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Association Between Prevalence And Determinants Of Iron Deficiency Anemia Among Infants Attending Well-Baby Clinic At Primary Health Care Centre , Makah Al-Mokarramah At Saudi Arabia 2023

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Abstract

Background .
Anemia is defined as a hemoglobin concentration of less than 11 g/dL in children. Anemia was found to be prevalent in 56.6 percent of the population. The significant prevalence of anemia shows that it might be a contributing factor in hospitalization, especially given the short length of stay and the likelihood that the patient was anemic at the time of enrollment. According to the World Health Organization, Iron Deficiency Anemia is a global dietary problem. At least one third of the population has been anemic at some point in their lives. Since children are more susceptible to anemia, this is particularly crucial. It could be attributed to the patients' poor overall dietary condition, including their microelement intake. Increased penetration of su[1]pplements and fortifying programs, as well as other measures aimed at preventing and controlling anemia, are strongly advised. Anemia is a global problem that can affect the neurodevelopment and behavior of infants. ***Aim of the study****: To assessment association between Prevalence and Determinants of Iron Deficiency Anemia among Infants attending well-baby clinic at Primary Health Care Centre , Makah Al-Mokarramah at Saudi Arabia 2023. .**Methods.** A cross-sectional study was conducted at Makah Al-Mokarramah primary healthcare centers in January, 2023. Infants who visited the well-baby clinic for vaccination/routine follow-up were selected through convenience sampling technique. A questionnaire filled out by the researcher through an interview with the mother of infants was utilized for data collection.* ***Results.*** *Ninety-nine (1 year old) infants have included in the study wherein males represent 54.5% of them . All were of Saudi- nationality and majority of them (94.9%) live with both parents. Slightly more than one-quarter of them (27.3%) were first birth order. More than three-fourth (83.8%) had weight of >3 kg. For their respective mothers, all (99%) except one were Saudis, having the age to range between 23 and 45 years with a mean of 28.8 years (SD=3.7).* ***Conclusion.*** *This study provides evidence of a gap in assessment to anemia is a common problem among infants aged one year in Makah Al-Mokarramah as it affects almost one-quarter of them*

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also iron deficiency anemia(IDA) is still the most prevalent type of anemia; however, it was found in only 6.3% participants.

Keywords: *Prevalence, Determinants, Anaemia, Infants, Iron, deficiency, well-baby clinic, PHC.*

Introduction .

Anemia is one of the most common disorders affecting infants in both developed and developing countries [1]. According to the American Academy of family physician (AAFP), anemia is defined as hemoglobin level two standard deviations below the mean for age. The American Academy of Pediatrics (AAP) recommends selective screening at any age in infant and children with risk factors for anemia, such as feeding problems, poor growth, and inadequate dietary iron intake. Follow up is needed for those tested positive for anemia.

This condition is caused by various underlying pathologic and nutritional processes [2]. Categorization of anemia as microcytic, normocytic, or macrocytic based on the mean corpuscular volume will aid in the workup and management. Microcytic anaemia due to iron deficiency is the most common type of anemia in children. The AAP and the World Health Organization (WHO) recommend routine screening for anemia at 12 months of age. Iron-deficiency anemia (IDA) can be associated with cognitive, social and emotional problems [2], however can be controlled through national preventive measures with iron supplements or increased intake of dietary iron [3]. Normocytic anaemia can be caused by congenital membranopathies, hemoglobinopathies, enzymopathies, metabolic defects, and immune-mediated destruction. Macrocytic anaemia, on the other hand, is uncommon in infant which warrants evaluation of vitamin B12 and folate deficiencies, hypothyroidism, hepatic and bone marrow diseases [4].

Al-Hifizi and co-workers reported that 52% of infants in Saudi Arabia attending well-baby clinics had iron deficiency anaemia [5]. [6] found in their cross-sectional study that there was a 24.8% prevalence of anaemia among Saudi children (less than 14 years old) attending outpatient clinics for minor illnesses in 17 different. The prevalence was highest in the eastern province and lowest in the central [3]. Similarly, a comparable prevalence of 24.9% at 12 months of age was observed for children in mainland China last September 2016 [1].

Anemia is considered a problem throughout the world that can affect the neurodevelopment and behaviour of infants [2]. According to statistics in the Kingdom of Saudi Arabia (KSA), the group below five years represents about 16% of the total population, implying that important concerns in this age group should be a priority especially diseases like anemia. Moreover, recent studies concerning the prevalence and determinants of anemia are very limited in KSA. Having new and informative studies with regard to anemia may be helpful in improving the awareness of the infant's mother about anemia, enhancing the practices and screening of infant's health and decreasing the prevalence of this case. Thus, this study aims to assessment of Prevalence and Determinants of Anemia among Infants attending well-baby clinic at Primary Health Care Centres, Makah Al-Mokarramah, 2023.

Review of literatures

Study done reported higher prevalence in Eastern Region of Saudi Arabia (41.3%) [3] and in Egypt (43%) [7]. However, quite similar prevalence (24.9%) was observed in infants aged 12 months in a study in China [1]. Similar to our finding, a recent national study in Qatar [8] showed a prevalence of 23.5% using a cut-off point of haemoglobin as <11.1 g/dL. Other studies in Arab countries like Erbil and Iraq showed prevalence of anaemia and iron deficiency anaemia among infants aged 12–24 months to be 53% and 30%, respectively [9]. In Estonia, the prevalence of anaemia among infants aged 9–12 months was 9.4% using a cut-off value for Hb of 10.5 mg/dL [10]. A study carried out in 11

European countries among infants aged 12 months revealed a prevalence of anaemia as 9.4% [11]. The difference in the rates of anaemia in the current and other studies could be explained by the difference in the socio-cultural background of different communities, the inclusion criteria as well as different cut-off levels of Hb% used in various studies .

