Article

Not peer-reviewed version

Characteristics of Anemia in Children Aged 6 Months to 5 Years Attending a Pediatric Hospital in Lisbon, Portugal

Réka Maulide Cane *, Sérgio Chicumbe, Youssouf Keita, Anaxore Casimiro, Bárbara Martins Saraiva, Joana Vasconcelos, Beatriz Lúzio Vaz, Afonso Sousa, Mafalda Cabral, Francisco Branco Caetano, Luís Varandas, Isabel Craveiro *

Posted Date: 6 May 2025

doi: 10.20944/preprints202505.0306.v1

Keywords: childhood; anemia; characteristics; Portugal; Southern Europe; Europe

 doi:10.20944/preprints202505.0306.v1

Article

Characteristics of Anemia in Children Aged 6 Months to 5 Years Attending a Pediatric Hospital in Lisbon, Portugal

Réka Maulide Cane [1,2,*], Sérgio Chicumbe [1], Youssouf Keita [3], Anaxore Casimiro [2,4,5], Bárbara Martins Saraiva [4], Joana Vasconcelos [4], Beatriz Lúzio Vaz [4], Afonso Sousa [4], Mafalda Cabral [4], Francisco Branco Caetano [4], Luís Varandas [2,4,5] and Isabel Craveiro [2,*]

[1] Instituto Nacional de Saúde, INS, Ministério da Saúde, MISAU, Estrada Nacional EN1, Bairro da Vila— Parcela no 3943, Distrito de Marracuene, Marracuene 264, Província de Maputo, Mozambique
[2] Global Health and Tropical Medicine, GHTM, Associate Laboratory in Translation and Innovation Towards Global Health, LA-REAL, Instituto de Higiene e Medicina Tropical, IHMT, Universidade NOVA de Lisboa, UNL, Rua da Junqueira 100, 1349-008 Lisboa, Portugal
[3] Public Health Independent Consultant, Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ)/C4N-NIPN, Bamako, Mali
[4] Hospital Dona Estefânia, Unidade Local de Saúde São José, Lisboa, Portugal
[5] NOVA Medical School, Faculdade de Ciências Médicas Universidade Nova de Lisboa, Campo Mártires da Pátria 130, 1169-056 Lisboa, Portugal
* Correspondence: rica.cane@gmail.com (R.M.C.); isabelc@ihmt.unl.pt (I.C.)

Abstract: Childhood anemia is a serious public health issue that adversely affects cognitive and psychomotor development, impacting school performance and adult productivity. In this cross-sectional descriptive study, we characterized the profile of children aged 6 months to 5 years diagnosed with or at risk of anemia while attending consultations at a pediatric hospital in Lisbon, Portugal. We found that 33.3% (74/222) of the children were either anemic or at risk of developing anemia. The overall anemia rates based on hemoglobin levels were 54.5% for mild anemia (36/66), 34.8% for moderate anemia (23/66), and 10.6% for borderline anemia (7/66). More than half (64/70) of the children had microcytic anemia, while 8.6% (6/70) had normocytic anemia. About 40.0% (12/30) of the children had iron deficiency anemia, and 33.3 % (3/9) had sickle cell trait. Our results indicate that anemia rates were higher in male children aged 2-3 years, those whose caregivers had a low level of education, and those whose mothers were from the Community of Portuguese Language Countries. Further research, including analytical cross-sectional or longitudinal studies, is necessary to explore the impact of feeding practices, dietary habits, and socioeconomic and metabolic factors on childhood anemia.

Keywords: childhood; anemia; characteristics; Portugal; Southern Europe; Europe

1. Introduction

Anemia is a condition where the number of erythrocytes or red blood cells (RBCs) is insufficient to meet metabolic demands [1]. It is a serious public health problem that affects both rich and poor countries and is associated with impaired development and reduced quality of life [1–7]. This condition negatively affects cognitive and psychomotor development, impacting school performance and adult productivity through developmental delays and behavioral disturbances [3,7]. Globally, anemia is one of the most widespread nutritional disorders, affecting nearly 40.0% of children aged 6 months to 5 years [3,8–10].

The causes of childhood anemia are multifactorial. For example, lack of iron, folate, vitamin B12, and vitamin A can cause nutritional anemia [6,7,10]. Iron deficiency is the most common nutritional

 doi:10.20944/preprints202505.0306.v1

deficiency and the primary cause of iron deficiency anemia (IDA) [11]. It often occurs when dietary iron intake is insufficient to meet iron needs, particularly during periods of life when iron requirements are increased, such as during growth and development in pregnancy and infancy [12]. Deficiencies in several other micronutrients (e.g., vitamin A, B12, folic acid, and riboflavin), which are essential for the normal production of red blood cells, likely contribute to the development of anemia [12]. Nutritional and iron deficiency anemia in children impairs immune function, delays mental, physical, and socioemotional development, and increases the risk of death among infants and young children [7,8,10]. Non-nutritional causes of anemia include parasitic infections (e.g., malaria, hookworm, schistosomiasis), as well as blood loss, blood-inherited diseases (e.g., sickle-cell), and infectious diseases (e.g., HIV/AIDS) [7,10]. The interaction mechanism between anemia and infections is complex. Preexisting anemia influences disease susceptibility, while infections can trigger anemia through inflammation, hemolysis, blood loss, nutrient malabsorption, and impaired red blood cell development [13,14]. Parasitic infections are often transmitted through the ingestion of contaminated water or food. While such infections are rarely fatal, they also impair the intestinal absorption of nutrients, causing malnutrition and anemia [15].

Sociodemographic and economic factors, child feeding practices, accessibility to preventive and curative health services, and maternal anemia also play a role in childhood anemia [16,17]. Anemia represents a key indicator of poor health and nutrition, acting as a marker of socioeconomic disparities, as it is inversely linked to household socioeconomic status, particularly in low- and middle-income settings [18]. Children from lower socioeconomic status are often at a higher risk of anemia and its long-term consequences [18]. Poverty, limited access to healthcare services, urban-rural disparities, and caregivers' education levels are additional factors that may restrict access to nutritious foods, delay timely medical interventions, and negatively influence feeding habits, further increasing the risk of childhood anemia [19]. Few studies [20,21] have shown an association between maternal and fetal anemia, with infants born to anemic mothers often developing anemia a few months after birth. Still, evidence on whether childhood anemia is due to maternal baseline conditions, particularly during pregnancy, is scarce [20,22].

Anemia is defined quantitatively by hemoglobin (Hb), hematocrit, or red blood cell count levels that fall below the normal age- and sex-specific ranges [1]. Anemia in children aged 6 months to 5 years is characterized by low blood hemoglobin and can be classified into the following categories according to severity: mild (10.0 g/dL ≤ Hb ≤ 10.9 g/dL), moderate (7.0 g/dL ≤ Hb ≤ 9.9 g/dL), and severe (Hb < 7.0 g/dL). Additionally, a borderline or pre-anemic stage is identified when 11.0 g/dL ≤ Hb ≤ 11.4 g/dL [6,12,23,24]. Most children with mild anemia have no signs or symptoms, while some may present irritability, jaundice, shortness of breath, or palpitations [25,26]. Moderate and severe anemia has been associated with poor cognitive, emotional, and physical development [27,28]. Severe anemia carries a high 'silent' morbidity and mortality, often occurring months after initial diagnosis and treatment, contributing to under-five child mortality [17].

Other important anemia classifications are based on mean corpuscular volume (MCV) and are categorized into microcytic (MCV < 80fL), normocytic (MCV = 80- 100fL), and macrocytic (MCV > 100fL) [1,29,30]. Microcytic anemia, commonly caused by iron deficiency due to reduced dietary intake, is a leading cause of childhood anemia and is associated with impaired cognitive performance, motor development, and academic performance [31–33]. Many pediatric anemias present as normocytic, while macrocytosis is rarely observed in children [1,34]. Normocytic anemia has many causes (e.g., chronic infections and systemic diseases), making its diagnosis more difficult, whereas macrocytic anemia is usually caused by a deficiency of vitamin B12 or folic acid [1,32,35]. Other possible causes of macrocytic anemia include chronic liver disease, hypothyroidism, and myelodysplastic disorders [31,36]. Often, macrocytosis is considered a significant indicator in the diagnosis of bone marrow diseases and acute leukemia in childhood [34].

In 2021, the global anemia prevalence was 24.3% (95% uncertainty interval [UI] 23.9–24.7), corresponding to 1.92 billion people [37]. In the same year, anemia caused 52·0 million years of healthy life lost due to disability (YLDs) [37]. Evidence in the literature shows that the prevalence of

 doi:10.20944/preprints202505.0306.v1

anemia in children remains high, with data from 2019 indicating that 40.0% (95.0% uncertainty interval [UI] 36–44) of children aged 6–59 months were anemic, compared to 48.0% in 2000 [38]. The burden of anemia is particularly high in the African region, affecting 60.2 % (95.0% uncertainty interval [UI] 56.6-63.7) of children under five [37,38]. In contrast, Europe has a lower prevalence, affecting 23.0% of children under five in 2011 [39,40].

In Portugal, national anemia prevalence estimates were 4.3 % (95.0% uncertainty interval [UI] 5.7-32.4) in children under five in 2019 [41]. Previous studies [42,43], have shown that anemia is highly prevalent in Portugal and largely undiagnosed. In 2016, a prevalence of 19.9% (95.0% uncertainty interval [UI] 19.0–20.8%) was observed among adults living in mainland Portugal, accounting for 54.2 % of cases in pregnant women and 20.7 % of cases in non-pregnant fertile women [42,43]. Nutritional deficiency anemia (57.7%), particularly iron deficiency anemia (52.7%), represented most of the cases diagnosed [43]. A recent study [40] showed that the prevalence of anemia remains high in mainland Portugal, accounting for 38.2% (95% uncertainty interval [UI] 35.4–41.1) of pregnant women and 51.8% (95.0% uncertainty interval [UI] 50.1–53.4) in non-pregnant fertile women.

While studies on childhood anemia in Portugal have been conducted, few were inherently reviews [44,45]. A 2005 study [46] examining the long-term developmental effects of anemia among infants in Braga, North Portugal, reported an iron deficiency anemia prevalence of 19,7%. Still, much of the available evidence on childhood anemia in Portugal remains scarce or outdated [47]. Given the implications of anemia on childhood cognitive and motor development, school performance, and adult productivity, there is an urgent need for updated research to better characterize children affected by this condition in Portugal.

This study aims to characterize the profile of children aged 6 months to 5 years who were diagnosed with or at risk of anemia, attending external pediatric consultations at the Dona Estefânia Hospital (HDE) in Lisbon, Portugal. The evidence generated in this research will contribute to a better understanding of childhood anemia in Portugal, providing valuable epidemiological insights that can inform targeted healthcare interventions and improve the management of children affected by this condition.

