| North | 420 | 14.1 | 3(1%) | |
| North West | 206 | 6.9 | 8(4%) | |
| West | 235 | 7.9 | 5(2.33%) | |
| South | 208 | 7.0 | 6(4%) | |
| South West | 204 | 6.9 | 6(3.37%) | |
| Yaoundé | 180 | 6.1 | 4(3%) | 15.17 |
| Wealth index | | | | |
| Poorest | 635 | 21.4 | 2(0.37%) | |
| Poorer | 673 | 22.6 | 9(2%) | |
| Middle | 558 | 19.8 | 13(3%) | |
| Richer | 530 | 17.8 | 16(3.52%) | |
| Richest | 547 | 18.4 | 17(4%) | 17.5** |
| Entries in maternity table | | | | |
| No | 930 | 31.2 | 57(10.16%) | |
| 1 | 1001 | 33.66 | 0(0%) | |
| 2 | 861 | 28.9 | 0(0%) | |
| 3 | 162 | 5.4 | 0(0%) | |
| 4 | 18 | 0.6 | 0(0%) | |
| 5 | 2 | 0.0 | 0(0%) | 201.70*** |
| Entries in health table | | | | |
| No | 929 | 31.3 | 57(10.16%) | |
| 1 | 1002 | 33.7 | 0(0%) | |

| Variable | Frequency (<i>n</i> = 2973) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|----------------------|--|--------------------------|-----------------------|--|
| 2 | 860 | 29.0 | 0(0%) | |
| 3 | 164 | 5.4 | 0(0%) | |
| 4 | 15 | 0.5 | 0(0%) | |
| 5 | 1 | 0.0 | 0(0%) | 201.70*** |
| Entries in | | | | |
| height/weight | | | | |
| table | | | | |
| No | 929 | 31.24 | 57(10.16%) | |
| 1 | 1000 | 33.6 | 0(0%) | |
| 2 | 860 | 28.9 | 0(0%) | |
| 3 | 164 | 5.5 | 0(0%) | |
| 4 | 17 | 0.5 | 0(0%) | |
| 5 | 3 | 0.0 | 0(0%) | 201.70*** |

Table 5: Percentage of Children Stunted in Cameroon by the Demographic and Health Survey 2018 (*N* = 2924)

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------|--|--------------------------|-----------------------|--|
| Sex of child | | | | |
| Female | 1181 | 43.5 | 14(1.26%) | |
| Male | 1273 | 40.4 | 23(2%) | 1.7 |
| Place of | | | | |
| residence | | | | |
| Urban | 1312 | 44.9 | 20(2%) | |
| Rural | 1612 | 55.1 | 17(1.37%) | 1.05 |

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|--------------------------------|--|--------------------------|-----------------------|--|
| Highest education level | | | | |
| No education | 788 | 26.9 | 6(1%) | 3.11 |
| Primary | 990 | 33.9 | 16(2.17%) | |
| Secondary | 1014 | 34.7 | 13(2%) | |
| Higher | 132 | 4.5 | 2(2%) | |
| Partner's occupation | | | | |
| Did not work | 100 | 3.4 | 3(5.35%) | 8.5 |
| Prof., Tech., Manag. | 99 | 3.4 | 1(1.29%) | |
| Clerical | 57 | 1.9 | 1(2.17%) | |
| Sales | 437 | 14.9 | 3(1%) | |
| Agric-self employed | 1327 | 45.4 | 17(2%) | |
| Don't know | 3 | 0.1 | 0(0%) | |
| Services | 282 | 9.6 | 3(1.31%) | |
| Skilled manual | 518 | 17.7 | 9(2.11%) | |
| Unskilled manual | 101 | 3.5 | 0(0%) | |
| Type of Toilet facility | | | | |
| Flush to piped sewer system | 41 | 1.4 | 2(5.4%) | 8.5 |
| Flush to septic tank | 245 | 8.4 | 3(1.56%) | |
| Flush to pit latrine | 32 | 1.1 | 2(8.33%) | |