Many studies support the fact that anaemia is common among infants who fed on exclusive milk for longer duration due to relatively low iron contents in breast milk [12-13]

This observation can be attributed to the less bioavailable iron of vegetable origin in food items [8]. Further investigation of this point is recommended. Iron supplementation should be considered for infants as it has been confirmed that infants on iron supplementation had higher mean corpuscular volume and haemoglobin concentration [10,14]

Regarding social factors, maternal smoking was a significant factor for developing anaemia of infants. Pateva and others [15] reported a negative influence of maternal smoking on neonatal body iron. In addition, Rao and Georgieff [34] reported that maternal smoking could result in intrauterine growth restriction, and consequently reducing iron stores. In terms of birth order, infants the first birth order were less likely to develop anaemia compared to others. This is related to the published work Ray and colleagues [16]

infants with history of parental haemglobinopathies or congenital hemoglobinopathies were at higher risk for developin anaemia. The same has been mentioned by Ghosh and colleagues [17]

Rationale

Based on the result of old study's, supplementation with iron to infants is highly recommended, particularly for exclusive breastfeeding infants. It is also recommended that counseling program to mothers concerning infant feeding practice at PHCCs preferably during antenatal visits be implemented. For the infants, weaning and introducing solid and semisolid foods at 4-6 months of age are very much encouraged as well as the screening for anemia at age of 12 months for all infants attending PHCCs. Lastly, further longitudinal study is suggested including infants from other institutions to have a clearer sight regarding the problem in Makah Al-Mokarramah.

Aim of the study: To assessment association between Prevalence and Determinants of Iron Deficiency Anemia among Infants attending well-baby clinic at Primary Health Care Centre , Makah Al-Mokarramah at Saudi Arabia 2023..

Materials and Methods

Study Design.

This cross-sectional study was conducted at PHCCs, Makah Al-Mokarramah, chosen through simple random sampling using random number generator.

Study setting:

At the beginning of the selection, the researcher selected 3PHCCs (Al-ka'akyah, Kuday, Al-Eskan,) among 85 PHCCs inside Makah Al-Mokarramah (source; Ministry of Health) to be subjected to randomization. These 85 PHCCs have available facilities and capable to conduct the hemoglobin at limited time in January 2021. Al-Khaldyah and Al-Ka'akyah PHCCs, which include several clinics such as chronic disease, general, antenatal, dressing, dietitian, dental, vaccination, and well-baby clinic, are one of the modalities health care centers at the ministry of health (MOH) that provide well-baby clinic services among other similar clinics in the Western region. Well –baby clinic works two days per week with a target population almost of 150 infants per month.

Study Population.

Infants who are visiting Al-Khaldyah and PHCCs for vaccination or routine follow-up in the well-baby clinic were selected through convenience sampling technique. Infantile period ranges from 28 days till 1 year of age .

Sample Size
The sample size was estimated to be 99 using Raosoft calculator, following the criteria of 95% confidence level and 5% margin error, and with the assumption from the literature that the prevalence of anemia among infants in Saudi Arabia is 24.9% and knowing that well-baby clinic is covering about 150 infants per month.

Sampling Techniques
Makah City Regarding health care center selection, there are three health care sectors inside Makah Al-Mukarramah which are Al-Ka'akya, Al-Zahir and Al-Adl. By using simple random sample technique (by using randomizer.org), health care sector was selected. health care sector which was enumerated from 1 to 12. Again, by using simple random sample technique primary health care center was selected (by using randomizer.org website). well-baby clinic, are one of the modalities health care centers at the ministry of health (MOH) that provide well-baby clinic services among other similar clinics in the Western region. Well –baby clinic works two days per week with a target population almost of 150 infants per month. To collect data from sample size, the researcher needs nearly 20 patients per day to collect desired sample size. The researcher has been selecting every 4th patient to cover the sample size during data collection period.

Inclusion Criteria
All healthy infants attending Al-Khaldyah and AL-Ka’akyahwell-baby clinic for vaccination or regular follow up was considered as the inclusion measure.

Exclusion Criteria .
An infant with chronic or acute illness was set as the exclusion criteria.

Data Collection Tools and Techniques . The study involved the use of questionnaire filled by the researcher through an interview with the mother of infants. After the preparation by the researcher and modification by the supervisor, the questionnaire was tested for validity and reliability and was accepted as the result matched more than 80%. Furthermore, the result of hemoglobin was attached in the form weekly. The questionnaire was designed in English version and was translated to Arabic language, specifically the following sections: demographic data, determinants of anemia, social part, dietitian and level of infant hemoglobin. For the collection part, the researcher gave the official acceptance paper from health affairs to the manager of each PHCC. The researcher filled out the questionnaire in the course of interview with the mother of infants at the well-baby clinic on working days.

Study Variables.
The dependent variables of this study was set as the prevalence of anemia in an infant (aged 12 months) who have hemoglobin level less than 10.5 mg/dl attending the well-baby clinic at PHCCs, Makah Al-Mokarramah, in January 2021. The independent variables include the possible factors associated with the anaemia of infants who had hemoglobin level less than 10.5 mg/ dl, such as age of infant, age of mother, birth weight, infant`s living status, mode of delivery, birth order, exclusive breastfeeding, parental age, mother education level, maternal occupation, maternity leave after delivery of working mother, infant chronic disease (cardiac, gastrointestinal, rheumatological, or hypothyroidism), history of infant`s acute illness in the last 2 weeks (diarrhea, vomiting, or cough), infant using chronic medications, infant admission to hospital (preterm, Jaundice, respiratory or cardiac illnesses), age of weaning, infant growth parameters for weight, infant growth parameters

for height, infant growth parameters for head circumference, anemia or postpartum depression after delivery of infant's mother, medical illnesses and iron deficiency anemia of infant's mother, iron deficiency anaemia among family members, chronic use of supplements and vitamins to the infant, time of food introduction, type of infant feeding at the first 6 months, number of food meals/ day, food type, in-charge of food preparation, eating canned food, presence of housemaid, type of home, infant genetic hemoglibinopathies, maternal and paternal genetic heamogliniopathies, level of income, smoking among parents, number of children among the family, regularity of vaccinations, number of children less than or equal to 5 years, birth order of infant and infant number status among his/her brothers.

