Mal J Nutr 32 (1): 089- 103, 2026

Rural–urban differences in prevalence and determinants of anaemia among school-aged children in the Philippines

Kim Irvin Protacio[1,2*], Jomaica Yvonne de Joya[2] & Cheder Sumangue[2]

[1]*Graduate School of Environmental, Life, Natural Science and Technology, Okayama University, Okayama 700-8530, Japan,* [2]*Department of Science and Technology – Food and Nutrition Research Institute, Gen. Santos Ave., Bicutan 1631 Taguig City, Metro Manila, Philippines,*

ABSTRACT

Introduction: Anaemia remains a significant public health issue among school-aged children in the Philippines, with multifactorial rural–urban disparities and limited evidence on their determinants. To address this gap, this study examined prevalence of anaemia and identified its key determinants among Filipino school-aged children in rural and urban communities. **Methods:** A secondary analysis of 5,173 school-aged children from 2018–2019 Expanded National Nutrition Survey (ENNS) examined data on biochemical, socioeconomic, anthropometric, food security, and participation in government programmes. Multivariate logistic regression analysis was conducted separately by place of residence to identify the determinants of anaemia. **Results:** National prevalence of anaemia was 16.6%, classified as a mild public health concern according to World Health Organization (WHO) criteria, with significantly higher prevalence in rural areas (18.5%) compared with urban areas (13.7%). Overweight and obesity were consistently associated with lower odds of anaemia across settings (national, rural, and urban). At the national level, key determinants included education of household head, sanitation, and non-participation in dietary supplementation programmes. In rural areas, limited education among household heads and poor sanitation were dominant predictors. In contrast, in urban areas, male sex, stunting, underweight, and non-participation in dietary supplementation programmes were influential factors. **Conclusion:** Anaemia among Filipino school-aged children reflects complex interplay of nutritional, socioeconomic, environmental, and programme-related factors, with distinct determinants observed between rural and urban settings, highlighting the need for setting-specific interventions.

Keywords: anaemia, determinants, Philippines, rural-urban differences, school-aged children

*Corresponding author:
Mr Kim Irvin Protacio
Graduate School of Environmental, Life, Natural Science, and Technology,
Okayama University
Okayama Prefecture, Japan
Tel: +8170-8988-7969; E-mail: pgk63dwm@s.okayama-u.ac.jp
doi: https://doi.org/10.31246/mjn-2026-0007

INTRODUCTION

Anaemia remains a major global public health problem, disproportionately affecting vulnerable groups such as women of reproductive age, adolescents, and especially young children in low- and middle-income countries (WHO, 2025). Characterised by reduced red blood cell count or haemoglobin concentration, anaemia impairs oxygen transport to tissues (UNICEF, 2024). Among children, it leads to poor growth and development, diminished cognitive function, lower school performance, and long-term productivity losses (Apu *et al.,* 2023). In Southeast Asia, including the Philippines, anaemia remains a significant challenge among school-aged children, with rural–urban disparities influenced by differences in food availability, dietary patterns, healthcare access, water, sanitation, and hygiene, alongside broader social and environmental factors (Saengnipanthkul *et al.,* 2025). National prevalence of anaemia among school-aged children has declined from moderate levels in the 1990s to a mild public health problem in the 2010s, persisting at this level into the early 2020s. However, rural and low-income communities continue to experience higher rates, reflecting ongoing nutritional gaps and inequities (DOST-FNRI, 2022).

Even with the recognised importance of addressing the issue, studies that examine rural–urban disparities in anaemia in the Philippines remain limited, warranting a spatially sensitive empirical analysis. Consequently, this study examined the prevalence of anaemia and identified its determinants among school-aged children in rural and urban communities in the Philippines. Examining rural–urban disparities is crucial for identifying vulnerable population groups that are at a higher risk of developing anaemia. The findings can also be beneficial to the development of more targeted, location-sensitive policies and interventions that may help improve overall health and nutritional outcomes of school-aged children in the country.

METHODOLOGY

Study design

This study was a secondary analysis of data from the 2018–2019 Expanded National Nutrition Survey (ENNS) of the Philippines. This national nutrition survey employed the 2013 Master Sample (MS) of the Philippine Statistics Authority (PSA), which uses a replicated sampling design with at least five provinces or highly urbanised cities (HUCs) per replicate in the country (DOST-FNRI, 2022). The 2018 and 2019 ENNS covered 40 and 39 provinces and HUCs, respectively, for a nationally representative sample.

Study population

A total of 5,173 Filipino school-aged children (6–12 years old) from sampled households covered in the 2018–2019 ENNS were included in the study. However, only those with complete biochemical, socioeconomic, anthropometric, food security, and government programme participation components of the survey were included in the analysis.

Measurements

Blood collection and determination of haemoglobin

Blood samples were collected from school-aged children by licensed and trained medical technologists via finger-prick method using sterile blood lancets. Haemoglobin status was determined by pipetting blood samples into glass tubes containing 5 mL of cyanmethaemoglobin solution. A portable spectrophotometer was used to measure absorbance. The prevalence and magnitude of anaemia were assessed using the World Health Organization (WHO) guidelines of 1971

and 2001, respectively.

Individual and household-level characteristics

All data from the 2018–2019 ENNS were collected via face-to-face interviews using an electronic data collection system by trained registered nutritionist-dietitians and nurses. All predictor variables were obtained from various survey components, particularly those related to socioeconomic, food security, anthropometric, and government programme participation. For socioeconomic status, the following data were grouped and categorised accordingly: place of residence (rural, urban); sex of school-aged children (male, female); age group of school-aged children (6–9 years old, 10–12 years old); educational attainment of household head (no grade completed, at least elementary level, at least high school level, at least college level, and others); occupation sector of household head (no occupation, engaged in agriculture, trade (stores), eatery, others); household size (1–5 members, >5 members); wealth status (poorest, poor, middle, rich, richest); source of drinking water (unimproved source, improved source); toilet facility (no toilet, not water-sealed, water-sealed); and waste segregation (yes, no).