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------------------|--|--------------------------|-----------------------|--|
| Flush to somewhere else | 2 | 0.1 | 0(0%) | |
| Flush don't know where | 2 | 0.1 | 0(0%) | |
| Ventilated improved pit latrine | 44 | 1.5 | 1(3.33%) | |
| Pit latrine with slab | 1214 | 41.5 | 14(1.49%) | |
| Pit latrine without slab | 1095 | 37.4 | 10(1.17%) | |
| No facility | 137 | 2.4 | 2(2%) | |
| Hanging toilet/latrine | 69 | 0.4 | 0(0%) | |
| Composting toilet | 12 | 1.1 | 0(0%) | |
| Not de jure resident | 31 | 1.0 | 0(0%) | 14.83 |
| Age groups | | | | |
| 15–19 | 225 | 7.7 | 0(0%) | |
| 20–24 | 428 | 14.6 | 0(0%) | |
| 25–29 | 582 | 19.9 | 0(0%) | |
| 30–34 | 524 | 17.9 | 2(0.4%) | |
| 35–39 | 392 | 13.4 | 6(2%) | |
| 40–44 | 296 | 10.1 | 10(4%) | |
| 45–49 | 214 | 7.3 | 19(11%) | |
| 50–54 | 75 | 2.9 | 19(11%) | |

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------------|--|--------------------------|-----------------------|--|
| 55–59 | 23 | 0.8 | 0(0%) | 123.83*** |
| Source of drinking water | | | | |
| Piped into dwelling | 169 | 5.8 | 4(3%) | |
| Piped to yard | 127 | 4.3 | 2(2.10%) | |
| Piped to neighbor | 193 | 6.6 | 5(2.24%) | |
| Public tap | 270 | 9.2 | 2(1%) | |
| Tube well or borehole | 958 | 32.8 | 7(1%) | |
| Protected well | 141 | 4.8 | 1(1%) | |
| Unprotected well | 338 | 11.6 | 1(0.34%) | |
| Protected source | 171 | 5.6 | 0(0%) | |
| Protected spring | 272 | 9.3 | 3(2.20%) | |
| Unprotected spring | 191 | 6.5 | 8(4%) | |
| River/stream/irrigation | 11 | 0.4 | 0(0%) | |
| Rainwater | 1 | 0.0 | 0(0%) | |
| Cart with small tank | 19 | 0.6 | 3(21.42%) | |
| Bottle water | 29 | 1.0 | 0(0%) | |
| Sachet water | 3 | 0.1 | 0(0%) | |
| Not de jure resident | 31 | 1.1 | 1(4.34%) | 55.08*** |
| Region | | | | |
| Adamaoua | 219 | 7.5 | 2(1.14%) | |
| Centre | 343 | 11.7 | 6(2.37%) | |

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|--------------------------|--|--------------------------|-----------------------|--|
| Douala | 192 | 6.6 | 6(4%) | |
| East | 249 | 8.5 | 4(2%) | |
| Far North | 415 | 14.2 | 1(0.3%) | |
| Littoral | 176 | 6.0 | 6(4.2%) | |
| North | 419 | 14.3 | 3(1%) | |
| North West | 96 | 3.3 | 0(0%) | |
| West | 259 | 8.9 | 3(1.51%) | |
| South | 292 | 10.0 | 4(2%) | |
| South West | 49 | 1.9 | 2(5%) | |
| Yaoundé | 215 | 7.4 | 0(0%) | 24.52*** |
| Wealth index | | | | |
| Poorest | 543 | 18.6 | 4(1%) | |
| Poorer | 657 | 22.5 | 6(1%) | |
| Middle | 668 | 22.8 | 9(2%) | |
| Richer | 538 | 18.4 | 5(1.2%) | |
| Richest | 518 | 17.7 | 13(3.12%) | 8.31 |
| Entries in | | | | |
| maternity table | | | | |
| No | 880 | 30.1 | 37(6.31%) | |
| 1 | 914 | 31.3 | 0(0%) | |
| 2 | 731 | 25.0 | 0(0%) | |
| 3 | 119 | 4.1 | 0(0%) | |
| 4 | 17 | 0.6 | 0(0%) | |
| 5 | 0 | 0.0 | 0(0%) | 108.78*** |
| Entries in health | | | | |
| table | | | | |
| No | 884 | 30.2 | 37(6.31%) | |

| Variable | Frequency (<i>N</i> = 2924) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|-----------------|--|--------------------------|-----------------------|--|
| 1 | 910 | 31.2 | 0(0%) | |
| 2 | 730 | 24.9 | 0(0%) | |
| 3 | 120 | 4.1 | 0(0%) | |
| 4 | 0 | 0.0 | 0(0%) | |
| 5 | 0 | 0.0 | 0(0%) | 108.78*** |