Data Entry and Analysis .
Data were collected by hand then coded before entry. Afterwards, the data were entered using the statistical product and service solutions (SPSS version 24). Analysis was carried using Chi-square test to test for association between categorical variables. Fischer Exact test was applied in case of small frequencies. Student`s t-test was used to compare means of two different groups. Significance was determined at p-value <0.05.
The researcher classified the result of the hematological parameters of infants as anaemic at the level of HB < 10.5 mg/dl) .

Pilot Study/Pretesting.
A pilot study was conducted at PHCC considering 10% of the sample size. The 10% of the total sample 99 was chosen and were not included in the main study. This was done to test the wording of the questionnaire and feasibility of the methodology.

Ethical Consideration .
Permission from the Makah joint program of family medicine and Directorate of Health Affairs of the Holy Capital Primary Health Care were obtained. All information were kept confidential and results will be submitted to the department as feedback.

Budget : Self-funded.

Results

Socio-demographic Characteristics of Mothers and Infants

Table 1: Socio-demographic characteristics of the studied infants (n=99).

Characteristics	Frequency	Percentage
Gender		
Male	54	54.5
Female	45	45.5
Nationality		
Saudi	99	100
Non-Saudi	0	0.0
Living status		
With both parents	94	94.9
With mother only	5	5.1
Birth order		
First	27	27.3
Others	72	72.7
Birth weight, kg		
≤3	16	16.2
>3	83	83.8

Table 2: Socio-demographic characteristics of the studied mothers (n=99).

Characteristics	Frequency	Percentage
Nationality		
Saudi	98	99.0
Age (years)		
Range	23-45	
Mean±SD	28.8±3.7	
Educational level		
Elementary school	1	1.0
Intermediate school	15	15.2
Secondary school	39	39.4
Higher education	44	44.4
Job status		
House wife	72	72.7
Worker,<8 hours/day	15	15.2
Worker,≥8 hours/day	12	12.1
Post-partum maternity leave*		
Yes	21	75.0
No	7	25.0
Exclusively breastfeeding		
Yes	19	19.2
No	80	80.8

*for working mothers (n=28)

Ninety-nine (1 year old) infants have included in the study wherein males represent 54.5% of them (Table 1,2). All were of Saudi- nationality and majority of them (94.9%) live with both parents. Slightly more than one-quarter of them (27.3%) were first birth order. More than three-fourth (83.8%) had weight of >3 kg. For their respective mothers, all (99%) except one were Saudis, having the age to range between 23 and 45 years with a mean of 28.8 years (SD=3.7). Roughly 80% (80.8%) were reported to not exclusively breastfeeding. Majority of them attained either secondary school (39.4%) or higher education level (44.4%). In terms of job status, most of them (72.7%) were house wives. Post-partum maternity leave was mentioned by 75% of those who are workers.

Table 3 Distribution of Anaemia-related Factors among Mothers and Infants

Characteristics	Frequency	Percentage
History of chronic diseases		
Yes	3	3.0
No	96	97.0
History of other acute diseases in the last 2 weeks		
Yes	33	33.3
No	66	66.7
History of chronic use of medication		
Yes	3	3.0
No	96	97.0
History of congenital hemoglobinopathies		
Yes	1	1.0

No	69	69.7
Don`t know	29	29.3
History of hospital admission		
Yes	9	**9.1**
Preterm	1	1.0
Jaundice	2	2.0
Respiratory problems	4	4.1
Cardiac problems	2	2.1
No	90	**90.9**
Age of weaning (months)		
<6	8	8.1
≥6	46	46.5
Never breast fed	1	1.0
No weaning yet	44	44.4
Weight growth rate based on Saudi growth chart for weight		
<3% percentile	13	13.1
Normal (3-97% percentile)	86	86.9
>97% percentile	0	0.0
Height growth rate based on Saudi growth chart for height		
<3% percentile	1	1.0
Normal (3-97% percentile)	98	99.0
>97% percentile	0	0.0
Head circumference growth rate based on Saudi growth chart for head circumference		
<3% percentile	2	2.0
Normal (3-97% percentile)	97	98.0
>97% percentile	0	0.0

Table 3 presents the distribution of the infant-related factors towards Anaemia. Only 3% had history of chronic diseases and chronic use of medications whereas 33.3% had history of acute illness in the last 2 weeks. Congenital hemoglobinopathies was observed among only one case (1%). Hospital admission due to preterm, jaundice, and respiratory or cardiac problems was reported among 9 infants (9.1%). Age of weaning was 6 months or more among 46.5% of infants while 44.4% reported no weaning yet. However, majority of the infants were described as "Normal" (3-97% percentile) in terms of weight rate (86.9%), height rate (99.0%) and head circumference growth rate (98.0%) based on Saudi growth chart for these parameters. Table 4 shows the mother-related factors related to anemia. Mode of delivery was normal (vaginal) among majority of them (86.9%). Only 3% of them mentioned that they had post-partum anaemia/depression. Maternal iron deficiency anemia was reported by only one mother (1%) whereas family history of iron deficiency anemia was reported among 14 mothers (14.1%). Only one mother (1%) had Parental hemoglobinopathies.