Household food security status was classified as food secure or food insecure using the nine-item Household Food Insecurity Access Scale (HFIAS), which has questions assessing household food conditions over the preceding 30 days with corresponding frequency of occurrence. The nutritional status of school-aged children was determined from weight and height measurements, with two measurements taken for each; mean values were used in the analysis. The 2007 WHO Child Growth Reference was applied to derive z-scores for weight-for-age, height-for-age or length-for-age, and body mass index-for-age. Participation in government programmes, including mass deworming drug administration and national dietary supplementation programmes, was coded as 'yes' or 'no', while participation in the conditional cash transfer programme was classified as beneficiary or non-beneficiary.

Statistical analysis

Descriptive statistics were employed to characterise the overall profile of school-aged children, disaggregated by their place of residence and respective individual- and household-level characteristics. Differences in individual and household-level characteristics by place of residence, as well as associations between anaemia prevalence and these characteristics, were assessed using chi-square tests. In this study, anaemia status among school-aged children (anaemic vs. non-anaemic) served as the dependent variable, while independent variables included place of residence, sex, age group, educational attainment and occupation of the household head, household size, wealth status, source of drinking water, toilet facility, waste segregation, household food security status, nutritional status indicators, and participation in government programmes.

To identify the determinants of anaemia, logistic regression analysis was conducted, starting with bivariate analyses between the dependent and independent variables. Variables showing associations in the preliminary analyses were then included in the multivariate logistic regression models, stratified by place of residence, to estimate the regression coefficients for the outcome variable. Crude and adjusted odds ratios were calculated for each covariate, with statistical significance set at $p<0.05$. All statistical analyses were performed using Stata software, version 16.0 (StataCorp LLC, College Station, Texas, United States of America).

Table 1. Individual characteristics of school-aged children in rural and urban areas in the Philippines: 2018-2019 ENNS

Variables	*Philippines (n=5173)*		*Rural (n=3729)*		*Urban(n=1444)*		*p-value*
	N	*% (95% CI)*	*n*	*% (95% CI)*	*n*	*% (95% CI)*	
Sex							0.487
Male	2645	50.3 (48.4–52.2)	1934	51.1 (49.3–52.9)	711	49.1 (43.5–54.7)	
Female	2528	49.7 (47.8–51.6)	1795	48.9 (47.1–50.7)	733	50.9 (45.3–56.5)	
Age group							0.963
6 - 9 years old	5049	97.6 (97.1–98.1)	3644	97.6 (96.9–98.2)	1405	97.7 (95.5–98.8)	
10 - 12 years old	124	2.4 (1.9–2.9)	85	2.4 (1.8–3.1)	39	2.3 (1.2–4.5)	
Nutritional status							
Underweight							<0.001*
Yes	1423	25.8 (21.5–30.6)	1076	29.3 (24.9–34.2)	347	20.4 (16.7–24.7)	
No	3750	74.2 (69.4–78.5)	2653	70.7 (65.8–75.1)	1097	79.6 (75.3–83.3)	
Thinness							0.212
Yes	461	8.7 (7.2–10.5)	343	9.5 (7.9–11.3)	118	7.6 (5.3–10.6)	
No	4712	91.3 (89.5–92.8)	3386	90.5 (88.7–92.1)	1326	92.4 (89.4–94.7)	
Stunted							<0.001*
Yes	1317	23.4 (19.7–27.6)	998	27.2 (23.1–31.7)	319	17.7 (14.1–21.9)	
No	3856	76.6 (72.4–80.3)	2731	72.8 (68.3–76.9)	1125	82.3 (78.1–85.9)	
Overweight/Obese							0.008*
Yes	434	9.3 (7.6–11.3)	252	6.6 (5.3–8.3)	182	13.4 (10.2–17.3)	
No	4739	90.7 (88.7–92.4)	3477	93.4 (91.7–94.7)	1262	86.6 (82.7–89.8)	
Mass administration of deworming drugs							<0.001*
Yes	3766	68 (61.1–74.2)	2881	76.7 (70.7–81.8)	885	54.6 (47.3–61.7)	
No	1407	32 (25.8–38.9)	848	23.3 (18.2–29.3)	559	45.4 (38.3–52.7)	
National dietary supplementation programme							0.778
Yes	1195	22.6 (18.9–26.8)	871	22.9 (17.6–29.3)	324	22.1 (18.6–26.1)	
No	3978	77.4 (73.2–81.1)	2858	77.1 (70.7–82.4)	1120	77.9 (73.9–81.4)	

*significant at 5% level of significance

Ethical clearance

The study was based on the analysis of available data from the 2018–2019 ENNS, which was reviewed and approved by the Food and Nutrition Research Institute Institutional Ethics Review Committee (FIERC) on 31 July 2017, with Protocol Code FIERC-2017-0. All surveyed households provided informed consent and assent forms before participation.

RESULTS

Among 5,173 school-aged children included in the analysis, 72.1% resided in rural areas and 27.9% in urban areas, as shown in Table 1. The national prevalence of underweight was 25.8% (95% *CI:* 21.5–30.6), with a significantly higher prevalence among rural children (29.3%, 95% CI*:* 24.9–34.2) compared with urban children (20.4%, 95% *CI:* 16.7–24.7). Similarly, stunting affected 23.4% (95% *CI:* 19.7–27.6) of children nationwide and was significantly more prevalent in rural areas (27.2%, 95% *CI:* 23.1–31.7) than in urban areas (17.7%, 95% *CI:* 14.1–21.9). In contrast, overweight or obesity affected 9.3% (95% *CI*: 7.6–11.3) of school-aged children overall and was significantly more common among urban children (13.4%, 95% *CI:* 10.2–17.3) than among their rural counterparts (6.6%, 95% *CI:* 5.3–8.3). Coverage of mass deworming drug administration was 68.0% (95% *CI:* 61.1–74.2) nationwide and was significantly higher among rural children (76.7%, 95% *CI:* 70.7–81.8) compared with urban children (54.6%, 95% *CI:* 47.3–61.7).