2. Results

2.1. Sociodemographic Characteristics

A total of 222 children, aged 6 months to 5 years, who were referred from the emergency department, primary health care centers, or evacuated from Portuguese-speaking African countries for various conditions, attended external general pediatric consultations between September 2023 and September 2024. Among them, 74 children had anemia or were at risk of developing anemia, and their caregivers were invited to participate. All caregivers agreed to participate, resulting in a 100% acceptance rate (Figure 1). The reasons for consultation are detailed in Supplementary Table 1. Among the 74 children, anemia was the primary reason for consultation in 51 cases (51/74; 69.3%). Other clinical presentations or reasons for consultation (23/74; 31.9%) included bowel failure, abdominal pain, poor weight gain, and others.

 doi:10.20944/preprints202505.0306.v1

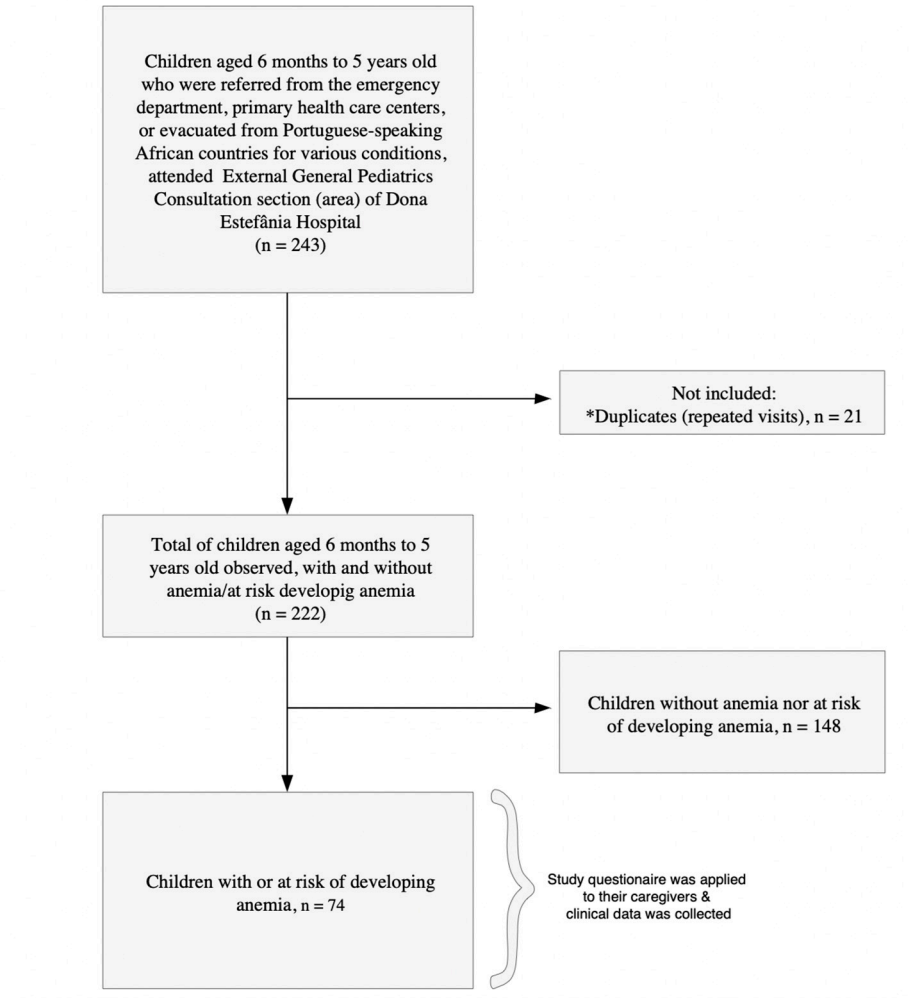

Figure 1. Flowchart of the study population.

Table 1 summarizes the sociodemographic characteristics of children with or at risk of developing anemia. Most participants were male (42/74; 56.8%), aged 2-3 years (29/74; 39.2%), lived in the Metropolitan Lisbon Area (61/74; 82.4%), and were accompanied by their mothers to the consultations (63/74; 85.1%). Most mothers were originally from the Community of Portuguese Language Countries (CPLP) (32/67; 47.8%) and worked in administrative, managerial, or support occupation roles (36/41; 87.8%). Meanwhile, most children's fathers were from other countries (including CPLP) (34/52; 65.4%) and worked in non-administrative, non-managerial, or non-support occupation roles (22/40; 55.0%).

Table 1. Sociodemographic characteristics of children aged 6 months - 5 years at Dona Estefânia Hospital, PAMC, September 2023 – September 2024.

Variables (n = 74)	Categories	N	%
Sex	Male	42	56.8
	Female	32	43.2
Child´s age	6 months - 1 year	28	37.8
	2 -3 years	29	39.2
	4-5 years	17	23.0
Country of	Portugal	73	98.6
residence	Cape Verde	1	1.4

 doi:10.20944/preprints202505.0306.v1

Region of residence	Metropolitan Lisbon Area (Greater Lisbon)	61	82.4
	Other regions (Setúbal peninsula, Alentejo, Madeira, West and Tagus Valley, etc)	13	17.6
Caregiver's Degree of Kinship	Mother	63	85.1
	Father	11	14.9
Caregiver´s Level of Education	Basic/Primary or Secondary Level	41	55.4
	Technical or Higher education (bachelor's, master's, doctorate)	22	29.7
	Other	11	14.9
Country of origin of the child´s mother	Portugal	20	29.9
	CPLP	32	47.8
	Other countries	15	22.4
Mother's occupation (by role)	Specialized Intellectual and scientific roles	5	12.2
	Administrative, Managerial, or Support roles	36	87.8
Country of origin of the child's father	Portugal	18	34.6
	Other countries	34	65.4
Father´s occupation (by role)	Administrative, Managerial, or Support roles	18	45.0
	Other roles	22	55.0

Notes:
- CPLP: Community of Portuguese Language Countries.
- Mother's other origin countries included: Nepal, Bangladesh, Ukraine, Lithuania, Spain, India, Venezuela, Ivory Coast, and the Republic of Guinea (Conakry). Father's other countries of origin included CPLP countries, Nepal, Bangladesh, India, and Ukraine.
- Mother's occupation, by roles, includes two large groups, namely: Specialized Intellectual and Scientific roles (experts in intellectual and scientific professions) and Administrative, Managerial or Support roles (administrative staff and similar, managers, self-employed individuals, entrepreneurs, service and sales staff, and unemployed or domestic workers).
- Father's occupation, by roles, includes two large groups, namely: Administrative, Managerial, or Support roles (administrative staff and similar, managers, self-employed individuals, entrepreneurs, service and sales staff, and unemployed or domestic workers) and other roles (experts in intellectual and scientific professions, technicians and professionals at the intermediate level, and industrial, agricultural, and fishing workers).

2.2. Nutritional and Health Characteristics

Our study results indicate that 33.3% (74/222) of children aged 6 months to 5 years who attended external general pediatric consultations were either anemic or at risk of developing anemia. Their nutritional and health characteristics are presented in Table 2. More than half (55/66; 83.3%) of the

 doi:10.20944/preprints202505.0306.v1

children had received exclusive breastfeeding. About 65.3 % (47/72) of the children had five or more meals/day, and 82.4% (61/74) had adequate minimum dietary diversity. Regarding their health status, 31.9% (23/72) had been previously hospitalized, and 16.2% (12/72) had a history of food selectivity behavior/refusal of certain types of food (8/12; 66.6%) or vomiting after consuming certain types of food (4/12; 33.3%). Children whose mothers reported vomiting after eating were attending the consultation primarily due to anemia (2/12; 16.7%), abdominal pain (1/12; 8.3%), and Down syndrome (1/12; 8.3%) (Supplementary Table 2).

The overall prevalence of anemia was 94.3% (66/74) based on hemoglobin levels, with 54.5% having mild anemia (36/66), 34.8% moderate anemia (23/66), and 10.6% borderline anemia (7/66). More than half (64/70) of the children had microcytic anemia, while 8.6% (6/70) had normocytic anemia. About 40.0% (12/30) of the children had iron deficiency anemia, and at least 33.3 % (3/9) had sickle cell trait.

Table 2. Nutritional and health characteristics of children aged 6 months - 5 years at Dona Estefânia Hospital, PAMC, September 2023 – September 2024.

Variables (n = 74)		Categories	N	%
Nutritional characteristics	History of exclusive breastfeeding	Yes (Past/Present)	55	83.3
		No	11	16.7
	Duration of breastfeeding	1-5 months	21	42.0
		6-12 months	29	58.0
	Complementary feeding*	Yes	64	86.5
		No	10	13.5
	Cereal porridge intake	Yes	43	58.9
		No	30	41.1
	Number of meals/days	3-4 meals/day	25	34.7
		5 or more meals/day	47	65.3
	Cereals and derivatives, tubes	Yes	57	77.0
		No	17	23.0
	Meat, fish, and eggs	Yes	65	87.8
		No	9	12.2
	Dairy products	Yes	70	94.6
		No	4	5.4
	Fruits	Yes	63	85.1
		No	11	14.9
	Legumes	Yes	67	90.5
		No	7	9.5
	Vegetables	Yes	53	71.6
		No	21	28.4
	Fats and oils	Yes	14	18.9
		No	60	81.1
	Minimum dietary diversity	Adequate (4 or more food groups)	61	82.4
		Inadequate (1-3 food groups)	13	17.6

 doi:10.20944/preprints202505.0306.v1

	Excessive milk consumption	Yes (> 500mL/day)	8	10.8
		No	66	89.2
	Supplements intake	Yes	39	52.7
		No	35	47.3
	Type of supplements	Iron	25	64.1
		Iron, folic acid, and vitamin B12, and/or multivitamins	14	35.9
Anthropometric characteristics	Weight percentile	Adequate weight for age (Percentile 3-97)	30	88.2
		Not adequate for age [Percentile <3 (low weight for age) or Percentile >97 (high weight for age]	4	11.8
Child anemia	Anemia based on hemoglobin (Hb) level	Has anemia/At risk of developing anemia (11.0g/dL≤Hb≤11.4g/dL)	66	94.3
		Without anemia (Hb>11.4g/dL)	4	5.7
	Anemia severity, based on hemoglobin (Hb) level	Borderline or pre-anemic stage (11.0 g/dL ≤ Hb ≤ 11.4 g/dL	7	10.6
		Mild (10.0 g/dL ≤ Hb ≤ 10.9 g/dL)	36	54.5
		Moderate (7.0 g/dL ≤ Hb ≤ 9.9 g/dL)	23	34.8
	Anemia based on hematocrit (%) level	Has anemia (Hematocrit<34.0%)	59	85.5
		Normal (34.0%≤Hematocrit≤40.0%)	10	14.5
	Anemia based on the size of red blood cells (RCBs) measured by the mean corpuscular volume (MCV)	Microcytic (<80 fL)	64	91,4
		Normocytic (80-100 fL)	6	8.6
	Iron deficiency by serum iron level	Iron deficiency (Serum iron < 30.0 mcg/dL)	10	37.0
		Mild iron deficiency /Pre-anemic stage (30.0 mcg/dL ≤ Serum iron ≤ 50.0 mcg/dL)	10	37.0