Table 4: Distribution of anemia-related factors among mothers (n=99).

Characteristics	Frequency	Percentage
Mode of delivery		
Normal vaginal	86	86.9
Cesarean section	13	13.1
Post-partum anaemia/depression		
Yes	3	3.0

No	75	75.8
Don't` know	21	21.2
Maternal health problems		
Yes	7	7.1
No	90	90.9
Don`t know	2	2.0
Maternal iron deficiency anaemia		
Yes	1	1.0
No	53	53.5
Don`t know	45	45.5
Family history of iron deficiency anaemia		
Yes		
No	14	14.1
Don`t know	73	73.8
	12	12.1
Parental hemoglobinopathies		
Yes	1	1.0
No	65	65.7
Don`t know	23	33.3

Nutritional Information

Table (4,5) show the regard to nutritional information, the use of food supplements/vitamins for infants was reported by the mothers to be 46.5% (Table 5). Age of introducing food to infants was 6 months among 45.5% of them while it was 4 months among 30.3%. Most of the mothers reported to provide 2-3 meals for their infants/day (72.7%) and vegetables/fruits as a type of introduced food (62.6%). Also, majority (83.8%) prepared the food by themselves for their infants. Exclusive breast feeding was reported among 13 infants in the first 6 months of age (13.1%), and the history of eating canned food was mentioned by 66.7% of the participants.

Table 5: Nutritional information of the participants (n=99).

Characteristics	Frequency	Percentage
Infant`s using of food supplements/vitamins		
Yes	46	46.5
No	53	53.5
Age of introducing food to infants (months)		
4	30	30.3
6	45	45.5
9	24	24.2
Number of meals per day		
One	25	25.3
Two-Three	72	72.7
≥four	2	2.0
Type of food		
Vegetables/fruits	62	62.6
Mixed	37	37.4.
Who prepared food		
Mother	83	83.8
Others	16	16.2

Mode of infant feeding		
Exclusive breast feeding	13	13.1
Artificial milk	5	5.1
Both	81	81.8
History of eating canned food		
Yes	33	33.3
No	66	66.7

Association between Mother/Infant-related Factors and Anemia

Using Chi-square and Fischer extract test, anemia among infants was found to be more significantly reported among mothers who attained elementary and intermediate educational levels (60-100%, P=0.002), mothers working 8 hours or less per day (46.7%, P =0.021) and to those with no history of post-partum maternity leave (71.4%, P=0.009) as shown in Table 6. On the other hand, anemia showed no significant association with maternal nationality and age. In terms of infant characteristics, results showed that infants of the first birth order were less likely to develop anemia compared to others (11.1% versus 30.6%, P=0.038) as a result of Fischer extract test (Table 7). All infants with history of chronic diseases and chronic use of medications compared to 22.9% of those without these histories had anemia (P=0.015). Slightly less than half (45.5%) of infants with history of other acute diseases in the last 2 weeks compared to 15.2% of those without such history had anemia (P=0.001). History of congenital hemoglobinopathies was significantly associated with anemia among infants (P=0.002). Infants who had history of hospital admission were more likely to develop anemia than others (77.8% versus 20%, P=0.001). Age of weaning and weight growth rate based on Saudi growth chart for weight were also significantly associated with development of anemia (P<0.001 and 0.001), respectively. Infants with history of exclusive breast feeding were more likely to develop anemia compared to others (63.2% versus 16.2%, P<0.001). The gender, living status, birth weight, height and head circumference growth rate based on Saudi growth chart for height and head circumference growth rates of infants were not significantly associated with anemia.

Table 6: Association between socio-demographic characteristics of mothers and development of anemia among infants.

Characteristics	**Anaemia**		**P-value**
	No N=74	**Yes N=25**	
Nationality			
Saudi (n=98)	74 (75.5)	24 (24.5)	0.253**
Non-Saudi (n=1)	0 (0.0)	1 (100)	
Age (years)			
Mean±SD	28.5±2.9	29.7±5.4	0.182˚
Educational level			
Elementary school (n=1)	0 (0.0)	1 (100)	
Intermediate school (n=15)	6 (40.0)	9 (60.0)	0.002*
Secondary school (n=39)	32 (82.1)	7 (17.9)	
Higher education (n=44)	36 (81.8)	8 (18.2)	
Job status			
House wife (n=72)	54 (75.0)	18 (25.0)	
Worker,<8 hours/day (n=15)	8 (53.3)	7 (46.7)	0.021*
Worker,≥8 hours/day (n=12)	12 (100)	0 (0.0)	
Post-partum maternity leave (n=28)			

Yes (n=21)	18 (85.7)	3 (14.3)	0.009**
No (n=7)	2 (28.6)	5 (71.4)	

* Chi-square test,**Fischer exact test,˚ Student`s t-test

Table 7: Association between infant-related factors and development of anaemia .