Table 6: Percentage of Children Stunted in Cameroon by the Demographic and Health Survey 2022 (*N* = 4506)

| Variable | Frequency (<i>N</i> = 4506) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|--------------------------------|--|--------------------------|-----------------------|--|
| Place of residence | | | | |
| Urban | 2177 | 48.3 | 133(7.37%) | |
| Rural | 2329 | 51.7 | 110(6.26%) | 2.52 |
| Highest education level | | | | |
| Primary | 1304 | 28.9 | 52(6.24%) | |
| 1st Secondary Cycle | 1154 | 25.7 | 65(6.33%) | |
| 2nd Secondary Cycle | 650 | 14.4 | 108(7.46%) | |
| Higher | 320 | 7.1 | 18(7%) | 12.68** |
| Partner's occupation | | | | |
| Did not work | 100 | 3.4 | 3(4.35%) | |

| Variable | Frequency (<i>N</i> = 4506) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|---------------------------------------|--|--------------------------|-----------------------|--|
| Prof., Tech., Manag. | 99 | 3.4 | 5(2.29%) | 18.5 |
| Clerical | 57 | 1.9 | 34(3.27%) | |
| Sales | 437 | 14.9 | 43(12%) | |
| Agric-self employed | 1327 | 45.4 | 74(12%) | |
| Don't know | 3 | 0.1 | 17(4%) | |
| Services | 282 | 9.6 | 38(5.31%) | |
| Skilled manual | 518 | 17.7 | 91(5.11%) | |
| Unskilled manual | 101 | 3.5 | 12(2%) | |
| Type of Toilet facility | | | | |
| Flush to piped sewer system | 59 | 1.3 | 2(4.34%) | |
| Flush to septic tank | 504 | 11.2 | 32(8%) | |
| Flush to pit latrine | 69 | 1.5 | 5(8.33%) | |
| Flush to somewhere else | 2 | 0.0 | 0(0%) | |
| Ventilated improved pit latrine | 34 | 0.8 | 4(13%) | |
| Pit latrine with slab | 1802 | 40.0 | 93(6.48%) | |
| Pit latrine without slab | 1430 | 31.7 | 68(6%) | |

| Variable | Frequency (<i>N</i> = 4506) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|-------------------------------------|--|--------------------------|-----------------------|--|
| No facility | 320 | 7.1 | 23(9%) | |
| Bucket toilet | 2 | 0.0 | 0(0%) | |
| Hanging toilet/latrine | 71 | 1.6 | 5(9.24%) | |
| Other | 2 | 0.0 | 1(0.5%) | |
| Not de jure resident | 211 | 4.7 | 0(0%) | 24.57 |
| Age groups | | | | |
| 0–14 | – | – | – | |
| 15–19 | | | 33(13%) | |
| 20–24 | | | 60(7%) | |
| 25–29 | | | 59(6.44%) | |
| 30–34 | | | 51(6%) | |
| 35–39 | | | 32(6%) | |
| 40–44 | | | 6(4%) | |
| 45–49 | | | 2(4.54%) | 169.20*** |
| Source of drinking water | | | | |
| Piped into dwelling | 175 | 3.9 | 10(7%) | |
| Piped to yard/plot | 301 | 6.7 | 17(7%) | |
| Piped to neighbor | 317 | 7.0 | 19(7.19%) | |
| Public tap/standpipe | 518 | 11.5 | 23(6%) | |
| Tube well or borehole | 1401 | 31.1 | 63(6%) | |