 doi:10.20944/preprints202505.0306.v1

		Normal (> 50.0 mcg/dL-120.0 mcg/dL)	7	25.9
	Iron deficiency anemia (IDA) by ferritin level	Iron deficiency anemia (Ferritin< 12 ng/mL)	12	40.0
		Adequate iron storage in children with infection or inflammation/ IDA in children with no inflammation (12-30 ng/mL)	4	13.3
		Normal (> 30.0 ng/mL)	12	40.0
		Risk of iron overload (> 500.0 ng/mL)	2	6.7
	Sickle cell trait	Yes (Sickle trait cell)	3	33.3
		No/pendent	6	66.7
Health characteristics	Vomit or refusal to eat**	Yes (had vomited or refused to eat)	12	16.2
		No	62	83.8
	Presence of infection or inflammation by C-reactive protein (CRP) level	Yes (CRP > 5.0 mg/mL)	15	31.9
		No (CRP <5.0 mg/mL)	32	68.1
	Blood glucose level	Normal (60.0–180.0 mg/dL)	18	100.0
	Bilirubin	Hyperbilirubinemia (Bilirubin>1.20 mg/dL)	10	90.9
		Normal (0.30-1.20 mg/dL)	1	9.1
	Urea	Uremia (Blood urea >36.0mg/dL)	5	13.9
		Normal (5.0-36.0mg/dL)	31	86.1
	Had any hospitalization (in the past)	Yes	23	31.9
		No	49	68.1
	Duration of hospitalization (in days)	Up to 5 days	7	53.8
		More than 5 days	6	46.2

Notes: (*) Children whose mothers reported that they had either previously received or were currently receiving complementary feeding.

(**) Children whose mothers reported a history of food selectivity behavior (e.g., children who eat "normally" at kindergarten or school but refuse to eat the same foods at home), refusal to eat certain types of food (such as meat), or vomiting after consuming certain types of food (e.g., due to irritability or irritated behavior, abdominal pain, or an unspecified reason).

 doi:10.20944/preprints202505.0306.v1

2.3. Childhood Anemia by Sociodemographic Characteristics

Our results indicate that anemia cases in children aged 6 months to 5 years, measured by hemoglobin levels, were slightly higher in males (54.5%; 36/66) (Table 3). Similarly, this pattern was observed for cases of microcytic anemia, with 54.7% (35/70) in males. Regarding anemia and its risk by age, the highest proportion of cases was found among children aged 2–3 years (39.4%; 26/66) compared to their peers. Microcytic anemia was also most common in the 2–3 years group (45.3%; 29/70) compared to their peers. Concerning anemia by regional and socioeconomic factors, most cases were in children residing in the Metropolitan Lisbon Area (81.8%; 54/66). Such a pattern was also observed across all anemia classifications. Regarding caregiver characteristics, most anemia cases were observed among children whose caregivers had a basic or secondary level of education (59.1%; 39/66), whose mothers were from CPLP countries (48.3%; 29/60), and whose mothers worked in administrative, managerial, or support roles (91.2%; 31/38). Similarly, children of fathers from non-Portuguese origins accounted for a higher proportion of cases of anemia (66.7%; 30/49) compared to their peers.

Table 3. Distribution of anemia cases among children aged 6 months to 5 years by sociodemographic characteristics, hemoglobin, hematocrit, and mean corpuscular volume.

Characteristics	Categories	Cases of anemia based on hemoglobin (Hb)				Cases of anemia based on hematocrit (%)				Cases of anemia based on mean corpuscular value (MCV)			
		Has anemia/At risk of developing anemia (11.0g/dL≤Hb≤11.4g/dL)		**Without anemia (Hb>11.4g/dL)**		**Has anemia (<33.0%)**		**Normal (34.0%-40.0%)**		**Microcytic anemia (<80 fL)**		**Normocytic anemia (80-100 fL)**	
		n	**%**	**n**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**n**	**%**
Gender	Male	36	54.5	3	75.0	34	57.6	4	40.0	35	54.7	4	66.7
	Female	30	45.5	1	25.0	25	42.4	6	60.0	29	45.3	2	33.3
Child´s age	6 months - 1 year	23	34.8	1	25.0	22	37.3	2	20.0	21	32.8	4	66.7
	2 -3 years	26	39.4	3	75.0	23	39.0	6	60.0	29	45.3	0	0.0
	4-5 years	17	25.8	0	0.0	14	23.7	2	20.0	14	21.9	2	33.3
Region of residence	Metropolitan Lisbon Area (Greater Lisbon)	54	81.8	3	75.0	48	81.4	9	90.0	53	82.8	4	66.7
	Other regions (Setúbal peninsula, Alentejo, Madeira, West and Tagus Valley, etc)	12	18.2	1	25.0	11	18.6	1	10.0	11	17.2	2	33.3
Caregiver's Degree of Kinship	Mother	56	84.8	4	100.0	50	84.7	9	90.0	54	84.4	6	100.0
	Father	10	15.2	0	0.0	9	15.3	1	10.0	10	15.6	0	0.0
Caregiver´s Level of Education	Basic/Primary or Secondary Level	39	59.1	1	25.0	34	57.6	5	50.0	36	56.3	3	50.0

doi:10.20944/preprints202505.0306.v1

	Technical or Higher education (bachelor's, master's, doctorate)	17	25.8	2	50.0	17	28.8	2	20.0	17	26.6	3	50.0
	Other	10	15.2	1	25.0	8	13.6	3	30.0	11	17.2	0	0.0
Country of origin of the child's mother	Portugal	18	30.0	2	50.0	17	31.5	3	33.3	19	32.8	1	16.7
	CPLP	29	48.3	1	25.0	24	44.4	5	55.6	26	44.8	4	66.7
	Other countries	13	21.7	1	25.0	13	24.1	1	11.1	13	22.4	1	16.7
Mother's occupation (by role)	Specialized Intellectual and scientific roles	3	8.8	1	2.0	3	9.1	2	50.0	5	13.2	-	-
	Administrative, Managerial or Support roles	31	91.2	3	75.0	30	90.9	2	50.0	33	86.8	-	-
Country of origin of the child's father	Portugal	15	33.3	3	75.0	14	32.6	4	80.0	18	39.1	0	0.0
	Other countries	30	66.7	1	25.0	29	67.4	1	20.0	28	60.9	3	100.0
Father's occupation (by role)	Administrative, Managerial or Support roles	15	45.5	1	25.0	15	46.9	2	50.0	17	45.9	-	-
	Other roles	18	54.5	3	75.0	17	53.1	2	50.0	20	54.1	-	-

Notes:

- Metropolitan Lisbon area: Amadora, Barreiro, Cascais, Lisbon, Loures, Moita, Montijo, Odivelas, Seixal, Sintra, Sesimbra, Vila Franca de Xira.
- CPLP: Community of Portuguese Language Countries.
- Mother's other origin countries included: Nepal, Bangladesh, Ukraine, Lithuania, Spain, India, Venezuela, Ivory Coast, and the Republic of Guinea (Conakry). Father's other countries of origin included CPLP countries, Nepal, Bangladesh, India, and Ukraine.
- Mother's occupation, by roles, includes two large groups, namely: Specialized Intellectual and Scientific roles (experts in intellectual and scientific professions) and Administrative, Managerial or Support roles (administrative staff and similar, managers, self-employed individuals, entrepreneurs, service and sales staff, and unemployed or domestic workers).
- Father's occupation, by roles, includes two large groups, namely: Administrative, Managerial, or Support roles (administrative staff and similar, managers, self-employed individuals, entrepreneurs, service and sales staff, and unemployed or domestic workers) and Other roles (experts in intellectual and scientific professions, technicians and professionals of intermediate level, industrial, agricultural and fishing workers).

doi:10.20944/preprints202505.0306.v1

 doi:10.20944/preprints202505.0306.v1

2.4. Childhood Anemia by Nutritional and Health Characteristics

Our findings indicate that more than half of the children with or at risk of anemia, as determined by hemoglobin levels, engaged in exclusive breastfeeding (81.4%; 48/59), had received or were receiving complementary feeding (84.8%; 56/66), and consumed cereal porridge (61.5%; 40/65) (Table 4). A similar pattern was observed among children with microcytic anemia, with 87.9% (51/58) receiving exclusive breastfeeding, 89.1% (57/64) having received or currently receiving complementary feeding, and 55.6% (35/63) consuming cereal porridge. Children with low minimum dietary diversity (consumption of 1-3 food groups) had lower rates of anemia, as measured by hemoglobin levels (19.7%; 13/66), than those with adequate dietary diversity (80.3%;53/66). Likewise, more cases of microcytic anemia were also reported among children with low minimum dietary diversity (12.5; 8/64). Supplement intake, after confirmation of anemia diagnosis, during the period of study, was reported in 51.5% (34/66) of anemic children, with iron supplements being the most commonly consumed (61.8%; 21/34). Among children with anemia or at risk, 86.7% (26/30) had an adequate weight-for-age percentile, while 13.3% (4/30) had an inadequate weight-for-age percentile. About 87.1% (27/31) of children with microcytic anemia also had an adequate weight-for-age percentile. A history of food selectivity behavior/refusal to eat certain types of food or vomiting after consuming certain types of food was reported in 16.7% (11/66) of children with anemia (measured by hemoglobin levels). The presence of infection or inflammation was reported in 34.9% (15/43) of anemic cases. About 14.3% (5/35) of children with anemia or at risk had uremia. At least 35.4% (23/66) of anemic children had a history of previous hospitalization, with longer hospital stays (>5 days) being slightly more frequent (53.8%; 7/13) than shorter stays.

Table 4. Distribution of anemia cases among children aged 6 months to 5 years by nutritional and health characteristics, hemoglobin, hematocrit, and mean corpuscular volume.