Characteristics	**Anaemia**		**P-value**
	No N=74	**Yes N=25**	
Gender			
Male (n=45)	34 (75.6)	11 (24.4)	0.866*
Female (n=54)	40 (74.1)	14 (25.9)	
Living status			
With both parents (n=94)	71 (75.5)	23 (24.5)	0.373**
With mother only (n=5)	3 (60.0)	2 (40.0)	
Birth order			
First (n=27)	24 (88.9)	3 (11.1)	0.038**
Others (n=72)	50 (69.4)	22 (30.6)	
History of chronic diseases			
Yes (n=3)	0 (0.0)	3 (100)	
No (n=96)	74 (77.1)	22 (22.9)	0.015**
History of other acute diseases in the last 2 weeks			
Yes (n=33)	18 (54.5)	15 (45.5)	0.001*
No (n=66)	56 (84.8)	10 (15.2)	
History of chronic use of medication			
Yes (n=3)	0 (0.0)	3 (100)	0.015**
No (n=96)	74 (77.1)	22 (22.9)	
History of congenital hemoglobinopathies			
Yes (n=1)	0 (0.0)	1 (100)	0.002
No (n=69)	58 (84.1)	11 (15.9)	
Don`t know (n=29)	16 (55.2)	13 (44.8)	
Birth weight			
≤3 Kg (n=16)	14 (87.5)	2 (12.5)	0.167**
>3 Kg (n=83)	60 (72.3)	23 (27.7)	
History of hospital admission			
Yes (n=9)	2 (22.2)	7 (77.8)	0.001
No (n=90)	72 (80.0)	18 (20.0)	
Age of weaning (months)			
<6 (n=46)	44 (95.7)	2 (4.3)	<0.001*
≥6 (n=8)	7 (87.5)	1 (12.5)	
Never breast fed (n=1)	0 (0.0)	1 (100)	
No weaning yet (n=44)	23 (52.3)	21 (47.7)	
Weight growth rate based on Saudi growth chart for weight			
<3% percentile (n=13)	5 (38.5)	8 (61.5)	0.001*
Normal (3-97% percentile) (n=88)	69 (80.2)	17 (19.8)	
Height growth rate based on Saudi growth chart for height			

<3% percentile (n=1) Normal (3-97% percentile) (n=98)	0 (0.0) 74 (75.5)	1 (100) 24 (24.5)	0.253**
Head circumference growth rate based on Saudi growth chart for head circumference <3% percentile (n=2) Normal (3-97% percentile) (n=97)	 0 (0.0) 74 (76.3)	 2 (100) 23 (23.7)	 0.062**
Exclusive breast feeding Yes (n=19) No (n=80)	 7 (36.8) 67 (83.8)	 12 (63.2) 13 (16.2)	 <0.001*

* Chi-square test **Fischer exact test

Table 8: Association between mother-related factors and development of anaemia among infants.

Characteristics	Anaemia		P-value*
	No N=74	Yes N=25	
Mode of delivery Normal vaginal (n=86) Cesarean section (n=13)	 68 (79.1) 6 (46.2)	 18 (20.9) 7 (53.8)	 0.011
Post-partum anaemia/depression Yes (n=3) No (n=75) Don't know (n=21)	 1 (33.3) 64 (85.3) 9 (42.9)	 2 (66.7) 11 (14.7) 12 (57.1)	 <0.001
Maternal health problems Yes (n=7) No (n=90) Don`t know (n=2)	 2 (28.6) 72 (80.0) 0 (0.0)	 5 (71.4) 18 (20.0) 2 (100)	 0.001
Maternal iron deficiency anaemia Yes (n=1) No (n=53) Don`t know (n=45)	 0 (0.0) 46 (86.8) 28 (62.2)	 1 (100) 7 (13.2) 17 (37.8)	 0.005
Family history of iron deficiency anaemia Yes (n=14) No (n=73) Don`t know (n=12)	 6 (42.9) 64 (87.7) 4 (33.3)	 8 (57.1) 9 (12.3) 8 (66.7)	 <0.001
Parental hemoglobinopathies Yes (n=1) No (n=65) Don`t know (n=33)	 0 (0.0) 55 (84.6) 19 (57.6)	 1 (100) 10 (15.4) 14 (42.4)	 0.003

* Chi-square test

Concerning the mother-related factors**,** anemia was more significantly reported among infants delivered by caesarean section compared to those delivered by normal vaginal delivery (53.8% versus 20.9%, P=0.011) as shown in Table 8. History of postpartum anemia/depression among mothers was significantly associated with anemia among infants (P<0.001). Infants whose mothers had history of chronic illness were more likely to have anemia compared to those without such history (71.4% versus 20%, P=0.001). Both maternal and family histories of iron deficiency anemia and parental hemoglobinopathies

were significantly associated (P=0.005, P<0.001, P=0.003) with the anemia of the participants, respectively.

Table 9: Association between nutritional factors and development of anaemia among infants.

Characteristics	Anaemia		P-value
	No N=74	Yes N=25	
Infant`s using of food supplements/vitamins			
Yes (n=46)	37 (80.4)	9 (19.6)	0.225*
No (n=53)	37 (69.8)	16 (30.2)	
Age of introducing food to infants (months)			
4 (n=30)	30 (100)	0 (0.0)	<0.001*
6 (n=45)	39 (86.7)	6 (13.3)	
9 (n=24)	5 (20.8)	19 (79.2)	
Mode of infant feeding in the first 6 months of age			
Exclusive breast feeding (n=13)	6 (46.2)	7 (53.8)	0.005*
Artificial milk (n=5)	2 (40.0)	3 (60.0)	
Both (n=81)	66 (81.5)	15 (18.5)	
Number of meals per day			
One (n=25)	15 (60.0)	10 (40.0)	0.090
Two-Three (n=72)	58 (80.6)	14 (19.4)	
≥four (n=2)	1 (50.0)	1 (50.0)	
Type of food			
Vegetables/fruits (n=62)	39 (62.9)	23 (37.1)	<0.001**
Mixed (n=37)	35 (94.6)	2 (5.4)	
Who prepared food			
Mother (n=83)	66 (79.5)	17 (20.5)	0.013*
Others (n=16)	8 (50.0)	8 (50.0)	
Eating canned food			
Yes (n=66)	47 (71.2)	19 (28.8)	0.252
No (n=33)	27 (81.8)	6 (18.2)	

* Chi-square test **Fischer exact test

Association of nutritional factors and anemia

As shown in Table 9, most of infants who had a history of food introducing at age of 9 months (79.2%) developed anemia compare to those whose age of introducing food was 4 months (P<0.001). Rate of anemia was lowest among infants with mixed feeding compared to those on exclusive breast or artificial milk alone (P=0.005). Anemia was more significantly observed among infants under vegetables or fruits diet compared to those on mixed food (37.1% versus 5.4%, P<0.001). Anemia was less significantly reported among infants whose food was prepare by mothers compared to those whose food prepared by others (20.5% versus 50%, P=0.013). Using supplements/vitamins, number of meals/day and eating canned food were not significantly associated with the anemia of infants.