| Variable | Frequency (<i>N</i> = 4506) | Percentage (%) | Stunted (%) | χ^2 value and level of significance |
|-------------------------|--|--------------------------|-----------------------|--|
| Protected well | 133 | 3.0 | 4(4%) | |
| Unprotected well | 441 | 9.8 | 26(7.30%) | |
| Protected spring | 219 | 4.9 | 10(5.56%) | |
| Unprotected spring | 420 | 9.3 | 41(12.23%) | |
| River/stream | 186 | 4.1 | 7(5%) | |
| Rainwater | 23 | 0.5 | 0(0%) | |
| Cart with small tank | 25 | 0.6 | 2(12%) | |
| Bottle water | 124 | 2.8 | 10(10%) | |
| Sachet water | 11 | 0.2 | 1(0.11%) | |
| Other | 1 | 0.0 | 0(0%) | |
| Not de jure resident | 211 | 4.7 | 10(8%) | 39.30 |
| Region | | | | |
| Adamaoua | 477 | 10.6 | 29(7%) | |
| Centre | 339 | 7.5 | 18(7%) | |
| Douala | 296 | 6.6 | 18(8.49%) | |
| East | 367 | 8.1 | 25(9%) | |
| Far North | 626 | 13.9 | 18(4%) | |
| Littoral | 202 | 4.5 | 14(8%) | |
| North | 642 | 14.2 | 40(8%) | |
| North West | 258 | 5.7 | 6(3%) | |
| West | 462 | 10.3 | 22(6%) | |
| South | 293 | 6.5 | 20(8.58%) | |
| South West | 277 | 6.1 | 16(7%) | |
| Yaoundé | 267 | 5.9 | 17(8%) | 25.88 |

Table 7: Dependent and selected explanatory variables

| Dependent Variables | Explanatory Variables | Categories |
|---|----------------------------------|--|
| Is child Stunted? (0=No, 1=Yes) | X_1 = Place of residence | 1=Urban; 2=Rural |
| | X_2 = Highest education level | 1=No education; 2=Primary; 3=Secondary; 4=Higher |
| | X_3 = Partner's occupation | 1=Did not work; 2=Prof., Tech., Manag.; 3=Clerical; 4=Sales; 5=Agric-self employed; 6=Agric-employed; 7=Household; 8=Services; 9=Skilled manual; 10=Unskilled manual |
| | X_4 = Type of toilet facility | 1=Flush sewer; 2=Septic tank; 3=Flush to pit latrine; 4=Flush elsewhere; 5=Ventilated improved pit; 6=Pit with slab; 7=Pit without slab; 8=No facility; 9=Hanging toilet; 10=Latrine; 11=Other; 12=Not de jure resident |
| | X_5 = Source of drinking water | 1=Piped dwelling; 2=Piped yard; 3=Public tap; 4=Tube well; 5=Protected well; 6=Unprotected well; 7=Protected spring; 8=Unprotected spring; 9=River; 10=Rainwater; 11=Cart tank; 12=Bottle water; 13=Other; 14=Not de jure resident |
| | X_6 = Age groups | 1=0–14; 2=15–19; 3=20–24; 4=25–29; 5=30–34; 6=35–39; 7=40–44; 8=45–49; 9=50–59 |

| Dependent Variables | Explanatory Variables | Categories |
|---------------------|---|--|
| | $X_7 = \text{Region}$ | 1=Adamaoua; 2=Centre; 3=Douala; 4=East; 5=Far North; 6=Littoral; 7=North; 8=North West; 9=West; 10=South; 11=South West; 12=Yaoundé |
| | $X_8 = \text{Wealth index}$ | 1=Poorest; 2=Poorer; 3=Middle; 4=Richer; 5=Richest |
| | $X_9 = \text{Entries in maternity table}$ | 1=0; 2=1; 3=2; 4=3; 5=4; 6=5 |

Descriptive and bivariate analyses using Chi-square tests (Tables 2–6) were conducted to explore associations between stunting and a range of socio-demographic and environmental factors. These included child’s age, region of residence, source of drinking water, type of toilet facility, household wealth index, maternal education, and the number of antenatal care visits. Height-for-age Z-scores (HAZ) were used to assess stunting based on WHO growth standards. Children with HAZ scores below -2 standard deviations were classified as stunted, reflecting chronic nutritional deprivation. The Z-scores provided a consistent framework to track and compare nutritional trends across survey years. Detailed analysis by year shows shifts in key predictors. In 2004 and 2011, urban-rural disparities, wealth index, type of toilet, and access to antenatal care showed strong associations with stunting. In 2018, regional differences and source of drinking water also became significant. In 2022, maternal education particularly at higher levels—emerged as a critical determinant, alongside child age.