Household characteristics differed significantly between rural and urban settings as described in Table 2. Educational attainment of household heads showed marked disparities (p<0.001), with rural households having a higher proportion of heads with at least elementary education, while urban households had a greater proportion with at least high school or college education. The occupation of household heads also varied significantly by residence (p<0.001); engagement in agriculture was substantially more common among rural households (44.5%, 95% *CI*: 42.3–46.7) compared with urban households (6.4%, 95% *CI*: 2.7–14.4), which more frequently reported employment in other non-agricultural sectors. Wealth status differed significantly across residence (p<0.001), with rural households disproportionately represented in the poorest and poor quintiles, while urban households were more commonly classified in the middle to richest wealth categories. Access to basic services also showed significant rural–urban differences. Use of improved drinking water sources was higher among urban households (98.5%, 95% *CI*: 96.1–99.5) than rural households (94.1%, 95% *CI*: 90.9–96.2). Similarly, access to water-sealed toilet facilities was more prevalent in urban areas (96.8%, 95% *CI*: 93.3–98.5) compared with rural areas (91.3%, 95% *CI*: 85.8–94.8). Participation in the government conditional cash transfer programme was significantly higher among rural households (40.1%, 95% *CI*: 34.1–46.4) than urban households (24.4%, 95% *CI*: 18.4–31.6).

As shown in Table 3, the overall prevalence of anaemia at the national level was 16.6% (95% *CI*: 14.2–19.4), with a significantly higher prevalence among children living in rural areas (18.5%, 95% *CI*: 15.8–21.6) compared with those in urban areas (13.7%, 95% *CI*: 11.6–16.2). By sex, a significant difference was observed in urban areas, where prevalence was higher among males (15.3%, 95% *CI*: 13.2–17.6) than females (12.2%, 95% *CI*: 9.5–15.6). No significant sex-based differences were observed at the national or rural levels. With respect to nutritional status, underweight status was significantly associated with anaemia among rural children, with a higher prevalence among underweight children

Table 2. Household characteristics of school-aged children in rural and urban areas in the Philippines: 2018-2019 ENNS

Variables	*Philippines (n=5173)*		*Rural (n=3729)*		*Urban(n=1444)*		*p-value*
	n	*% (95% CI)*	*n*	*% (95% CI)*	*n*	*% (95% CI)*	
Educational attainment of the household head							<0.001*
No grade completed	127	2.05 (1.46–2.86)	116	2.94 (1.89–4.53)	11	0.68 (0.29–1.6)	
At least elementary Level	2111	36.98 (32.63–41.54)	1725	45.91 (42.68–49.17)	386	23.25 (20.16–26.66)	
At least high school level	2203	45.28 (42.46–48.14)	1463	39.16 (36.47–41.92)	740	54.7 (52.49–56.88)	
At least college level	714	15.32 (12.89–18.12)	413	11.65 (9.45–14.27)	301	20.97 (17.45–24.99)	
Others	18	0.36 (0.09–1.52)	12	0.34 (0.09–1.33)	6	0.4 (0.07–2.23)	
Occupation (sector) of household head							<0.001*
No occupation	614	12.63 (10.63–14.95)	400	10.36 (9.36–11.45)	214	16.13 (12.68–20.3)	
Engage in agriculture	1815	29.49 (22.44–37.67)	1668	44.49 (42.3–46.7)	147	6.42 (2.73–14.38)	
Trade (stores), eatery	216	4.13 (2.59–6.52)	134	3.26 (2.39–4.45)	82	5.46 (2.96–9.86)	
Others	2528	53.75 (46.69–60.66)	1527	41.89 (39.39–44.43)	1001	71.98 (61.92–80.24)	
Household size							0.606
1–5 members	2404	48.28 (43.02–53.59)	1731	48.96 (44.16–53.78)	673	47.24 (39.17–55.46)	
>5 members	2769	51.72 (46.41–56.98)	1998	51.04 (46.22–55.84)	771	52.76 (44.54–60.83)	
Wealth status							<0.001*
Poorest	1821	28.54 (23.11–34.68)	1525	37.99 (30.47–46.13)	296	14.02 (9.09–21.01)	
Poor	1430	25.73 (22.15–29.67)	1074	28.48 (26.01–31.09)	356	21.5 (17–26.79)	
Middle	971	21.7 (19.09–24.56)	617	17.36 (15.03–19.96)	354	28.37 (23.18–34.2)	
Rich	608	15.02 (11.12–19.97)	345	10.93 (7.67–15.35)	263	21.3 (16.19–27.48)	
Richest	343	9.02 (6.86–11.76)	168	5.24 (3.4–8)	175	14.82 (11.33–19.14)	
Food security							0.259
Food secure	1422	31.74 (27.78–36)	969	29.67 (23.48–36.7)	453	34.94 (28.21–42.33)	
Food insecure	3751	68.26 (64–72.22)	2760	70.33 (63.3–76.52)	991	65.06 (57.67–71.79)	
Source of drinking water							0.015*
Unimproved source	280	4.15 (3.03–5.67)	244	5.91 (3.78–9.11)	36	1.46 (0.53–3.95)	
Improved source	4893	95.85 (94.33–96.97)	3485	94.09 (90.89–96.22)	1408	98.54 (96.05–99.47)	
Toilet facility							0.016*
No toilet	246	3.49 (2.01–6)	213	4.59 (2.5–8.27)	33	1.8 (0.69–4.63)	
Not water-sealed	200	3.04 (1.72–5.31)	166	4.13 (2.05–8.15)	34	1.36 (0.71–2.62)	
Water-sealed	4727	93.47 (89.99–95.79)	3350	91.28 (85.83–94.77)	1377	96.83 (93.34–98.52)	
Waste segregation							0.977
Yes	3010	55.48 (48.75–62.01)	2189	55.56 (48.89–62.03)	821	55.36 (41.44–68.49)	
No	2163	44.52 (37.99–51.25)	1540	44.44 (37.97–51.11)	623	44.64 (31.51–58.56)	
Government conditional cash transfer programme							0.008*
Beneficiary	2038	33.94 (31.22–36.78)	1645	40.13 (34.14–46.43)	393	24.43 (18.41–31.64)	
Non-beneficiary	3134	66.06 (63.22–68.78)	2084	59.87 (53.57–65.86)	1050	75.57 (68.36–81.59)	