Characteristics		Categories	Cases of anemia based on hemoglobin (Hb)				Cases of anemia based on hematocrit (%)				Cases of anemia based on mean corpuscular value (MCV)			
			Has anemia/At risk of developing anemia (11.0g/dL≤Hb≤11.4g/dL)		**Without anemia (Hb>11.4g/dL)**		**Has anemia (<33.0%)**		**Normal (34.0%-40.0%)**		**Microcytic anemia (<80 fL)**		**Normocytic anemia (80-100 fL)**	
			n	**%**	**N**	**%**	**N**	**%**	**n**	**%**	**N**	**%**	**n**	**%**
Nutritional characteristics	History of exclusive breastfeeding	Yes (Past/Present)	48	81.4	4	100.0	43	81.1	9	90.0	51	87.9	2	33.3
		No	11	18.6	0	0.0	10	18.9	1	10.0	7	12.1	4	66.7
	Duration of breastfeeding	1-5 months	18	40.9	1	33.3	17	42.5	3	42.9	19	41.3	1	50.0
		6-12 months	26	59.1	2	66.7	23	57.5	4	57.1	27	58.7	1	50.0
	History of complementary feeding	Yes (Past/Present)	56	84.8	4	100.0	49	83.1	10	100.0	57	89.1	3	50.0
		No	10	15.2	0	0.0	10	16.9	0	0.0	7	10.9	3	50.0
	Cereal porridge intake	Yes	40	61.5	1	25.0	34	58.6	6	60.0	35	55.6	5	83.3
		No	25	38.5	3	75.0	24	41.4	4	40.0	28	44.4	1	16.7
	Number of meals/days	3-4 meals/day	23	35.9	3	75.0	18	31.6	6	60.0	22	34.9	2	40.0
		5 or more meals/day	41	64.1	1	25.0	39	68.4	4	40.0	41	65.1	3	60.0
	Cereals and derivatives, tubes	Yes	52	78.8	2	50.0	48	81.4	4	40.0	49	76.6	4	66.7
		No	14	21.2	2	50.0	11	18.6	6	60.0	15	23.4	2	33.3
	Meat, fish, and eggs	Yes	57	86.4	4	100.0	50	84.7	10	100.0	57	89.1	4	66.7
		No	9	13.6	0	0.0	9	15.3	0	0.0	7	10.9	2	33.3
	Dairy products	Yes	62	93.9	4	100.0	55	93.2	10	100.0	62	96.9	4	66.7
		No	4	6.1	0	0.0	4	6.8	0	0.0	2	3.1	3	33.3

doi:10.20944/preprints202505.0306.v1

	Fruits	Yes	56	84.8	4	100.0	50	84.7	9	90.0	56	87.5	4	66.7
		No	10	15.2	0	0.0	9	15.3	1	10.0	8	12.5	2	33.3
	Legumes	Yes	59	89.4	4	100.0	53	89.8	9	90.0	59	92.2	4	66.7
		No	7	10.6	0	0.0	6	10.2	1	10.0	5	7.8	2	33.3
	Vegetables	Yes	49	74.2	1	25.0	45	76.3	5	50.0	45	70.3	5	83.3
		No	17	25.8	3	75.0	14	23.7	5	50.0	19	29.7	1	16.7
	Fats and oils	Yes	14	21.2	0	0.0	13	22.0	1	10.0	14	21.9	0	0.0
		No	52	78.8	4	100.0	46	78.0	9	90.0	50	78.1	6	100.0
	Minimum dietary diversity	Adequate (4 or more food groups)	53	80.3	4	100.0	47	79.7	9	90.0	56	87.5	1	16.7
		Inadequate (1-3 food groups)	13	19.7	0	0.0	12	20.3	1	10.0	8	12.5	5	83.3
	Excessive milk consumption	Yes (> 500mL/day)	6	9.1	2	50.0	6	10.2	1	10.0	8	12.5	0	0.0
		No	60	90.9	2	50.0	53	89.3	9	90.0	56	87.5	6	100.0
	Supplements intake	Yes	34	51.5	3	75.0	29	49.2	7	70.0	32	50.0	5	83.3
		No	32	48.5	1	25.0	30	50.8	3	30.0	32	50.0	1	16.7
	Type of supplements	Iron	21	61.8	3	100.0	18	62.1	4	57.1	22	68.8	1	20.0
		Iron, folic acid, and vitamin B12, and/or multivitamins	13	38.2	0	0.0	11	37.9	3	42.9	10	31.3	4	80.0
Anthropometric characteristics	Weight percentile	Adequate weight for age (Percentile 3-97)	26	86.7	3	100.0	24	85.7	4	100.0	27	87.1	2	100.0
		Not adequate for age [Percentile <3 (low weight	4	13.3	0	0.0	4	14.3	0	0.0	4	12.9	0	0.0

doi:10.20944/preprints202505.0306.v1

		for age) or Percentile >97 (high weight for age]											
Health characteristics	Vomit or refusal to eat*	Yes (had vomited or refused to eat)	11	16.7	1	25.0	10	16.9	1	10.0	11	17.2	1	16.7
		No	55	83.3	3	75.0	49	83.1	9	90.0	53	82.8	5	83.3
	Presence of infection or inflammation by C reactive protein (CRP) level	Yes (CRP>5.0mg/mL)	15	34.9	0	0.0	15	36.6	0	0.0	14	33.3	1	20.0
		No (CRP<5.0mg/mL)	28	65.1	3	100.0	26	63.4	6	100.0	28	66.7	4	80.0
	Glucose	Normal (60.0-180.0mg/dL)	18	100.0	-	-	16	100.0	2	100.0	15	100.0	3	100.0
	Bilirubin	Hyperbilirubinemia (Bilirubin>1.20mg/dL)	1	9.1	-	-	1	11.1	0	0.0	0	0.0	1	25.0
		Normal (0.30-1.20mg/dL)	10	90.9	-	-	8	88.9	2	100.0	7	100.0	3	75.0
	Urea	Uremia (Blood urea >36.0mg/dL)	5	14.3	0	0.0	3	9.4	2	50.0	5	15.6	0	0.0
		Normal (5.0-36.0mg/dL)	30	85.7	1	100.0	29	90.6	2	50.0	27	84.4	4	100.0
	Had any hospitalization (in the past)	Yes	23	35.4	0	0.0	20	34.5	3	30.0	18	28.6	5	83.3
		No	42	64.6	4	100.0	38	65.5	7	70.0	45	71.4	1	16.7
	Duration of hospitalization (in days)	Up to 5 days	6	46.2	-	-	7	58.3	0	0.0	6	60.0	1	33.3
		More than 5 days	7	53.8	-	-	5	41.7	1	100.0	4	40.0	2	66.7

Notes: (*) Children whose mothers reported a history of food selectivity behavior (e.g., children who eat "normally" at kindergarten or school but refuse to eat the same foods at home), refusal to eat certain types of food (such as meat), or vomiting after consuming certain types of food (e.g., due to irritability or irritated behavior, abdominal pain, or an unspecified reason).

doi:10.20944/preprints202505.0306.v1

 doi:10.20944/preprints202505.0306.v1

3. Discussion

This study characterized the profile of children aged 6 months to 5 years who attended the Dona Estefânia Hospital (HDE) in Lisbon, Portugal, and were diagnosed with or at risk of anemia. Our research focused on a specific subgroup of the pediatric population presenting a particular condition within a specialized sector of the hospital unit. We also observed that a significant portion of the anemic children had a background from the Community of Portuguese Language Countries (CPLP), reflecting the multicultural composition of the hospital's catchment area. Our findings are especially relevant in providing recent evidence on childhood anemia within this specific context in Portugal. Consequently, they cannot be fully generalized to the general pediatric Portuguese population, and some comparisons presented with population-based studies should be interpreted with caution.

Our results showed that the overall prevalence of anemia among children in this age group was 33.3%, indicating that anemia poses a moderate public health issue [48,49]. This prevalence is higher than the national estimates for under-five anemia in Portuguese children (14.3%), the European region (20.3%), and Central and Eastern Europe (22.0%) [38,41]. This prevalence was also slightly higher than those reported by other authors in various regions of Brazil (23.1%) [50] and in Timor-Leste (31.3%) [51]. However, anemia rates were lower than those found in the Community of Portuguese Language Countries (CPLP), namely, in Brazil (38.1% - 56.6%) [52–54], in Angola (44.4%) [55], in Cape Verde (51.8%) [56], in São Tomé and Príncipe (83.0%) [57], in Equatorial Guinea (85.0%) [58], and in Mozambique (62.2% - 83.0%) [59–61]. Our findings are also slightly higher than those reported for the Portuguese adult population residing in mainland Portugal (19.9%) [42].

We observed that rates of moderate (MO) and mild (MI) anemia were 54.5% and 34.8%, respectively, higher than the national estimates for Central and Eastern Europe (6.0% for moderate and 16.0% for mild anemia) [38]. These rates were also higher than those reported in studies conducted in Northwest Ethiopia (MO: 42.3% and MI: 23.7%) [62], in Western Peru (MO: 32.7% and MI: 10.9%) [63], in Southwest Ethiopia (MO: 15.8% and MI: 25.0%) [64], in Tanzania (MO: 44.8% and MI: 9.1%) [65]. Microcytic anemia rates were high (91.4%), with 74.0% of children having an iron deficiency (ID), 40.0% having iron deficiency anemia (IDA), and 33.3% having the sickle cell trait (SCT). The rates of iron deficiency and iron deficiency anemia observed in our study are higher than those reported in a previous study [47] conducted in the Cascais Municipality of the Metropolitan Lisbon Area among children aged 6 to 24 months (15.8% and 5.0%, respectively). We found higher rates of ID and IDA than those reported in Brazil (ID: 35.8%) [66], in Thessaloniki-Northern Greece (ID: 14.0% and IDA: 2.9%) [67], in Almería-Spain (ID: 8.7% and IDA: 2.0%) [68], in Thessalia- Central Greece (IDA: 7.9%) [69] and in Western Europe (ID:11.8%) [70].

The high rates of anemia reported in our study should be interpreted in the light of its unique sociodemographic characteristics. As such, these rates might be partly explained by the considerable portion of children who have a background from the Community of Portuguese Language Countries (CPLP) and African regions, where anemia and hemoglobinopathies are more prevalent [71]. Additionally, as stated in previous studies, these variations in anemia prevalence might also be attributed to a combination of geographical disparities (e.g. differences in climate), cultural factors (e.g. food practices), nutritional factors (e.g. dietary habits and food intake), genetic factors (e.g. inherited blood disorders), and socioeconomic context (e.g. caregivers' education level and access to health facilities) [17,44,70,72,73].

Sociodemographic patterns in childhood anemia

Our results indicate that anemia rates were higher in male children, aged 2-3 years, and among those with caregivers who had a basic or secondary level of education. Consistent with our findings, several studies [17,74–76] have demonstrated that boys are generally more susceptible to anemia than their peers. This may be attributed to increased prenatal and post-natal growth in males, which elevates their micronutrient needs, often not fulfilled through diet alone [74,76].

 doi:10.20944/preprints202505.0306.v1

Our results align with previous studies in Brazil [66] and India (Raju et al., 2024). Nevertheless, our findings differ from studies conducted in northern Tanzania [77], Ethiopia [78] and Eastern Burkina Faso [2], which reported higher anemia rates among children aged 6-23 months compared to their peers. This discrepancy may be explained by differences in disease burden, cultural and dietary practices, and maternal nutrition between Portugal and these countries [17,37,42,70,72,73].