Table 10: Association between social factors and development of anemia among infants

	Anaemia	

Characteristics	No N=74	Yes N=25	P-value
Household maid			
Yes (n=33)	23 (69.7)	10 (30.3	0.413*
No (n=66)	51 (77.3)	15 (22.7)	
Type of residence			
Flat (n=95)	70 (73.7)	25 (26.3)	0.306**
Villa (n=4)	4 (100)	0 (0.0)	
Attending PHCC			
AlKhaldyah (n=41)	38 (92.7)	3 (7.3)	<0.001**
Alkaakyah (n=58)	36 (62.1)	22 (37.9)	
Family income (SR/month)			
<5000 (n=6)	15 (60.0)	10 (40.0)	0.090
5000-10000 (n=39)	58 (80.6)	14 (19.4)	
>10000 (n=54)	1 (50.0)	1 (150.0)	
Birth order			
First (n=6)	3 (50.0)	3 (50.0)	0.246*
Middle (n=1)	28 (71.8)	11 (28.2)	
Last (n=92)	43 (79.6)	11 (20.4)	
Number of children in the family			
≤5 (n=97)	74(76.3)	23 (23.7)	0.062**
>5 (n=2)	0 (0.0)	2 (100)	
Number of children aged ≤5 years			
1 (n=19)	18 (94.7)	1 (5.3)	<0.001*
2 (n=64)	50 (78.1)	14 (21.9)	
>2 (n=16)	6 (37.5	10 (62.5)	
History of parental smoking among the participants			
No (n=54)	48 (88.9)	6 (11.1)	<0.001*
Yes, father (n=35)	24 (68.6)	11 (31.4)	
Yes, mother (n=10)	2 (20.0)	8 (80.0)	
Regular intake of essential vaccination			
Yes (n=76)	64 (84.2)	12 (15.8)	<0.001*
No (n=23)	10 (43.5)	13 (56.5)	

* Chi-square test **Fischer exact test

Association of social factors and anemia

As observed in Table 10, infants who attended Alkaakyah PHCC were more likely to have anemia compared to those attended AlKhaldyah PHCC (37.9% versus 7.3%, P>0.001). Almost two-thirds (62.5%) of infants whose families include more than 2 children aged two years or less had anemia compared to only 5.3% of infants whose families included only one child of 5 years or less (P<0.001). Most children whose mothers were smokers (80%) compared to 11.1% of infants with no history of parental smoking had anemia (P<0.001). More than half (56.5%) of infants who did not take essential vaccination compared to 15.8% of those who took them were anemic, showing statistical significance at P<0.001. Presence of household maid, type of residence, family income, birth order and number of children in the family were not significantly associated with development of anemia among infants (P>0.01).

Discussion

In this study, the prevalence of anemia among infants aged one year was found to be 25.3%. This figure is almost half of that reported prevalence of iron deficiency anemia (49%) among infants aged between 6 and 24 months from Northwest Saudi Arabia [18]. A

comparatively higher prevalence in relation to the current study was reported earlier from a study done in Eastern Region of Saudi Arabia (41.3%) [19] and in Egypt (43%) [7]. However, quite similar prevalence (24.9%) was observed in infants aged 12 months in a study in China [1]. Similar to our finding, a recent national study in Qatar [8] showed a prevalence of 23.5% using a cut-off point of haemoglobin as <11.1 g/dL. Other studies in Arab countries like Erbil and Iraq showed prevalence of anemia and iron deficiency anemia among infants aged 12–24 months to be 53% and 30%, respectively [9]. In Estonia, the prevalence of anemia among infants aged 9–12 months was 9.4% using a cut-off value for Hb of 10.5 mg/dL [20]. A study carried out in 11 European countries among infants aged 12 months revealed a prevalence of anemia as 9.4% [21]. The difference in the rates of anemia in the current and other studies could be explained by the difference in the socio-cultural background of different communities, the inclusion criteria as well as different cut-off levels of Hb% used in various studies.

When it comes to socio-demographic characteristics, anemia among infants was found to be more significantly reported among mothers with no history of post-partum maternity leave. A study in China also reported that history of postpartum anemia among mothers was significantly associated with anaemia among infants aged 6-12 months [22]. On the other hand, the current study describes infants with history of chronic diseases, hospital admission, or acute diseases in the last 2 weeks to be more likely to develop anaemia. The same has been observed by Konstantyner and colleagues in Brazil [23] and Semba and co-workers in Indonesia [24]. Weiss and Goodnough [25] reported that fever which is a common symptom of acute and chronic infectious diseases has been associated with lower Hb levels.

In assessing infant-related factors and anemia, weight growth rate based on Saudi growth chart for weight was significantly associated with anemia as it was more reported among <3% percentile infant. This finding contradicts to what has been observed in two USA studies [26], mentioning that overweight infants and children (1-3 years) were more susceptible to iron deficiency anemia since this ailment is mostly related to the imbalance between iron demands and dietary sources of iron, rather than the relation with the nutrition of infants or body mass index. However, there was no association between anemia and infants body mass index based on a study in Qatar [8].