*significant at 5% level of significance

(20.6%, 95% *CI*: 16.5–25.5) compared with non-underweight children (17.7%, 95% *CI*: 15.4–20.2). Thinness was also significantly associated with anaemia in rural areas, where thin children exhibited a higher prevalence (23.1%, 95% *CI*: 17.2–30.3) than non-thin children (18.1%, 95% *CI*: 15.5–20.9). Overweight or obesity was significantly associated with anaemia at the national (p=0.005), rural (p=0.024), and urban (p=0.041) levels. Participation in the national dietary supplementation programmes was significantly associated with anaemia among urban children, with lower prevalence among beneficiaries (7.0%, 95% *CI*: 4.0–11.9) compared with non-beneficiaries (15.6%, 95% *CI*: 13.5–18.0).

Household-level characteristics showed several significant associations with anaemia by place of residence, as shown in Table 4. At the national level, prevalence differed significantly according to the educational attainment of household heads (p=0.048). Higher prevalence was observed among households where the head had no formal education (29.2%, 95% *CI*: 12.5–54.2), while lower prevalence was noted among those with at least college-level education (12.4%, 95% *CI*: 8.7–17.3). Occupation of the household head was significantly associated with anaemia, both nationally (p=0.012) and in rural areas (p=0.016). Nationally, households with heads engaged in agriculture exhibited a higher prevalence of anaemia (20.7%, 95% *CI*: 17.6–24.2) compared with those employed in trade-related activities (12.1%, 95% *CI*: 8.2–17.7) or other sectors (15.1%, 95% *CI*: 13.1–17.4). A similar pattern was observed in rural settings, where agricultural households had a prevalence of 21.4% (95% *CI*: 18.0–25.1). Wealth status was also significantly associated with anaemia at the national (p=0.028) and rural levels (p=0.029). Nationally, prevalence was highest among the poorest households (21.9%, 95% *CI*: 19.1–25.0) and lowest among middle-income households (13.8%, 95% *CI*: 9.3–19.9). In rural areas, children from the poorest households similarly exhibited a higher prevalence (22.5%, 95% *CI*: 19.2–26.0).

Table 5 shows several characteristics that are significantly associated with anaemia. In urban areas, male children had higher odds of anaemia compared with females (AOR=1.31, 95% *CI*: 1.00–1.71), while no significant sex differences were observed at the national or rural levels. Nutritional status showed differential associations by residence. Among urban children, being underweight was associated with lower odds of anaemia (AOR=0.66, 95% *CI*: 0.45–0.97), whereas stunting was associated with higher odds (AOR=2.29, 95% *CI*: 1.14–4.58). Overweight or obesity was consistently associated with lower odds of anaemia at the national (AOR=0.45, 95% *CI*: 0.26–0.76), rural (AOR=0.44, 95% *CI*: 0.21–0.91), and urban levels (AOR=0.44, 95% *CI*: 0.22–0.87). Non-participation in the national dietary supplementation programmes was associated with higher odds of anaemia nationally (AOR=1.41, 95% *CI*: 1.00–1.98), particularly in urban areas (AOR=2.77, 95% *CI*: 1.59–4.84). Educational attainment of the household head was significantly associated with anaemia at the national and rural levels. Compared with households where the head had at least a college education, those with no grades completed showed higher odds of anaemia nationally (AOR=2.64, 95% *CI*: 1.15–6.03) and in rural areas (AOR=2.07, 95% *CI*: 1.08–3.97). At the national level, households with heads having at least an elementary education also had higher odds of anaemia (AOR=1.56, 95% *CI*: 1.02–2.37). Regarding sanitation, lack of toilet facility was associated with higher odds of anaemia nationally (AOR=1.39, 95% *CI*: 1.06–1.82) and in rural areas (AOR=1.47, 95% *CI*: 1.18–1.82).

Table 3. Prevalence of anaemia in rural and urban areas in the Philippines disaggregated by school-aged children's individual characteristics: 2018-2019 ENNS

Variables	*Philippines (n=5173)*			*Rural (n=3729)*			*Urban(n=1444)*		
	n	*% (95% CI)*	*p-value*	*n*	*% (95% CI)*	*p-value*	*n*	*% (95% CI)*	*p-value*
Philippines	5173	16.6 (14.2–19.4)	0.009*	3729	18.5 (15.8–21.6)	-	1444	13.7 (11.6–16.2)	-
Sex			0.082			0.190			0.043*
Male	2645	18.3 (15.6–21.4)		1934	20.2 (17.2–23.6)		711	15.3 (13.2–17.6)	
Female	2528	15 (11.8–18.8)		1795	16.9 (12.8–21.9)		733	12.2 (9.5–15.6)	
Age group			0.207			0.223			0.827
6 - 9 years old	5049	16.8 (14.3–19.6)		3644	18.7 (15.9–21.9)		1405	13.8 (11.4–16.5)	
10 - 12 years old	124	11.1 (5.2–22.3)		85	10.9 (3.8–27.6)		39	11.4 (1.5–52.6)	
Nutritional status									
Underweight			0.056			0.022*			0.692
Yes	1423	18.7 (15.1–23)		1076	20.6 (16.5–25.5)		347	14.6 (10.2–20.3)	
No	3750	15.9 (13.6–18.5)		2653	17.7 (15.4–20.2)		1097	13.5 (10.8–16.7)	
Thinness			0.265			0.040*			0.544
Yes	461	19 (13.5–26.1)		343	23.1 (17.2–30.3)		118	11.2 (5.3–22.3)	
No	4712	16.4 (14.1–19)		3386	18.1 (15.5–20.9)		1326	13.9 (11.5–16.8)	
Stunted			0.101			0.490			0.051
Yes	1317	20.2 (15.6–25.7)		998	19.9 (14.3–27)		319	20.7 (13.2–31)	
No	3856	15.6 (12.8–18.8)		2731	18 (15.5–20.9)		1125	12.2 (9.8–15.2)	
Overweight/Obese			0.005*			0.024*			0.041*
Yes	434	8.4 (5.6–12.6)		252	9.2 (4.8–16.9)		182	7.8 (4.3–13.7)	
No	4739	17.5 (14.9–20.4)		3477	19.2 (16.3–22.5)		1262	14.6 (12.1–17.6)	
Mass administration of deworming drugs			0.459			0.515			0.615
Yes	3766	17.1 (13.9–20.8)		2881	18.9 (15.4–23)		885	13.2 (10–17.2)	
No	1407	15.7 (13.2–18.5)		848	17.4 (14.5–20.8)		559	14.4 (11.4–18)	
National dietary supplementation programme			0.152			0.766			0.005*
Yes	1195	14.4 (10.2–19.8)		871	19 (14.4–24.7)		324	7 (4–11.9)	
No	3978	17.3 (15.2–19.7)		2858	18.4 (15.7–21.4)		1120	15.6 (13.5–18)	