Similar to previous studies [77,79,80], higher anemia rates were observed among children whose caregivers had a lower level of education. Our study also showed higher rates of anemia among children whose mothers are from the Community of Portuguese Language Countries (CPLP) and fathers of non-Portuguese origins. Few studies [44] were conducted to analyze anemia in Portugal and other CPLP countries, showing that anemia plays a relevant role in disability and life imbalances in pregnant women and children under five years of age in Mozambique compared with Portugal. In addition, some authors [81] argue that, in past years, sickle cell trait disease in Portugal has been aggravated by immigrants from Angola and São Tomé and Príncipe. Other authors [82] state that immigrant mothers often may carry pre-existing conditions common in their countries of origin (e.g., anemia and hemoglobinopathies) that are less frequent in host countries like Portugal, and these women often request and receive less health care during and after pregnancy. A recent study [71] conducted in the municipalities of Amadora and Sintra, in the Lisbon Metropolitan Area, also reported high rates of anemia (30.1%; 65/216) and iron deficiency anemia (27.7%; 18/65) among migrant children and adolescents (aged between 1 and 16 years). The same study [71] emphasized the need to include systematic screening for sickle cell disease among the migrant population from African countries, where haemoglobinopathies are common, due to the importance of the disease in the Portuguese population. Broader socioeconomic strategies [83], nutrition education for caregivers [78], and strengthening the training and education of healthcare providers in the area of multiculturalism [82] could be crucial for mitigating childhood anemia in this setting. Nationwide strategies for the prevention and management of anemia in Portugal, which integrate nutrition education, particularly for pregnant women and caregivers of young children [42,43] may play a vital role in the prevention of childhood anemia. More research on socioeconomic disparities and childhood anemia is needed to better guide future strategies for mitigating this condition in this setting.

Nutritional patterns and health-related characteristics in childhood anemia

In this study, we observed that exclusive breastfeeding and complementary feeding rates were high among children with anemia. Meal frequency (consumption of five or more food groups per day) and adequate dietary diversity (consumption of four or more food groups) were also higher in children with anemia. These results contrast with several studies [80,84,85]. An explanation for this discrepancy may be linked to the nutritional quality of children's diets, particularly a low intake of key micronutrients such as iron, folate, and vitamin A, or the limited bioavailability of iron due to poor absorption [84].

Our findings show that some children with anemia also exhibit uremia. As noted by several authors [80,86], comorbidities (such as metabolic dysfunctions and infections) may play a crucial role in childhood anemia. On the other hand, anemia-related impairment may worsen the management of children with coexisting comorbidities, negatively impacting their quality of life [87]. Thus, more research (e.g., analytical cross-sectional or longitudinal studies) is needed to assess not only feeding practices and dietary habits in this age group but also the cultural, socioeconomic, and metabolic factors that might influence childhood anemia in this setting.

4. Materials and Methods

Study setting

Portugal, officially the Portuguese Republic, is the westernmost country of mainland Europe, located in the Iberian Peninsula and occupying a total area of 92,211.9 km2 [88,89]. It is bordered to the north and east by Spain, and its western and southern coastline is surrounded by the Atlantic

 doi:10.20944/preprints202505.0306.v1

Ocean. Portugal's territory also includes two autonomous regions, the archipelagos of the Azores and Madeira, located in the Atlantic Ocean [88–90]. Portugal has the 12th-largest population in the European Union, with 10.6 million inhabitants [88,90]. Lisbon is the capital of Portugal, the largest Portuguese municipality (with over 550,000 inhabitants), and, along with 17 other municipalities, forms the Lisbon Metropolitan Area (which has around 3 million inhabitants) [90]. This study was conducted at the External Consultations of the Pediatrics Medical Service of Dona Estefânia Hospital (HDE)—Unidade Local de Saúde de São José (ULS São José) in Lisbon. Dona Estefânia Hospital is a reference unit in pediatrics for Southern Portugal and the archipelagos of the Azores and Madeira. It specializes in maternal and child health care [91]. The external consultations are conducted in a building with two sections: one dedicated to medical specialties and the other to surgical specialties. Within the medical specialties, consultations are offered in nine areas: general pediatrics, pulmonology, cystic fibrosis, sleep pathology, infectious diseases, travel medicine, rheumatology, nephrology, and chronic renal failure [92]. In addition, other specialized consultations are included, such as the Acute Patient Reassessment Consultation (CORDA), adolescent pediatrics, cooperation, palliative care, the Pre-Immunosuppressive Treatment Infectious Screening Consultation (CRIIPTO), and the Pediatric Risk Support Consultation (CARPE), as well as the Acute Diseases Consultation. In 2024, Dona Estefânia Hospital recorded a total of 59,870 pediatric medical consultations across all medical specialties. Of these, 4,169 were general pediatrics consultations, with 1,046 corresponding to first consultations and 2,420 to subsequent consultations (follow-up appointments), covering a total of 2,301 patients [92].

Study design, population, and sample universe

This hospital-based, cross-sectional descriptive study was conducted from September 2023 to September 2024. The sample universe was the External General Pediatrics Consultation section (area) of the Dona Estefânia Hospital. All children aged 6 months to 5 years old who attended the external general pediatric consultations during the study period were included (census-based approach).

Inclusion and Exclusion Criteria

The inclusion criteria were children aged between 6 months and 5 years, diagnosed with or at risk of anemia, who attended the External General Pediatrics Consultation section (area) at Dona Estefânia Hospital. This included: children referred from the emergency department for evaluation or follow-up by a pediatrician; children referred by family doctors from Health Centers; and children evacuated from Portuguese-speaking African countries due to various pathologies.

The exclusion criteria were children younger than 6 months, children aged 6 years or older, and children without available hemoglobin or hematocrit measurements. Also excluded were children followed in hematology or other specialized consultations.

Data collection and quality control

The total number of children aged 6 months to 5 years, both with and without anemia, who attended external pediatric consultations during the study period was obtained from daily consultation records. Children diagnosed with anemia or those identified as at risk were selected during each consultation. The study was then explained to the children's caregivers, and their written informed consent was obtained. A pretested questionnaire, consisting of three sections on sociodemographic characteristics, feeding habits, and health status, was used to collect information. Clinical data were obtained from electronic medical records and children's health cards. Investigators carefully monitored data collection. To ensure data quality, double data entry verification was conducted, and the information from paper-based forms and electronic questionnaires was compared. Data cleaning was performed to verify frequencies, consistency, and missing values, and any errors identified were corrected.

Outcome variable

The outcome variable for this study was the presence of anemia or the risk of developing anemia in children aged 6 months to 5 years. In the context of this study, anemia and the risk of developing anemia were defined as 11.0 g/dL ≤ Hb ≤ 11.4 g/dL. We used the following hemoglobin (Hb) cut-off

 doi:10.20944/preprints202505.0306.v1

values to classify anemia in children aged 6 months to 5 years: not anemic (Hb > 11.4 g/dL), borderline or pre-anemic stage (11.0 g/dL ≤ Hb ≤ 11.4 g/dL), mild (10.0 g/dL ≤ Hb ≤ 10.9 g/dL), moderate (7.0 g/dL ≤ Hb ≤ 9.9 g/dL), and severe (Hb < 7.0 g/dL) anemia [6,12,23,24]. Other anemia definitions used in this study were: anemia based on hematocrit levels [not anemic (hematocrit = 34.0%-40.0%) and anemic (hematocrit<33.0%)] and red blood cell size, measured by the mean corpuscular volume (MCV) [microcytic (<80 fL), normocytic (80-100 fL) and macrocytic (>100fL)] [29,93]. More details on definitions of anemia and the outcome variable can be found in the Supplementary file Table 3.

Exposure variables

In this study, exposure variables included sociodemographic characteristics (sex, age, residence area, caregiver's degree of kinship, caregiver's education level, country of origin, and parental occupation) and nutritional characteristics (history of breastfeeding, complementary feeding, cereal porridge intake, number of meals/day, intake of various food groups: cereals and derivatives, tubers, meat, fish and eggs, dairy products, fruits, legumes, vegetables, fats, and oils). Minimum dietary diversity was classified as "adequate" if children consumed four or more food groups, and "inadequate" if children consumed less than four food groups. Other exposure variables included anthropometric characteristics (weight percentiles) and health characteristics (vomiting or refusal to eat, presence of infections or inflammatory conditions, glucose and bilirubin levels, uremia, hospitalization, and duration of hospitalization). More details on exposure variables can be found in Supplementary file Table 3.

Data analysis

Data were analyzed using SPSS 28.0 software (International Business Machine Corporation [IBM Corp]) [95]. Descriptive statistics, including frequency distributions and cross-tabulations, were performed to summarize the characteristics of study participants and key variables.

5. Conclusions

This study describes anemia among children aged 6 months to 5 years attending external general pediatric consultations in Portugal. Our findings indicate that childhood anemia poses a moderate public health issue in this setting. Anemia rates were higher among male children, those aged 2-3 years, those whose caregivers had a low level of education, and those whose mothers were from the Community of Portuguese Language Countries (CPLP). Further research, including analytical cross-sectional or longitudinal studies, is necessary to better understand the role of feeding practices, dietary habits, nutritional adequacy, and other potential influencing determinants, such as cultural, socioeconomic, and metabolic factors, in childhood anemia in this setting.

6. Strengths and Limitations

To our knowledge, this is the first hospital-based study in Lisbon to characterize children aged 6 months to 5 years who are diagnosed with or at risk of anemia. Given the limited existing research on this issue in Portugal, our study can serve as a baseline for future research (whether analytical cross-sectional or longitudinal) focused on the role of feeding practices, dietary habits, nutritional adequacy, and other potential influencing determinants, such as cultural, socioeconomic, and metabolic aspects, on childhood anemia in Portugal. In addition, by providing valuable evidence, our study establishes a foundation for improving the prevention, management, and care of anemia in children living in Portugal.

However, there are some limitations to our study. First, due to constraints from the COVID-19 pandemic, which placed significant pressure on the National Health Service (SNS) and pediatric care in Portugal, the data collection process was impacted. Consequently, this study adopted a purely descriptive design. Our one-year study focused on characterizing the profiles of children diagnosed with or at risk of anemia and did not include children without anemia, limiting the analysis of relationships or associations between various determinants and childhood anemia. Second, our sample universe was not randomly selected, as it consisted of all children aged 6 months to 5 years

 doi:10.20944/preprints202505.0306.v1

old who attended the external general pediatric consultations section of Dona Estefânia Hospital and were chosen based on availability during the study period. As such, our findings should not be generalized to all pediatric consultations or patient profiles at the hospital. Third, the sociodemographic composition of our sample, which includes a substantial proportion of anemic children with backgrounds from the Community of Portuguese Language Countries (CPLP), may contribute to the high rates of anemia observed in this study and further limit the generalizability of our findings to the broader Portuguese pediatric population. Therefore, more comprehensive studies are needed to explore anemia associations with various determinants, provide more generalizable results, and enhance our understanding of the factors influencing anemia in children in Portugal.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org, Supplementary Table 1. Reasons for consultations, Supplementary Table 2. Reasons for Consultation Among Children With a History of Food Selectivity, Refusal to Eat, or Vomiting After Eating, Supplementary Table 3. Study variables.