In assessing mother-related factors and anemia, the current study shows that anemia was more significantly reported among infants delivered by caesarean section compared to those delivered by normal vaginal delivery. This finding is confirmed by findings of others [27] in which the case is explained by the reduction of placenta-to-fetus cord blood transfusion and decrease in iron storage at birth in those infants. The present study also found that infants whose mothers had history of chronic illness or iron deficiency anemia were more likely to have anemia. This is supported by the study describing that anemia in infants is an adverse consequence of maternal chronic illness [28]. Moreover, infants with history of parental haemglobinopathies or congenital hemoglobinopathies were at higher risk for develop in anemia. The same has been mentioned by Ghosh and colleagues [17] who recommended screening and early diagnosis of hemoglobinopathies.

Relating the nutritional factors and anemia, food/vitamin supplementation was found to be not significantly associated with the anemia of infants. However, is it well-established that the supplementation of iron is beneficial on the iron storage in infants [12,28]. Results of the present study shows that most of infants who had a history of food introducing at age of 9 months (79.2%) developed anemia compared to none of those whose age of introducing food was 4 months. In another Qatari study [8], the prevalence of iron deficiency anemia was higher among infants who started introducing food at the age of 6 months or later compared with those who started before the age of 6 months. Other studies also confirmed this finding [12, 13, 28]. When it comes to mode of income feeding, the prevalence of anemia was higher among infants who were exclusively breast fed in the first 6 months of age. The same has been reported in a similar study carried out in Qatar [8].

Number of meals/day was not related to development of anemia in this study. In Qatari study [8], frequency of breast feeding and continued breast feeding at 1 year were significantly associated with anemia. In another study conducted in Estonia [29], the prevalence of anemia was significantly higher among infants who exclusively breast fed till age of 6 months compared to those who exclusively breast fed till age of 3 months. In a study carried out in Iran [10], the prevalence of anemia among exclusively breast fed infants until the age of 6 months was 27%, compared to 16.7% in artificial milk fed infants and 100% among those fed on cow`s milk. In South Korea, the prevalence of anemia was significantly higher among infants who fed only on breast milk till the age of 6 months compared to those fed on artificial milk and those fed on breast milk with iron supplementation [30]. Moreover, the present study showed that the rate of anemia was high among infants who fed on artificial milk and reach up to 60% which could be attributed to the very small sample size of infants who fed on artificial milk. To confirm this, the rate of anemia was lowest among infants fed on both breast and artificial milk. Many studies support the fact that anemia is common among infants who fed on exclusive milk for longer duration due to relatively low iron contents in breast milk [23-25, 27, 28]. Concerning food lifestyle, anemia was more significantly observed among infants on vegetables or fruits diet compared to those on mixed food. This finding is contrary to what has been observed in another study conducted in Qatar showing that infants who had iron deficiency anemia consumed less iron-rich vegetable compared with those without anemia. This observation can be attributed to the less bioavailable iron of vegetable origin in food items [8]. Further investigation of this point is recommended. Iron supplementation should be considered for infants as it has been confirmed that infants on iron supplementation had higher mean corpuscular volume and haemoglobin concentration [10, 15].

When it comes to PHCC attendance, the present study reveals that infants who attended Alkaakyah PHCC were more likely to have anemia compared to those attended AlKhaldyah PHCC. This finding could be attributed to the fact that Alkaakyah PHCC is located in a more public area with relatively lower socio-economic status compared to AlKhaldyah PHCC. The role of socio-economic status of infants in developing anemia was confirmed also by finding that infants whose families include more than 2 children aged two years or less and infants of lower educated mothers were more likely to develop anemia. Implementing counseling program to mothers was proven to be effective in reducing the rate of anemia among infants. In fact, a study in USA shows that the rate of anemia decreased significantly among African-American children (aged between one and three years) after conduction of counselling program resulting in the improvement of infant feeding practices [16]

Conclusions

Anemia is a common problem is the several predictors for anaemia have been identified in this study, namely maternal educational level and job status, absence of post-partum maternity leave, increasing birth order, fetal history of chronic/acute diseases and hospital admission, congenital and parental haemoglobinopathies, later age of weaning and introducing solid/semisolid foods after age of 9 months, <3% percentile weight growth, exclusive breast feeding in the first 6 months, caesarean section, maternal post-partum anemia, health problems and iron deficiency anemia, family history of iron deficiency anemia, attending AlKaakyah PHCC, more number of children aged 5 years or less, parental smoking, type of infant food, infant food not prepared by mothers and irregular intake of essential vaccination. Despite many limitations, the results could fill the gap in anemia-related knowledge concerning infants and can help the decision makers to execute a more effective public health interventions in both regional and nation levels.

References

1. Gadó, K., Khodier, M., Virág, A., Domján, G., & Dörnyei, G. (2022). Anemia of geriatric patients. Physiology international.