*significant at 5% level of significance

Table 4. Prevalence of anaemia in rural and urban areas in the Philippines disaggregated by school-aged children's household characteristics: 2018-2019 ENNS

Variables	*Philippines (n=5173)*			*Rural (n=3729)*			*Urban(n=1444)*		
	n	*% (95% CI)*	*p-value*	*n*	*% (95% CI)*	*p-value*	*n*	*% (95% CI)*	*p-value*
Educational attainment of the household head			0.048*			0.342			0.372
No grade completed	127	29.2 (12.5–54.2)		116	28 (11.7–53.4)		11	36.7 (2.8–92.2)	
At least elementary Level	2111	18.9 (15.9–22.3)		1725	19.8 (16.1–24.1)		386	16.1 (10.9–23)	
At least high school level	2203	15.8 (12.8–19.2)		1463	17.3 (12.9–22.9)		740	14.1 (11.2–17.5)	
At least college level	714	12.4 (8.7–17.3)		413	15.5 (10.4–22.4)		301	9.7 (4.8–18.5)	
Others	18	8.6 (1.4–38.2)		12	15.2 (3.7–45.6)		6		
Occupation (sector) of household head			0.012*			0.016*			0.805
No occupation	614	15.3 (10.4–21.8)		400	17.3 (11.6–24.9)		214	13.2 (7.9–21.3)	
Engage in agriculture	1815	20.7 (17.6–24.2)		1668	21.4 (18–25.1)		147	13.6 (7–24.6)	
Trade (stores), eatery	216	12.1 (8.2–17.7)		134	14.7 (10.3–20.5)		82	9.8 (3.6–24.1)	
Others	2528	15.1 (13.1–17.4)		1527	16.2 (13.5–19.3)		1001	14.1 (11.5–17.2)	
Household size			0.901			0.708			0.750
1–5 members	2404	16.7 (14.3–19.4)		1731	18.9 (16.5–21.5)		673	13.3 (10.5–16.7)	
>5 members	2769	16.6 (13.5–20.1)		1998	18.2 (14.4–22.8)		771	14.1 (10.5–18.7)	
Wealth status			0.028*			0.029*			0.278
Poorest	1821	21.9 (19.1–25)		1525	22.5 (19.2–26)		296	19.6 (14.1–26.5)	
Poor	1430	14.6 (12–17.6)		1074	16 (12.6–20)		356	11.8 (7.9–17.1)	
Middle	971	13.8 (9.3–19.9)		617	16.6 (11.6–23.1)		354	11.1 (7.1–17)	
Rich	608	14 (9.7–19.8)		345	13.3 (9.2–19)		263	14.5 (8.9–22.6)	
Richest	343	17.3 (10.7–26.6)		168	21.7 (11.4–37.3)		175	14.9 (8–25.9)	
Food security			0.360			0.520			0.772
Food secure	1422	15.9 (13.5–18.6)		969	17.9 (14.6–21.7)		453	13.3 (10.9–16.2)	
Food insecure	3751	17 (14.2–20.2)		2760	18.8 (15.9–22.2)		991	13.9 (10.8–17.8)	
Source of drinking water			0.253			0.362			0.973
Unimproved source	280	21.3 (12–34.8)		244	22.5 (13.2–35.7)		36	13.5 (3.4–41)	
Improved source	4893	16.4 (14.2–19)		3485	18.3 (15.5–21.4)		1408	13.7 (11.7–16.1)	
Toilet facility			0.066			0.112			0.700
No toilet	246	75 (68.9–80.3)		213	26.8 (20.6–34)		33	18 (8.1–35.4)	
Not water-sealed	200	86.6 (74.5–93.4)		166	14.1 (6.7–27.5)		34	10 (1.8–40.6)	
Water-sealed	4727	83.6 (80.6–86.2)		3350	18.3 (15.2–21.9)		1377	13.7 (11.3–16.4)	
Waste segregation			0.399			0.279			0.763
Yes	3010	16 (12.7–19.9)		2189	17.2 (13.1–22.2)		821	14.2 (11.1–17.9)	
No	2163	17.5 (15–20.3)		1540	20.3 (16.8–24.2)		623	13.2 (8.9–19.2)	
Government conditional cash transfer programme			0.646			0.151			0.322
Beneficiary	2038	16 (12.2–20.6)		1645	16 (11.9–21.2)		393	15.9 (10–24.4)	
Non-beneficiary	3134	17 (14.1–20.3)		2084	20.2 (16.8–24.2)		1050	13 (11.4–14.9)	

*significant at 5% level of significance

Table 5. Determinants of anaemia among school-aged children in rural and urban areas in the Philippines: 2018-2019 ENNS