Author Contributions: Conceptualization: R.M.C., L.V., and I.C.; methodology: R.M.C., L.V., and I.C.; data collection: R.M.C., A.C., B.M.S., J.V., B.L.V., A.S., M.C., and F.B.C.; coordination of data collection on site: R.M.C.; software: R.M.C.; formal analysis: R.M.C., S.C. and Y.K.; investigation: R.M.C.; resources: R.M.C., L.V., and I.C.; data curation: R.M.C., and S.C.; writing—original draft preparation: R.M.C; writing—review and editing: R.M.C., A.C., Y.K., S.C., B.M.S., J.V., B.L.V., A.S., M.C., F.B.C., L.V. and I.C.; visualization: R.M.C.; supervision: L.V and I.C. All authors have read and agreed to the published version of the manuscript.

Funding: R.M.C., L.V., and I.C. were supported by Fundação para a Ciência e a Tecnologia for funds to GHTM - UID/04413/2020 and LA-REAL – LA/P/0117/2020. R.M.C was supported by Fundação para a Ciência e a Tecnologia for funds for her Doctoral Program (Reference UI/BD/151065/2021; DOI: https://doi.org/10.54499/UI/BD/151065/2021). The views expressed in this paper are from the authors and not the official position of the institutions or funder.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee for Health of the Central Lisbon University Hospital Center (CES-CHULC) (CES 947/2020, first approval on 19th November 2020; with the second approval extension on 3rd April 2024). This research is also described as a sub-study - that integrates the study protocol on the same topic (PAMC, Ref. Of 0110/CC/2020) approved by the Institutional Committee of Bioethics in Health of the Faculty of Medicine/Maputo Central Hospital (CIBS FM&HCM; HCM/004/2020, first approval on 30th March 2020, with the fourth approval extension granted on 29th February 2024).

Informed Consent Statement: Informed consent was obtained from all parents or legal guardians of the subjects involved in this study.

Data Availability Statement: Data from this study are not publicly available due to patients' privacy and ethical restrictions. However, the data presented in this study are available in this article and its supplementary information files.

Acknowledgments: We sincerely thank the children's caregivers for agreeing to participate in this study. We also thank the doctors and pediatric residents of Dona Estefânia Hospital for their support in data collection: Ana Isabel Carvalho, António Campos, Caroline Lopes, Conceição Neves, Diana Amaral, João Simões, Margarida Almendra, Mafalda Borges, Rita Machado, and Sara Ferreira. We further thank the operational assistants and "Ludoteca" personnel of Dona Estefânia Hospital: Andreia Filipa, Cátia Dias, Fernanda Pires Paulo, Claudia, Rute Gomes, Maria dos Anjos Santos, Sara Fernanda Paiva, Susana Mendes, Isabel Fernandes, and Tomé André. The first author would like to express gratitude to Francisco Merca, Ana Varão, Alexandre Azeredo, Duarte Santos, Eduardo Pedro, Diogo Gonçalves, Rui Ribeiro, Salima Rehemtula and André Gonçalves. Special thanks to Michel Jareski Andrade for his valuable support in formatting the manuscript.

 doi:10.20944/preprints202505.0306.v1

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

AIDS	Acquired immunodeficiency syndrome
CPLP	Community of Portuguese Language Countries
ID	Iron deficiency
IDA	Iron deficiency anemia
Hb	Hemoglobin
HIV	Human immunodeficiency virus
HDE	Dona Estefânia Hospital
MI	Mild anemia
MCV	Mean corpuscular volume
MO	Moderate anemia
RCBs	Red blood cells
UI	Uncertainty interval
ULS	Unidade Local de Saúde

References

1. Gallagher P. G. (2022). Anemia in the pediatric patient. *Blood*, *140*(6), 571–593. https://doi.org/10.1182/blood.2020006479
2. Ouédraogo, O., Rakièta Compaoré, E. W., Ouédraogo, O., Kiburente, M., & Dicko, M. H. (2024). Prevalence and Associated Factors of Anemia in Children Aged 6 to 59 Months in the Eastern Region of Burkina Faso. *Global Pediatric Health*, *11*, 2333794X241263163. https://doi.org/10.1177/2333794X241263163
3. World Health Organization. (2023). *Anaemia*. World Health Organization. Retrieved January 30, 2025, from https://www.who.int/news-room/fact-sheets/detail/anaemia
4. Matysiak, M. (2021). Anemia in children: A pediatrician's view. *Acta Haematologica Polonica, 52*(4), 402–405. https://doi.org/10.5603/AHP.2021.0075
5. Lopes, A. I., Azevedo, S., Cabral, J., Ferreira, M. G., Sande-Lemos, P., Ferreira, R., Trindade, E., Lima, R., & Antunes, H. (2020). Portuguese Consensus on Diagnosis, Treatment, and Management of Anemia in Pediatric Inflammatory Bowel Disease. *GE Portuguese journal of gastroenterology*, *27*(4), 244–254. https://doi.org/10.1159/000505071
6. Gelaw, Y., Getaneh, Z., & Melku, M. (2021). Anemia as a risk factor for tuberculosis: a systematic review and meta-analysis. *Environmental health and preventive medicine*, *26*(1), 13. https://doi.org/10.1186/s12199-020-00931-z
7. Ohene-Agyei P, Ndoadoumgue AL, Bana-Ewai E, Yaya I, Nambiema A. Population attributable fractions for risk factors for childhood anaemia: Findings from the 2017 Togo Malaria Indicator Survey. *British Journal of Nutrition*. Published online 2025:1-27. doi:10.1017/S0007114524003313
8. Thompson, L., Arnold, C., Peerson, J., Long, J. M., Westcott, J. L. E., Islam, M. M., Black, R. E., Krebs, N. F., & McDonald, C. M. (2025). Predictors of Anaemia Among Young Children Receiving Daily Micronutrient Powders (MNPs) for 24 Weeks in Bangladesh: A Secondary Analysis of the Zinc in Powders Trial. *Maternal & child nutrition*, e13806. Advance online publication. https://doi.org/10.1111/mcn.13806
9. Braat, S., Fielding, K. L., Han, J., Jackson, V. E., Zaloumis, S., Xu, J. X. H., Moir-Meyer, G., Blaauwendraad, S. M., Jaddoe, V. W. V., Gaillard, R., Parkin, P. C., Borkhoff, C. M., Keown-Stoneman, C. D. G., Birken, C. S., Maguire, J. L., Genes & Health Research Team, Bahlo, M., Davidson, E. M., & Pasricha, S. R. (2024). Haemoglobin thresholds to define anaemia from age 6 months to 65 years: estimates from international data sources. *The Lancet. Haematology*, *11*(4), e253–e264. https://doi.org/10.1016/S2352-3026(24)00030-9
10. King, F. S., Burgess, A., Quinn, V. J., & Osei, A. J. (2015). *Nutrition for developing countries* (3rd ed.). Oxford University Press.

 doi:10.20944/preprints202505.0306.v1

11. Qiu, Y., Long, Z., & Long, Z. (2025). Epidemiology of dietary iron deficiency in China from 1990 to 2021: findings from the global burden of disease study 2021. *BMC public health*, *25*(1), 596. https://doi.org/10.1186/s12889-025-21665-z
12. Chaparro, C. M., & Suchdev, P. S. (2019). Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. *Annals of the New York Academy of Sciences*, *1450*(1), 15–31. https://doi.org/10.1111/nyas.14092
13. Brittenham, G. M., Moir-Meyer, G., Abuga, K. M., Datta-Mitra, A., Cerami, C., Green, R., Pasricha, S. R., & Atkinson, S. H. (2023). Biology of Anemia: A Public Health Perspective. *The Journal of nutrition*, *153 Suppl 1*, S7–S28. https://doi.org/10.1016/j.tjnut.2023.07.018
14. USAID Advancing Nutrition. (2022). *Understanding anemia and its coexisting factors: A brief*. USAID. Retrieved April 2, 2025, from https://www.advancingnutrition.org/sites/default/files/2022-10/usaid-an-anemia-coexisting-brief-2022.pdf
15. Martins, R. R., Paixão, F., Mendes, I., Schäfer, S., Monge, I., Costa, F., & Correia, P. (2024). Intestinal Parasitic Infections in Children: A 10-Year Retrospective Study. *Cureus*, *16*(12), e75862. https://doi.org/10.7759/cureus.75862
16. Shimanda, P. P., Amukugo, H. J., & Norström, F. (2020). Socioeconomic factors associated with anemia among children aged 6-59 months in Namibia. *Journal of public health in Africa*, *11*(1), 1131. https://doi.org/10.4081/jphia.2020.1131
17. Melku, M., Alene, K. A., Terefe, B., Enawgaw, B., Biadgo, B., Abebe, M., Muchie, K. F., Kebede, A., Melak, T., & Melku, T. (2018). Anemia severity among children aged 6-59 months in Gondar town, Ethiopia: a community-based cross-sectional study. *Italian journal of pediatrics*, *44*(1), 107. https://doi.org/10.1186/s13052-018-0547-0
18. Yang, F., Liu, X., & Zha, P. (2018). Trends in Socioeconomic Inequalities and Prevalence of Anemia Among Children and Nonpregnant Women in Low- and Middle-Income Countries. *JAMA network open*, *1*(5), e182899. https://doi.org/10.1001/jamanetworkopen.2018.2899
19. Osborne, A., Adeleye, K., Bangura, C., & Wongnaah, F. G. (2024). Trends and inequalities in anaemia prevalence among children aged 6-59 months in Ghana, 2003-2022. *International journal for equity in health*, *23*(1), 231. https://doi.org/10.1186/s12939-024-02315-z
20. Zhao, B., Sun, M., Wu, T., Li, J., Shi, H., & Wei, Y. (2024). The association between maternal anemia and neonatal anemia: a systematic review and meta-analysis. *BMC pregnancy and childbirth*, *24*(1), 677. https://doi.org/10.1186/s12884-024-06832-1
21. Chandran, V., & Kirby, R. S. (2021). An Analysis of Maternal, Social and Household Factors Associated with Childhood Anemia. *International journal of environmental research and public health*, *18*(6), 3105. https://doi.org/10.3390/ijerph18063105
22. Sowe, A., Wood, E., & Gautam, S. K. (2025). Maternal Anemia as a Predictor of Childhood Anemia: Evidence from Gambian Health Data. *Nutrients*, *17*(5), 879. https://doi.org/10.3390/nu17050879
23. World Health Organization. (2011). *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity*. World Health Organization. Retrieved April 2, 2025, from https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1
24. Williams, A. M., Ansai, N., Ahluwalia, N., & Nguyen, D. T. (2024). *Anemia prevalence: United States, August 2021–August 2023* (NCHS Data Brief No. 519). National Center for Health Statistics. Retrieved April 2, 2025, from https://www.cdc.gov/nchs/products/databriefs/db519.htm
25. Leung, A. K. C., Lam, J. M., Wong, A. H. C., Hon, K. L., & Li, X. (2024). Iron deficiency anemia: An updated review. *Current Pediatric Reviews, 20*(3), 339–356. https://doi.org/10.2174/1573396320666230727102042
26. Janus, J., & Moerschel, S. K. (2010). Evaluation of anemia in children. *American family physician*, *81*(12), 1462–1471.
27. Ngnie-Teta, I., Receveur, O., & Kuate-Defo, B. (2007). Risk factors for moderate to severe anemia among children in Benin and Mali: Insights from a multilevel analysis. *Food and Nutrition Bulletin, 28*(1), 109–118. https://doi.org/10.1177/156482650702800109