The results reveal a multifactorial structure of stunting in Cameroon. Stunting prevalence is consistently higher among children in rural areas, in households with poor access to sanitation and drinking water, with low maternal education, no maternal employment, no antenatal care, and short birth intervals (less than 20 months). These patterns indicate that both household-level and structural factors significantly influence child nutrition. Overall, the analysis underscores the need for integrated public health strategies targeting education, healthcare access, water and

sanitation infrastructure, and maternal health. These findings provide a foundation for identifying high-risk groups and formulating data-driven interventions to reduce child malnutrition in Cameroon.

The 2004 logistic regression analysis of stunting among children under five in Cameroon reveals significant regional disparities based on CDHS data. Most notably, the Far North region showed a statistically significant negative association with stunting ($\beta = -1.97$, OR = 0.13, $p < 0.05$) compared to Yaoundé, the reference category. This indicates that, controlling for socio-economic and demographic factors such as wealth index, maternal education, and access to services, children in the Far North were approximately 87% less likely to be stunted than those in Yaoundé. Other regions, including the North ($\beta = -1.43$, OR = 0.22) and Adamaoua ($\beta = -1.56$, OR = 0.21), also showed lower odds of stunting, though these associations were not statistically significant. This lack of significance may result from smaller sample sizes, overlapping covariates, or greater variability in nutritional outcomes within those regions. The strong protective effect in the Far North may seem surprising given its high poverty and food insecurity. However, it could reflect the impact of targeted nutrition interventions, humanitarian aid, or local health programs active before or during the 2004 survey. Additionally, region-specific factors such as traditional diets, caregiving practices, or healthcare access—may have contributed to better outcomes not fully captured in the model.

The logistic regression analysis of stunting from the 2011 Cameroon Demographic and Health Survey (CDHS) shows a statistically significant association for the 20–24 month age group. This group had a coefficient of $\beta = -0.50$ and an odds ratio (OR) of 0.55 ($p < 0.01$), indicating that children in this age range were 45% less likely to be stunted compared to the reference group aged 15–19 months. This result suggests a protective effect against stunting as children grow slightly older. This finding is noteworthy given that stunting typically increases with age during the first two years due to cumulative exposure to poor nutrition and frequent infections. The lower risk in the 20–24 month group may reflect improved feeding practices, greater dietary diversity, better maternal awareness, or access to healthcare during this stage. Alternatively, it could result from a survivorship effect, where the most vulnerable children had

already experienced stunting earlier. The result highlights the need for further research. Age-disaggregated or stratified analyses could help determine whether this pattern persists across regions or socio-economic groups. Additionally, evaluating the timing and effectiveness of nutrition interventions around weaning age could inform more effective policies to reduce child malnutrition in Cameroon.

The 2018 logistic regression analysis reveals a strong and statistically significant association between household wealth status and stunting among children under five in Cameroon. Compared to children from the richest households (the reference group), those from poorer wealth quintiles face substantially higher odds of being stunted. Children from the poorest households have an odds ratio of 4.68 ($p < 0.001$), indicating they are over four times as likely to be stunted. The risk is even greater among children in the "poorer" group, with an odds ratio of 27.26 ($p < 0.01$), while those in middle-income households face the highest risk, with an odds ratio of 34.23 ($p < 0.001$). All of these associations are statistically significant. These findings underscore the impact of socio-economic inequality on child nutrition. The elevated risk of stunting in lower-income households reflects ongoing barriers such as limited access to nutritious food, healthcare, clean drinking water, and sanitation. Addressing these poverty-related challenges through targeted social and health interventions is essential to reducing stunting and improving overall child health outcomes in Cameroon.

The 2022 logistic regression results indicate that none of the explanatory variables included in the model are statistically significant predictors of stunting among children under five in Cameroon. While variables such as type of toilet facility, place of residence, and source of drinking water show varying odds ratios, their coefficients do not reach statistical significance, suggesting no meaningful difference compared to reference categories. This lack of significant associations may point to random variation rather than strong, consistent effects. It could also reflect improvements in public health infrastructure or increased uniformity in living conditions, which may have reduced disparities across households. However, further research with larger sample sizes or additional variables is needed to validate these findings and better understand the drivers of child stunting in 2022.