Variables	*Philippines (n=5173)*		*Rural (n=3729)*		*Urban(n=1444)*	
	AOR (95% CI)	*p-value*	*AOR (95% CI)*	*p-value*	*AOR (95% CI)*	*p-value*
Sex						
Male	1.28 (0.98–1.66)	0.063	1.25 (0.88–1.76)	0.177	1.31 (1–1.71)	0.047*
Female	1.00	-	1.00	-	1.00	-
Nutritional status						
Underweight						
Yes	0.89 (0.69–1.16)	0.337	1.03 (0.82–1.29)	0.797	0.66 (0.45–0.97)	0.038*
No	1.00	-	1.00	-	1.00	-
Thinness						
Yes	1.23 (0.84–1.8)	0.249	1.27 (0.89–1.8)	0.161	1.06 (0.45–2.47)	0.883
No	1.00	-	1.00	-	1.00	-
Stunted						
Yes	1.31 (0.81–2.12)	0.224	0.98 (0.61–1.58)	0.934	2.29 (1.14–4.58)	0.026*
No						
Overweight/Obese						
Yes	0.45 (0.26–0.76)	0.009*	0.44 (0.21–0.91)	0.032*	0.44 (0.22–0.87)	0.025*
No	1.00	-	1.00	-	1.00	-
National dietary supplementation programme						
Yes	1.00	-	1.00	-	1.00	-
No	1.41 (1–1.98)	0.050*	1.06 (0.79–1.43)	0.638	2.77 (1.59–4.84)	0.003*
Educational attainment of the household head						
No grade completed	2.64 (1.15–6.03)	0.028*	2.07 (1.08–3.97)	0.033*	4.11 (0.1–168.3)	0.398
At least elementary level	1.56 (1.02–2.37)	0.042*	1.31 (0.75–2.28)	0.293	1.67 (0.55–5.03)	0.307
At least high school level	1.27 (0.78–2.05)	0.283	1.11 (0.53–2.31)	0.748	1.44 (0.69–3.02)	0.278
At least college level	1.00	-	1.00	-	1.00	-
Others	0.66 (0.1–4.11)	0.604	1.08 (0.21–5.43)	0.915	1.08 (0.21-5.54)	0.920
Toilet facility						
No toilet	1.39 (1.06–1.82)	0.025*	1.47 (1.18–1.82)	0.004*	0.91 (0.27–3.06)	0.854
Not water-sealed	0.64 (0.3–1.36)	0.203	0.63 (0.25–1.57)	0.270	0.54 (0.09–3.27)	0.448
Water-sealed	1.00	-	1.00	-	1.00	-

*significant at 5% level of significance

DISCUSSION

Prevalence of anaemia among school-aged children

This study showed that anaemia among school-aged children in the Philippines remains a public health concern, with a clear and persistent rural disadvantage. The national anaemia prevalence of 16.6% meets the WHO threshold for a mild public health problem, but the significantly higher prevalence observed in rural areas compared with urban areas underscores enduring spatial inequities. Rural areas are more disadvantaged when it comes to access to health services, livelihoods, and sanitation (United Nations, 2021), as well as weaker food system resilience (Koroma *et al.,* 2024), reflecting broader structural inequalities. These findings suggest that anaemia among school-aged children is shaped not only by individual nutrition but also by place-based vulnerabilities.

Overweight/obesity as determinants in national, rural, and urban settings

Across national, rural, and urban models, overweight/obesity was consistently associated with significantly lower odds of anaemia, indicating a robust inverse relationship across settings. While this inverse association may appear counterintuitive, it should not be interpreted as evidence of a healthy nutritional status. Rather, it likely reflects higher overall energy intake, which may be characterised by greater access to calorie-dense but micronutrient-poor foods and low dietary diversity (Rahman *et al.,* 2016). Recent studies of the obesity-anaemia paradox describe how obesity can cause chronic, low-grade inflammation and increased plasma volume, which in turn may increase hepcidin production and alter iron absorption in the body (Alshwaiyat *et al.,* 2021), while also diluting circulating iron biomarkers and inconsistently increasing haemoglobin (Cepeda-Lopez *et al.,* 2019). Similarly, obesity is characterised by augmented adiposity in the body, increasing erythropoietin production and erythropoiesis, possibly counterbalancing hepcidin-mediated iron restriction (Pergola *et al.,* 2024). This pattern reinforces the complexity of the triple burden of malnutrition, in which anaemia intersects differently with undernutrition and overnutrition depending on context.

National-level determinants of anaemia among school-aged children

At the national level, anaemia among school-aged children was significantly associated with participation in national dietary supplementation programmes, educational attainment of the household head, and sanitation conditions. Children not involved in government nutrition programmes had higher odds of anaemia, highlighting the protective role of supplementation and micronutrient interventions, consistent with global evidence showing that programme coverage and access to preventive iron supplementation reduce anaemia risk among children in low- and middle-income settings (Mabetha *et al.,* 2025). A clear inverse educational gradient was also evident, with higher odds of anaemia among children from households with limited formal educational attainment, aligning with multi-country analyses linking parental education to child nutritional outcomes via income, knowledge, and health-seeking pathways (Shibeshi *et al.,* 2024). Inadequate sanitation emerged as a significant risk factor, as children from households without improved toilet facilities had higher odds of anaemia, a pattern seen in multi-country survey data showing that improved household sanitation is associated with lower anaemia prevalence (Kothari *et al.,* 2019).