 doi:10.20944/preprints202505.0306.v1

28. Benedict, R. K., Pullum, T. W., Riese, S., & Milner, E. (2024). Is child anemia associated with early childhood development? A cross-sectional analysis of nine Demographic and Health Surveys. *PloS one*, *19*(2), e0298967. https://doi.org/10.1371/journal.pone.0298967
29. Maner, B. S., Killeen, R. B., & Moosavi, L. (2024). Mean corpuscular volume. In *StatPearls* [Internet]. StatPearls Publishing. Retrieved April 5, 2025, from https://www.ncbi.nlm.nih.gov/books/NBK545275/
30. Turner, J., Parsi, M., & Badireddy, M. (2023). Anemia. In *StatPearls* [Internet]. StatPearls Publishing. Retrieved April 5, 2025, from https://www.ncbi.nlm.nih.gov/books/NBK499994/
31. Yeboah, F. A., Bioh, J., Amoani, B., Effah, A., Senu, E., Mensah, O. S. O., Agyei, A., Kwarteng, S., Agomuo, S. K. S., Opoku, S., Agordzo, S. K., Aidoo, E. K., & Sakyi, S. A. (2024). Iron deficiency anemia and its association with cognitive function among adolescents in the Ashanti Region - Ghana. *BMC public health*, *24*(1), 3209. https://doi.org/10.1186/s12889-024-20640-4
32. Irwin, J. J., & Kirchner, J. T. (2001). Anemia in children. *American family physician*, *64*(8), 1379–1386.
33. Chaudhry, H. S., & Kasarla, M. R. (2025). Microcytic hypochromic anemia. In *StatPearls*. StatPearls Publishing. Retrieved April 29, 2025, from https://www.ncbi.nlm.nih.gov/books/NBK470252/
34. Sarbay, H., & Ay, Y. (2018). Evaluation of children with macrocytosis: clinical study. *The Pan African medical journal*, *31*, 54. https://doi.org/10.11604/pamj.2018.31.54.15498
35. Yilmaz, G., & Shaikh, H. (2023). Normochromic normocytic anemia. In *StatPearls*. StatPearls Publishing. Retrieved April 29, 2025, from https://www.ncbi.nlm.nih.gov/books/NBK565880/
36. Moore, C. A., Killeen, R. B., & Adil, A. (2025). Macrocytic anemia. In *StatPearls*. StatPearls Publishing. Retrieved April 29, 2025, from https://www.ncbi.nlm.nih.gov/books/NBK459295/
37. GBD 2021 Anaemia Collaborators. (2023). Prevalence, years lived with disability, and trends in anaemia burden by severity and cause, 1990–2021: Findings from the Global Burden of Disease Study 2021. *The Lancet Haematology*, 10(9), e713–e734. https://doi.org/10.1016/S2352-3026(23)00160-6
38. Stevens, G. A., Paciorek, C. J., Flores-Urrutia, M. C., Borghi, E., Namaste, S., Wirth, J. P., Suchdev, P. S., Ezzati, M., Rohner, F., Flaxman, S. R., & Rogers, L. M. (2022). National, regional, and global estimates of anaemia by severity in women and children for 2000–19: A pooled analysis of population-representative data. *The Lancet Global Health*, 10(5), e627–e639. https://doi.org/10.1016/S2214-109X(22)00084-5
39. World Health Organization. (2015). *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity*. WHO/NMH/NHD/MNM/11.1. Retrieved March 12, 2025, from https://iris.who.int/bitstream/handle/10665/177094/9789241564960_eng.pdf
40. Robalo Nunes, A., Mairos, J., Brilhante, D., Marques, F., Belo, A., Cortez, J., & Fonseca, C. (2020). Screening for Anemia and Iron Deficiency in the Adult Portuguese Population. *Anemia*, *2020*, 1048283. https://doi.org/10.1155/2020/1048283
41. World Health Organization. (2022). Global Health Observatory Data Repository: By Category, Child Malnutrition, Anaemia in children <under 5 years - Estimates by country. World Health Organization. Retrieved February 17, 2025, from https://apps.who.int/gho/data/view.main.ANEMIACHILDRENv?lang=en
42. Fonseca, C., Marques, F., Robalo Nunes, A., Belo, A., Brilhante, D., & Cortez, J. (2016). Prevalence of anaemia and iron deficiency in Portugal: the EMPIRE study. *Internal medicine journal*, *46*(4), 470–478. https://doi.org/10.1111/imj.13020
43. Marques, F., Fonseca, C., Robalo Nunes, A., Belo, A., Brilhante, D., & Cortez, J. (2016). Contextualising the High Prevalence of Anaemia in the Portuguese Population: Perception, Characterisation and Predictors: an EMPIRE Sub-Study. *Internal Medicine*, *23*(4), 26–38. https://doi.org/10.24950/rspmi.838
44. Maulide Cane, R., Chidassicua, J. B., Varandas, L., & Craveiro, I. (2022). Anemia in Pregnant Women and Children Aged 6 to 59 Months Living in Mozambique and Portugal: An Overview of Systematic Reviews. *International journal of environmental research and public health*, *19*(8), 4685. https://doi.org/10.3390/ijerph19084685
45. Palaré, M.J., Ferrão, A., Carreira, M., & Morais, A. (2004). Défice de ferro na criança. Acta Pediátrica Portuguesa, 3 (35), 243-247.
46. Antunes, H., Gonçalves, S., Teixeira-Pinto, A., Costa-Pereira, A., Tojo-Sierra, R., & Aguiar, Á. (2005). Anemia por deficiência de ferro no lactente: Resultados preliminares do desenvolvimento aos cinco anos.

 doi:10.20944/preprints202505.0306.v1

Acta Médica Portuguesa, 18(4), 261–266. Retrieved March 10, 2025, from https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/1034/702

47. Virella, D., & Pina, M. J. (1998). Prevalence of iron deficiency in early infancy. *Acta Médica Portuguesa*, *11*(7), 607–13. https://doi.org/10.20344/amp.2310
48. World Health Organization. (2024). *Haemoglobin cutoffs to define anaemia in individuals and populations*. Guideline Central. Retrieved March 20, 2025, from https://www.guidelinecentral.com/guideline/3534081/#section-3534102
49. World Health Organization. (2023). Nutrition landscape information system (Nlis). Anaemia. Nutrition and nutrition-related health and development data. Geneva, Switzerland: WHO. Retrieved March 20, 2025, from https:// www.who.int/data/nutrition/nlis/info/anaemia
50. da Silva, L. L. S., Fawzi, W. W., Cardoso, M. A., & ENFAC Working Group (2018). Factors associated with anemia in young children in Brazil. *PloS one*, *13*(9), e0204504. https://doi.org/10.1371/journal.pone.0204504
51. Agho, K. E., Dibley, M. J., D'Este, C., & Gibberd, R. (2008). Factors associated with haemoglobin concentration among Timor-Leste children aged 6-59 months. *Journal of health, population, and nutrition*, *26*(2), 200–209.
52. Ferreira, H. S., Vieira, R. C. S., Livramento, A. R. S., Dourado, B. L. L., Silva, G. F., & Calheiros, M. S. C. (2021). Prevalence of anaemia in Brazilian children in different epidemiological scenarios: an updated meta-analysis. *Public health nutrition*, *24*(8), 2171–2184. https://doi.org/10.1017/S1368980019005287
53. Dos Santos, R. F., Gonzalez, E. S., de Albuquerque, E. C., de Arruda, I. K., Diniz, A.daS., Figueroa, J. N., & Pereira, A. P. (2011). Prevalence of anemia in under five-year-old children in a children's hospital in Recife, Brazil. *Revista brasileira de hematologia e hemoterapia*, *33*(2), 100–104. https://doi.org/10.5581/1516-8484.20110028
54. Oliveira, C. S. M., Cardoso, M. A., Araújo, T. S., & Muniz, P. T. (2011). *Anemia em crianças de 6 a 59 meses e fatores associados no Município de Jordão, Estado do Acre, Brasil*. *Cadernos de Saúde Pública*, 27(5), 1008–1020. Retrieved March 25, 2025, from https://repositorio.usp.br/item/002344964
55. Fançony, C., Lavinha, J., Brito, M., & Barros, H. (2020). Anemia in preschool children from Angola: a review of the evidence. *Porto biomedical journal*, *5*(1), e60. https://doi.org/10.1097/j.pbj.0000000000000060
56. Semedo, R. M., Santos, M. M., Baião, M. R., Luiz, R. R., & da Veiga, G. V. (2014). Prevalence of anaemia and associated factors among children below five years of age in Cape Verde, West Africa. *Journal of health, population, and nutrition*, *32*(4), 646–657.
57. Castro Silva, C., & Catarino, E. (2023). Malnutrition and anemia in children aged 6 to 59 months in the Autonomous Region of Príncipe and its relation to maternal health. *Population Medicine*, 5(Supplement), A1199. https://doi.org/10.18332/popmed/164213
58. Ncogo, P., Romay-Barja, M., Benito, A., Aparicio, P., Nseng, G., Berzosa, P., Santana-Morales, M. A., Riloha, M., Valladares, B., & Herrador, Z. (2017). Prevalence of anemia and associated factors in children living in urban and rural settings from Bata District, Equatorial Guinea, 2013. *PloS one*, *12*(5), e0176613. https://doi.org/10.1371/journal.pone.0176613
59. Aly, M. M., Berti, C., Chemane, F., Macuelo, C., Marroda, K. R., La Vecchia, A., Agostoni, C., & Baglioni, M. (2025). Prevalence of anemia among children aged 6-59 months in the Ntele camp for internally displaced persons (Cabo Delgado, Mozambique): a preliminary study. *European journal of clinical nutrition*, *79*(1), 79–82. https://doi.org/10.1038/s41430-024-01516-7
60. Maulide Cane, R., Keita, Y., Lambo, L., Pambo, E., Gonçalves, M. P., Varandas, L., & Craveiro, I. (2023). Prevalence and factors related to anaemia in children aged 6-59 months attending a quaternary health facility in Maputo, Mozambique. *Global public health*, *18*(1), 2278876. https://doi.org/10.1080/17441692.2023.2278876
61. Muhajarine, N., Adeyinka, D. A., Matandalasse, M., & Chicumbe, S. (2021). Inequities in childhood anaemia at provincial borders in Mozambique: Cross-sectional study results from multilevel Bayesian analysis of 2018 National Malaria Indicator Survey. *BMJ Open*, 11(12), e051395. https://doi.org/10.1136/bmjopen-2021-051395