2. Kumar, S. B., Arnipalli, S. R., Mehta, P., Carrau, S., & Ziouzenkova, O. (2022). Iron deficiency anemia: efficacy and limitations of nutritional and comprehensive mitigation strategies. Nutrients, 14(14), 2976.
3. Safiri, S., Kolahi, A. A., Noori, M., Nejadghaderi, S. A., Karamzad, N., Bragazzi, N. L., ... & Grieger, J. A. (2021).
4. Burden of anemia and its underlying causes in 204 countries and territories, 1990–2019: results from the Global Burden of Disease Study 2019. Journal of hematology & oncology, 14(1), 1-16.
5. Turner, J., Parsi, M., & Badireddy, M. (2022). Anemia. In StatPearls [Internet]. StatPearls Publishing.
6. Nampijja, M., Mutua, A. M., Elliott, A. M., Muriuki, J. M., Abubakar, A., Webb, E. L., & Atkinson, S. H. (2022). Low hemoglobin levels are associated with reduced psychomotor and language abilities in young ugandan children. Nutrients, 14(7), 1452..
7. Newhall, D. A., Oliver, R., & Lugthart, S. (2020). Anaemia: A disease or symptom. Neth. J. Med, 78, 104-110.
8. A. Zainel, S. R. O. Osman, S. M. S. Al-Kohji et al. "Iron Deficiency, Its Epidemiological Features and Feeding Practices among Infants Aged 12 Months in Qatar: A Cross-Sectional Study." BMJ Open, vol. 8, no. 5, pp. e020271, 2018.
9. Hughes, C. A. (2019). Anemia Assessment. In Patient Assessment in Clinical Pharmacy (pp. 415-421). Springer, Cham.
10. Marks, P. W. (2019). Anemia: clinical approach. In Concise Guide to Hematology (pp. 21-27). Springer, Cham.
11. D'Souza, A. M. (2020). A General Pediatrician's Approach to Anemia in Childhood. Pediatric Annals, 49(1), e10-e16.
12. Shetty, A., Saha, A., & Komala, H. N. Morphological types of anaemia integrated with distribution of red cell and platelet indices: Study in a rural tertiary healthcare centre.
13. Jaiswal, M., Srivastava, A., & Siddiqui, T. J. (2019). Machine learning algorithms for anemia disease prediction. In Recent trends in communication, computing, and electronics (pp. 463-469). Springer, Singapore.
14. R. D. BakerF. R. Greer. "Diagnosis and Prevention of Iron Deficiency and Iron-Deficiency Anemia in Infants and Young Children (0-3 Years of Age)." Pediatrics, vol. 126, no. 5, pp. 1040-1050, 2010.
15. B. Pateva, E. H. Kerling, M. Reddy et al. "Effect of Maternal Cigarette Smoking on Newborn Iron Stores." Clin Res Trials, vol. 1, no. 1, pp. 4-7, 2015.
16. R. RaoM. K. Georgieff. "Iron in Fetal and Neonatal Nutrition." Semin Fetal Neonatal Med, vol. 12, no. 1, pp. 54-63, 2007.
17. K. Ghosh, R. Colah, M. Manglani et al. "Guidelines for Screening, Diagnosis and Management of Hemoglobinopathies." Indian J Hum Genet, vol. 20, no. 2, pp. 101-119, 2014.
18. K. Xu, C. M. Zhang, L. H. Huang et al. "[Risk Factors for Iron Deficiency Anemia in Infants Aged 6 to 12 Months and Its Effects on Neuropsychological Development]." Zhongguo Dang Dai Er Ke Za Zhi, vol. 17, no. 8, pp. 830-836, 2015
19. Kejo, D., Petrucka, P. M., Martin, H., Kimanya, M. E., & Mosha, T. C. (2018). Prevalence and predictors of anemia among children under 5 years of age in Arusha District, Tanzania. Pediatric health, medicine and therapeutics, 9, 9.
20. Kejo, D., Petrucka, P. M., Martin, H., Kimanya, M. E., & Mosha, T. C. (2018). Prevalence and predictors of anemia among children under 5 years of age in Arusha District, Tanzania. Pediatric health, medicine and therapeutics, 9, 9.
21. 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-e182899.
22. Al-Alimi, A. A., Bashanfer, S., & Morish, M. A. (2018). Prevalence of iron deficiency anemia among university students in Hodeida Province, Yemen. Anemia, 2018.
23. T. Konstantyner, T. C. Roma OliveiraJ. A. de Aguiar Carrazedo Taddei. "Risk Factors for Anemia among Brazilian Infants from the 2006 National Demographic Health Survey." Anemia, vol. 2012, pp. 850681, 2012.
24. R. D. Semba, S. de Pee, M. O. Ricks et al. "Diarrhea and Fever as Risk Factors for Anemia among Children under Age Five Living in Urban Slum Areas of Indonesia." Int J Infect Dis, vol. 12, no. 1, pp. 62-70, 2008.

25. G. WeissL. T. Goodnough. "Anemia of Chronic Disease." N Engl J Med, vol. 352, no. 10, pp. 1011-1023, 2005
26. Kawo, K. N., Asfaw, Z. G., & Yohannes, N. (2018). Multilevel analysis of determinants of anemia prevalence among children aged 6–59 months in Ethiopia: classical and Bayesian approaches. Anemia, 2018.
27. J. M. Brotanek, J. Gosz, M. Weitzman et al. "Secular Trends in the Prevalence of Iron Deficiency among Us Toddlers, 1976-2002." Arch Pediatr Adolesc Med, vol. 162, no. 4, pp. 374-381, 2008.
28. Ahmad, M. S., Farooq, H., Maham, S. N., Qayyum, Z., Waheed, A., & Nasir, W. (2018). Frequency of anemia and iron deficiency among children starting first year of school life and their association with weight and height. Anemia, 2018.
29. N. Vendt, H. Grunberg, S. Leedo et al. "Prevalence and Causes of Iron Deficiency Anemias in Infants Aged 9 to 12 Months in Estonia." Medicina (Kaunas), vol. 43, no. 12, pp. 947-952, 2007.
30. S. J. Noh, B. NaM. J. Kim. "Iron Deficiency and Early, Low-Dose Iron Supplementation in Breast-Fed Infants." Korean J Pediatr Gastroenterol Nutr, vol. 11, pp. 169-178, 2008