4. DISCUSSION

The logistic regression analyses conducted on the Cameroon Demographic and Health Surveys (CDHS) for the years 2004, 2011, 2018, and 2022 offer valuable insights into the determinants of stunting among children under five. In 2004, the region of residence emerged as a strong predictor, with the Far North region showing a significantly lower likelihood of stunting compared to Yaoundé. This result may reflect the geographic disparities in nutrition, health service accessibility, and socio-economic conditions that existed at the time. Additionally, the wealth index and number of antenatal visits also played important roles, suggesting that poverty and limited maternal healthcare access were critical drivers of child malnutrition. These findings align with those of [19], who showed that geographic disparities and antenatal care use significantly influenced child nutritional outcomes in Ethiopia.

In 2011, age-specific vulnerability became more prominent. Children aged 20–24 months were significantly more likely to be stunted, highlighting the critical period of weaning and the transition from exclusive breastfeeding to solid food. This age is known to be particularly sensitive due to increased nutritional needs and exposure to infections. Moreover, drinking water sources, particularly unimproved ones, were positively associated with stunting, suggesting that environmental factors and water-borne diseases remained central concerns in child health during this period. Similar associations were reported by [20], who found that unimproved water sources significantly elevated stunting risk in rural Kenya, especially among children undergoing dietary transitions.

By 2018, socio-economic disparities in stunting risk were even more pronounced. The logistic regression showed that children from poorest, poorer, and middle-income households had significantly higher odds of stunting than those from the richest households. This pattern underscores the persistent influence of household wealth on child nutritional status, despite national and international efforts to promote equity. It also reflects the need for targeted poverty-reduction strategies and improved access to food and healthcare among vulnerable populations. Comparable findings were observed by [21], who demonstrated that household wealth quintiles were the most powerful predictors of child undernutrition across 14 sub-Saharan African countries.

Interestingly, the 2022 findings mark a notable shift, as none of the investigated variables showed statistical significance. Despite variability in odds ratios across categories like water sources, toilet facilities, and education levels, the lack of significance suggests that disparities in these dimensions may have diminished over time. This may indicate progress in public health coverage, infrastructure, or national policies aimed at reducing inequalities. However, it may also reflect methodological limitations or sample homogeneity in the 2022 survey, warranting cautious interpretation. A study by [22] supports this notion, arguing that marginal improvements in health infrastructure can reduce the visible impact of traditional determinants on stunting, especially in countries where basic service access is improving uniformly. Overall, these results demonstrate an evolving landscape of child malnutrition in Cameroon. While region, age, household wealth, and environmental conditions were strong predictors in earlier years, their influence appears to have weakened by 2022. This shift may signal progress, but it also calls for renewed efforts in monitoring, evaluating, and tailoring interventions. Continuous investments in health, education, and social protection, especially in rural and economically disadvantaged areas, remain essential to achieving equitable and sustained reductions in child stunting. These conclusions are consistent with global reviews, such as that by [23], which emphasize the importance of integrated, multisectoral approaches to sustainably reduce stunting and improve child development outcomes.

This study highlights that malnutrition among children under five in Cameroon remains a major public health concern, despite a gradual decline in prevalence from 2004 to 2022. Analysis of Demographic and Health Survey (DHS) data revealed that in earlier years (2004–2018), factors such as region of residence, child's age, household wealth, and access to safe water and sanitation significantly influenced stunting risk. In 2004, regional disparities were particularly marked, while in 2011 and 2018, age-specific vulnerability and socioeconomic inequality were dominant. By 2022, however, no factor showed a statistically significant association, which may reflect either a narrowing of inequalities or methodological limitations in the data.

To address malnutrition effectively, coordinated efforts by the government, civil society, and local communities are required. Intervention programs must target the most at-risk

groups—especially children from low-income households and those with limited maternal support. In addition to direct child-focused measures, improving maternal health, nutrition, and education is crucial. A comprehensive, integrated, and community-centered approach is essential to sustainably reduce child malnutrition and improve long-term health outcomes in Cameroon.

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DATA AVAILABILITY

Data are available in a public, open access repository. The database is available and the URL is: https://dhsprogram.com/methodology/survey-search.cfm?pgtype=main&SrvyTp=country&ctry_id=5.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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