 doi:10.20944/preprints202505.0306.v1

62. Hailu B. A. (2023). Mapping, trends, and factors associated with anemia among children aged under 5 y in East Africa. *Nutrition (Burbank, Los Angeles County, Calif.)*, *116*, 112202. https://doi.org/10.1016/j.nut.2023.112202
63. Arce-Huamani, M. Á., & Aliaga-Gastelumendi, R. A. (2023). Calidad de atención y satisfacción del usuario en un Servicio de Emergencia de un Hospital del Seguro Social. *Acta Médica Peruana*, 40(4), 308–313.
64. Kebede, D., Getaneh, F., Endalamaw, K., Belay, T., & Fenta, A. (2021). Prevalence of anemia and its associated factors among under-five age children in Shanan gibe hospital, Southwest Ethiopia. *BMC pediatrics*, *21*(1), 542. https://doi.org/10.1186/s12887-021-03011-5
65. Mghanga, F. P., Genge, C. M., Yeyeye, L., Twalib, Z., Kibopile, W., Rutalemba, F. J., & Shengena, T. M. (2017). Magnitude, Severity, and Morphological Types of Anemia in Hospitalized Children Under the Age of Five in Southern Tanzania. *Cureus*, *9*(7), e1499. https://doi.org/10.7759/cureus.1499
66. Ferraz, I. S., Daneluzzi, J. C., Vannucchi, H., Jordão, A. A., Jr, Ricco, R. G., Del Ciampo, L. A., Martinelli, C. E., Jr, Engelberg, A. A., Bonilha, L. R., & Custódio, V. I. (2005). Prevalência da carência de ferro e sua associação com a deficiência de vitamina A em pré-escolares [Prevalence of iron deficiency and its association with vitamin A deficiency in preschool children]. *Jornal de Pediatria*, 81(2), 169–174.
67. Gompakis, N., Economou, M., Tsantali, C., Kouloulias, V., Keramida, M., & Athanasiou-Metaxa, M. (2007). The effect of dietary habits and socioeconomic status on the prevalence of iron deficiency in children of northern Greece. *Acta haematologica*, *117*(4), 200–204. https://doi.org/10.1159/000098273
68. López-Ruzafa, E., Vázquez-López, M. A., Galera-Martínez, R., Lendínez-Molinos, F., Gómez-Bueno, S., & Martín-González, M. (2021). Prevalence and associated factors of iron deficiency in Spanish children aged 1 to 11 years. *European journal of pediatrics*, *180*(9), 2773–2780. https://doi.org/10.1007/s00431-021-04037-8
69. Tympa-Psirropoulou, E., Vagenas, C., Dafni, O., Matala, A., & Skopouli, F. (2008). Environmental risk factors for iron deficiency anemia in children 12-24 months old in the area of Thessalia in Greece. *Hippokratia*, *12*(4), 240–250.
70. Akkermans, M. D., van der Horst-Graat, J. M., Eussen, S. R., van Goudoever, J. B., & Brus, F. (2016). Iron and Vitamin D Deficiency in Healthy Young Children in Western Europe Despite Current Nutritional Recommendations. *Journal of pediatric gastroenterology and nutrition*, *62*(4), 635–642. https://doi.org/10.1097/MPG.0000000000001015
71. Castello-Branco Ribeiro, L., Paixão, F., Costa, F., & Correia, P. (2024). Migrant Pathology Screening in the Pediatric Population: A Five-Year Retrospective Study From a Level II Hospital. *Cureus*, *16*(2), e53770. https://doi.org/10.7759/cureus.53770
72. van der Merwe, L. F., & Eussen, S. R. (2017). Iron status of young children in Europe. *The American journal of clinical nutrition*, *106*(Suppl 6), 1663S–1671S. https://doi.org/10.3945/ajcn.117.156018
73. Leal, L. P., Batista Filho, M., Lira, P. I., Figueiroa, J. N., & Osório, M. M. (2011). Prevalence of anemia and associated factors in children aged 6-59 months in Pernambuco, Northeastern Brazil. *Revista de saude publica*, *45*(3), 457–466. https://doi.org/10.1590/s0034-89102011000300003
74. Aheto, J. M. K., Alhassan, Y., Puplampu, A. E., Boglo, J. K., & Sedzro, K. M. (2023). Anemia prevalence and its predictors among children under-five years in Ghana. A multilevel analysis of the cross-sectional 2019 Ghana Malaria Indicator Survey. *Health science reports*, *6*(10), e1643. https://doi.org/10.1002/hsr2.1643
75. Belachew, A., & Tewabe, T. (2020). Under-five anemia and its associated factors with dietary diversity, food security, stunted, and deworming in Ethiopia: systematic review and meta-analysis. *Systematic reviews*, *9*(1), 31. https://doi.org/10.1186/s13643-020-01289-7
76. Tadesse, S. E., Zerga, A. A., Mekonnen, T. C., Tadesse, A. W., Hussien, F. M., Feleke, Y. W., Anagaw, M. Y., & Ayele, F. Y. (2022). Burden and Determinants of Anemia among Under-Five Children in Africa: Systematic Review and Meta-Analysis. *Anemia*, *2022*, 1382940. https://doi.org/10.1155/2022/1382940
77. Mboya, I. B., Mamseri, R., Leyaro, B. J., George, J., Msuya, S. E., & Mgongo, M. (2020). Prevalence and factors associated with anemia among children under five years of age in Rombo district, Kilimanjaro region, Northern Tanzania. *F1000Research*, *9*, 1102. https://doi.org/10.12688/f1000research.24707.3
78. Omer, A., Hailu, D., Nigusse, G., & Mulugeta, A. (2022). Magnitude and morphological types of anemia differ by age among under five children: A facility-based study. *Heliyon*, *8*(9), e10494. https://doi.org/10.1016/j.heliyon.2022.e10494

 doi:10.20944/preprints202505.0306.v1

79. Martinez-Torres, V., Torres, N., Davis, J. A., & Corrales-Medina, F. F. (2023). Anemia and Associated Risk Factors in Pediatric Patients. *Pediatric health, medicine and therapeutics*, *14*, 267–280. https://doi.org/10.2147/PHMT.S389105
80. Sunardi, D., Bardosono, S., Basrowi, R. W., Wasito, E., & Vandenplas, Y. (2021). Dietary Determinants of Anemia in Children Aged 6-36 Months: A Cross-Sectional Study in Indonesia. *Nutrients*, *13*(7), 2397. https://doi.org/10.3390/nu13072397
81. Costa, S. N., Madeira, S., Sobral, M. A., & Delgadinho, G. (2016). Hemoglobinopatias em Portugal e a intervenção do médico de família. *Revista Portuguesa de Medicina Geral e Familiar*, 32, 416–424. https://rpmgf.pt/ojs/index.php/rpmgf/article/view/11963
82. Estrela, P. (2009). A saúde dos imigrantes em Portugal. *Revista Portuguesa de Clínica Geral*, 25, 45–55. https://rpmgf.pt/ojs/index.php/rpmgf/article/view/10590
83. Raju, A. A., Boddu, A. B., Raju, D. S. S. K., & Surabhi, U. S. (2023). The prevalence and predictors of iron deficiency anemia in toddlers: A population-based study. *Journal of Advances in Medicine and Pharmacy*, 6(2), 648–651. Retrieved March 25, 2025, from https://academicmed.org/Uploads/Volume6Issue2/137.%20[3019.%20JAMP_PH]%20648-651.pdf
84. Shibeshi, A. H., Mare, K. U., Kase, B. F., Wubshet, B. Z., Tebeje, T. M., Asgedom, Y. S., Asmare, Z. A., Asebe, H. A., Lombebo, A. A., Sabo, K. G., Fente, B. M., & Seifu, B. L. (2024). The effect of dietary diversity on anemia levels among children 6-23 months in sub-Saharan Africa: A multilevel ordinal logistic regression model. *PloS one*, *19*(5), e0298647. https://doi.org/10.1371/journal.pone.0298647
85. Kathuria, N., Bandyopadhyay, P., Srivastava, S., Garg, P. R., Devi, K. S., Kurian, K., Rathi, S. K., & Mehra, S. (2023). Association of minimum dietary diversity with anaemia among 6-59 months' children from rural India: An evidence from a cross-sectional study. *Journal of family medicine and primary care*, *12*(2), 313–319. https://doi.org/10.4103/jfmpc.jfmpc_926_22
86. Soliman, A. T., De Sanctis, V., Yassin, M., Wagdy, M., & Soliman, N. (2017). Chronic anemia and thyroid function. *Acta bio-medica : Atenei Parmensis*, *88*(1), 119–127. https://doi.org/10.23750/abm.v88i1.6048
87. Chand, D. H., & Valentini, R. P. (2019). Chronic Kidney Disease: Treatment of Comorbidities II (Hypertension, Anemia, and Electrolyte Management). *Current Treatment Options in Pediatrics*, *5*(2), 93-101. https://doi.org/10.1007/s40746-019-00153-8
88. Ministério dos Negócios Estrangeiros. (2025). *Sobre Portugal*. Portal Diplomático. Retrieved February 19, 2025, from https://portaldiplomatico.mne.gov.pt/sobre-portugal
89. European Union. (2024). *Portugal*. Retrieved February 6, 2025, from https://european-union.europa.eu/principles-countries-history/eu-countries/portugal_en
90. European Parliament. (2019). *Economic, social and territorial situation of Portugal: Briefing requested by the REGI committee*. Retrieved February 6, 2025, from https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/629190/IPOL_BRI(2019)629190_EN.pdf
91. Serviço Nacional de Saúde. (2025). *Unidade Local de Saúde de São José*. Retrieved February 20, 2025, from https://www.sns.gov.pt/entidades-de-saude/unidade-local-de-saude-de-sao-jose/
92. Hospital Dona Estefânia. (2025). *ULS São José: Contexto regional e nacional da instituição*.
93. Staples, A. O., Wong, C. S., Smith, J. M., Gipson, D. S., Filler, G., Warady, B. A., Martz, K., & Greenbaum, L. A. (2009). Anemia and risk of hospitalization in pediatric chronic kidney disease. *Clinical journal of the American Society of Nephrology : CJASN*, *4*(1), 48–56. https://doi.org/10.2215/CJN.05301107
94. World Health Organization. (2025). *Child growth standards*. World Health Organization. Retrieved March 15, 2025, from https://www.who.int/tools/child-growth-standards/standards
95. IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*. Armonk, NY: IBM Corp.