Rural-level determinants: education and sanitation as structural drivers

In rural areas, educational attainment of the household head and sanitation emerged as dominant determinants of anaemia, reflecting systemic and deeply embedded inequalities. School-aged children from households where the head had no education had higher odds of anaemia compared with those whose household heads attained higher levels of education, underscoring how limited education constrains nutrition-related knowledge and health-seeking behaviours in rural contexts, consistent with evidence linking household education to child health and anaemia risk across populations (Chandran & Kirby, 2021). Sanitation-related inequalities were likewise pronounced, as the absence of improved household toilet facilities has been associated with higher anaemia prevalence in national surveys, suggesting that environmental exposure and infection pathways contribute to micronutrient deficiencies (Yu *et al.,* 2019). These findings align with Philippine evidence showing that socioeconomic and environmental conditions remain key drivers of anaemia among school-aged children, particularly in rural areas where high poverty incidence and limited access to basic health services compound these risks (Ross *et al.,* 2017). Overall, the results indicate that anaemia in rural settings is less shaped by individual biological factors and more by broader socioeconomic and environmental inequalities, reinforcing the need for nutrition-sensitive interventions that integrate education and WASH (water, sanitation, and hygiene) improvements to effectively reduce anaemia among vulnerable populations, including young children (Goyena, Maniego & Angeles-Agdeppa, 2020).

Urban-level determinants: individual nutritional status and programme access

In urban areas, anaemia risk was driven mainly by individual-level characteristics and programme participation rather than household socioeconomic factors. Male school-aged children had significantly higher odds of anaemia than females, consistent with findings from Mexico (Da Silva Ferreira *et al.,* 2016) and Ethiopia (Melku *et al.,* 2018), likely reflecting gender differences in dietary intake (Shomaker *et al.,* 2010) and physical activity patterns (Kretschmer *et al.,* 2023) that influence energy balance and micronutrient status. Underweight status showed an inverse association with anaemia, underscoring the context-specific and complex interplay of diet, infection, and micronutrient deficiencies (Petry *et al.,* 2016). Notably, non-participation in government national dietary supplementation programmes emerged as the strongest predictor of anaemia, highlighting the critical role of nutrition-specific interventions in urban settings, where supplementation and food fortification have been shown to improve haemoglobin levels and reduce anaemia prevalence (Vaivada *et al.,* 2017). Unlike rural models, educational attainment of household heads and sanitation were not significant predictors, suggesting that in urban contexts with broader access to basic services, anaemia risk is shaped more by effective programme reach and utilisation than by structural access alone (Ruel & Alderman, 2013).

Strengths and limitations

This study has several important strengths, including the use of a large, nationally representative sample of school-aged children that enabled robust rural–urban comparisons and stratified analyses to identify place-specific determinants of anaemia. The integration of individual- and household-

level characteristics, as well as the application of multivariate regression models, allowed a more comprehensive assessment of anaemia beyond prevalence estimates, while standardised survey protocols enhanced the reliability and comparability of findings.

Nonetheless, key limitations should be acknowledged. Firstly, the lack of dietary intake data limited the assessment of iron intake, dietary diversity, and the potential influence of dietary enhancers or inhibitors of iron absorption. Secondly, the cross-sectional design precluded causal inference. Thirdly, reliance on secondary data restricted the inclusion of other relevant factors such as infection or inflammation that may influence anaemia risk. We also explored potential differences in anaemia risk across age groups (6–9 vs. 10–12 years) during the bivariate analysis; however, age group was not significantly associated with anaemia and therefore was not retained in the final multivariable model. Moreover, the relatively small number of children aged 10–12 years limited the feasibility of conducting age-stratified analyses with sufficient statistical power. Future studies with larger samples may further examine age-related physiological and nutritional differences among school-aged children, particularly in relation to growth and early pubertal transitions. Despite these constraints, the study provided valuable evidence on the structural and contextual drivers of anaemia among Filipino school-aged children.

CONCLUSION

Overall, anaemia among Filipino school-aged children demonstrates the aggregated effects of nutritional status, socioeconomic disparities, environmental conditions, and unequal programme reach, with these effects manifesting differently across rural and urban settings in the Philippines. The findings highlighted that anaemia is not solely a health issue, but a place-based vulnerability shaped by structural inequalities, particularly in rural areas of the country. Effective responses must therefore move beyond uniform, one-size-fits-all interventions and adopt place-sensitive strategies that integrate targeted nutrition intervention programmes with sustained investments in education, sanitation, and development to address the root causes of persistent anaemia in rural and urban communities.

Acknowledgements

The authors would like to thank all local government unit officials and all participants in the 2018–2019 ENNS. Heartfelt thanks are also extended to all field and office-based personnel who made the timely conduct and completion of the survey possible.

Authors' contributions

Protacio KI, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript, reviewed and revised the manuscript; de Joya JY, assisted in designing the study, preparing the draft of the manuscript, reviewed and revised the manuscript; Sumangue C, assisted in designing the study, conducted data analysis and interpretation, and assisted in drafting the manuscript.

Conflict of interest

The authors declare no competing interests.

References

Alshwaiyat N, Ahmad A, Hassan WMRW & Al-Jamal H (2021). Association between obesity and iron deficiency. *Exp Ther Med* 22(5):1268. https://doi.org/10.3892/etm.2021.10703

Apu MAI, Halder D, Shuvo MS & Sarker MR (2023). Iron deficiency in children can impair growth and contribute to anaemia. *Am J Health Res* 11(2):58–63. https://doi.org/10.11648/j.ajhr.20231102.14

Cepeda-Lopez AC, Zimmermann MB, Wussler S, Melse-Boonstra A, Naef N, Mueller SM, Toigo M & Herter-Aeberli I (2019). Greater blood volume and Hb mass in obese women quantified by the carbon monoxide-rebreathing method affects interpretation of iron biomarkers and iron requirements. *Int J Obes* 43(5):999–1008.

https://doi.org/10.1038/s41366-018-0127-9

Chandran V & Kirby RS (2021). Maternal, social and household factors associated with childhood anaemia. *Int J Environ Res Public Health* 18(6):3105. https://doi.org/10.3390/ijerph18063105

Da Silva Ferreira H, De Assunção Bezerra MK, De Assunção ML & De Menezes RCE (2016). Prevalence of and factors associated with anaemia in school children from Maceió, northeastern Brazil. *BMC Public Health* 16:380. https://doi.org/10.1186/s12889-016-3073-2

DOST-FNRI (2022). Philippine Nutrition Facts and Figures: 2018-2019 Expanded National Nutrition Survey (ENNS). Department of Science and Technology - Food and Nutrition Research Institute. FNRI Bldg., DOST Compound, Gen. Santos Avenue, Bicutan, Taguig City, Metro Manila, Philippines. From https://enutrition.fnri.dost.gov.ph/uploads/2018-2019%20ENNS%20FACTS%20AND%20FIGURES_JULY182023.pdf [Retrieved 10 December 2025].

Goyena E, Maniego ML & Angeles-Agdeppa I (2020). Determinants of haemoglobin status in Filipino children and women based on a nationwide survey. *Philipp J Sci* 149(3-A):733–746.

Koroma NI, Sawi NMK, Sheriff NF & Smith NA (2024). Factors associated with food security in rural communities across the globe. *Int J Sci Res Arch* 11(2):1735–1743. https://doi.org/10.30574/ijsra.2024.11.2.0638

Kothari MT, Coile A, Huestis A, Pullum T, Garrett D & Engmann C (2019). Exploring associations between water, sanitation, and anaemia through 47 nationally representative demographic and health surveys. *Ann N Y Acad Sci* 1450(1):249–267. https://doi.org/10.1111/nyas.14109

Kretschmer L, Salali GD, Andersen LB, Hallal PC, Northstone K, Sardinha LB, Dyble M, Bann D & Van Sluijs EMF (2023). Gender differences in the distribution of children's physical activity: Evidence from nine countries. *Int J Behav Nutr Phys Act* 20(1):103. https://doi.org/10.1186/s12966-023-01496-0

Mabetha D, Kallon II, Visser M, Naude C, Odendaal W, Brand AS & Cooper S (2025). Iron supplementation in children to prevent deficiency and anaemia: A qualitative synthesis. *Afr J Prim Health Care Fam Med* 17(1):e1–e14. https://doi.org/10.4102/phcfm.v17i1.4825

Melku M, Takele WW, Anlay DZ, Ekubagewargies DT, Getaneh Z, Abebe M & Abebe Z (2018). Male and undernourished children at high risk of anaemia in Ethiopia: A systematic review and meta-analysis. *Ital J Pediatr* 44:79. https://doi.org/10.1186/s13052-018-0513-x

Pergola PE, Davidson M, Jensen C, Zonoozi AAM, Raj DS, Schytz PA, Tuttle KR & Perkovic V (2024). Effect of ziltivekimab on determinants of haemoglobin in patients with CKD stage 3–5. *J Am Soc Nephrol* 35(1):74–84. https://doi.org/10.1681/ASN.0000000000000245

Petry N, Olofin I, Hurrell R, Boy E, Wirth J, Moursi M, Angel MD & Rohner F (2016). Proportion of anaemia associated with iron deficiency in countries with different Human Development Index. *Nutrients* 8(11):693. https://doi.org/10.3390/nu8110693

Rahman S, Ahmed T, Rahman AS, Alam N, Ahmed AS, Ireen S, Chowdhury IA, Chowdhury FP & Rahman SM (2016). Determinants of iron status and haemoglobin in Bangladesh: Role of groundwater iron. *Public Health Nutr* 19(10):1862–1874. https://doi.org/10.1017/S1368980015003651

Ruel MT & Alderman H (2013). Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? *The Lancet* 382(9891):536–551. https://doi.org/10.1016/S0140-6736(13)60843-0

Ross A, Papier K, Luceres-Catubig R, Chau T, Inobaya M & Ng S (2017). Poverty, dietary intake, intestinal parasites and nutritional status among school-age children in rural Philippines. *Trop Med Infect Dis* 2(4):49. https://doi.org/10.3390/tropicalmed2040049

Saengnipanthkul S, Sirikarn P, Musikaboonleart S, Tran LC & Puwanant M (2025). Prevalence and associated factors of anaemia risk among children under five in Northeast Thailand. *Sci Rep* 15:23215. https://doi.org/10.1038/s41598-025-05550-8

Shibeshi AH, Mare KU, Kase BF, Wubshet BZ, Tebeje TM, Asgedom YS, Asmare ZA, Asebe HA, Lombebo AA, Sabo KG, Fente BM & Seifu BL (2024). Effect of dietary diversity on anaemia among children 6–23 months in sub-Saharan Africa. *PLoS One* 19(5): e0298647. https://doi.org/10.1371/journal.pone.0298647

Shomaker LB, Tanofsky-Kraff M, Savastano DM, Kozlosky M, Columbo KM, Wolkoff LE, Zocca JM, Brady SM, Yanovski SZ, Crocker MK, Ali A & Yanovski JA (2010). Puberty and observed energy intake. *Am J Clin Nutr* 92(1):123–129. https://doi.org/10.3945/ajcn.2010.29383

StataCorp LLC (2019). Stata software: Release 16. StataCorp LLC, College Station, Texas, United States of America.

UNICEF (2024). *In: Everything you need to know*

about anaemia. From https://www.unicef.org/india/stories/everything-you-need-know-about-anaemia [Retrieved 10 December 2025].

United Nations (2021). *In: Tackling inequalities in public service coverage to build forward better for the rural poor.* From https://cdn.who.int/media/docs/default-source/documents/gender/un-hlpc-itt-policy-brief-rural-inequalities-2021_print.pdf?sfvrsn=155e5f0e_5&download=true [Retrieved 10 December 2025].

Vaivada T, Gaffey MF, Das JK & Bhutta ZA (2017). Evidence-based interventions to improve maternal and child nutrition in low-income settings. *Curr Opin Clin Nutr Metab Care* 20(3):204–210. https://doi.org/10.1097/MCO.0000000000000365

WHO (2025). *In: Anaemia.* World Health Organization. From https://www.who.int/news-room/fact-sheets/detail/anaemia [Retrieved 10 December 2025].

Yu EX, Addo OY, Williams AM, Engle-Stone R, Ou J, Huang W, Guo J, Suchdev PS & Young MF (2019). Association between anaemia and water or sanitation in preschool children. *Am J Clin Nutr* 112(Suppl 1):488S–497S. https://doi.org/10.1093/ajcn/nqaa148