

Prevalence and Determinants of Anaemia among Infants Attending Well-baby Clinic at Primary Health Care Centres, Makkah Al-Mokarramah, January 2018: A Cross Sectional Study

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Abstract *Background.* Anaemia is a global problem that can affect the neurodevelopment and behaviour of infants. A study shows that 52% of infants attending well-baby clinics in Saudi Arabia had iron deficiency anaemia, however limited works are done concerning its prevalence and determinants. Thus, this study aims obtain new helpful information towards anaemia among infants by determining its prevalence and determinants at the primary health care centers (PHCCs) in Makkah Al-Makaramah, KSA. *Methods.* A cross-sectional study was conducted at Makkah Al-Mokarramah primary healthcare centers (Al-khaldyah and Al-Ka'akyah) in January, 2018. 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.* The prevalence of anaemia among 99 infants was found to be 25.3%. Factors significantly associated with anaemia were determined as maternal educational level, 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, introducing solid/semisolid foods after age of 9 months, <3% weight growth, exclusive breast feeding (first 6 months), caesarean section, maternal post-partum anaemia, health problems and iron deficiency anaemia (IDA), family history of IDA, attending AlKaakyah PHCC, more number of children (≤ 5 years), parental smoking, infant food type, infant food not prepared by mothers and irregular intake of essential vaccines. *Conclusion.* Anaemia is a common problem among infants aged one year in Makkah Al-Mokarramah as it affects almost one-quarter of them. Several predictors for anaemia have been identified in relation to infants, mothers, nutrition and social aspects. Overall, the results may enhance the anaemia-related knowledge among infants and help the authorities to execute a more effective public health interventions in both regional and nation levels.

Keywords: prevalence-determined-anemia-infants-well baby-primary health care

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1. Introduction

Anaemia is one of the most common disorders affecting infants in both developed and developing countries [1]. According to the American Academy of family physician (AAP), anaemia 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 anaemia, such as feeding problems, poor growth, and inadequate dietary iron intake. Follow up is needed for those tested positive for anaemia.

This condition is caused by various underlying pathologic and nutritional processes [2]. Categorization of anaemia 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 anaemia in children. The AAP and the World Health Organization (WHO) recommend routine screening for anaemia at 12 months of age. Iron-deficiency anaemia (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]. Also, El-hazmi MA and colleagues (1999) 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].

Anaemias 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 anaemia. Moreover, recent studies concerning the prevalence and determinants of anaemia are very limited in KSA. Having new and informative studies with regard to anaemia may be helpful in improving the awareness of the infant's mother about anaemia, enhancing the practices and screening of infant's health and decreasing the prevalence of this case. Thus, this study aims to determine the current prevalence and determinants of anaemia at primary health care centers (PHCCs) in Makkah Al-Makaramah.

2. Materials and Methods

Study Design and Area. This cross-sectional study was conducted at Al-khaldyah and Al-Ka'akyah PHCCs, Makkah Al-Mokarramah, chosen through simple random sampling using random number generator (<http://www.random.org>).

At the beginning of the selection, the researcher selected 4 PHCCs (Al-ka'akyah, Kuday, Al-Eskan, Al-Khaldya) among 85 PHCCs inside Makkah 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 2018. 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, Sample Size and Sampling Techniques. Infants who are visiting Al-Khaldyah and Al-Ka'akyah 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 [6]. The sample size was estimated to be 99 using Raosoft calculator (http://www.raosoft.com/sample_size.html),

following the criteria of 95% confidence level and 5% margin error, and with the assumption from the literature that the prevalence of anaemia among infants in Saudi Arabia is 24.9% [1] and knowing that well-baby clinic is covering about 150 infants per month.

Inclusion and Exclusion Criteria. All healthy infants attending Al-Khaldyah and AL-Ka'akyah well-baby clinic for vaccination or regular follow up was considered as the inclusion measure, while infants 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 anaemia, 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 anaemia in an infant (aged 12 months) who have hemoglobin level less than 10.5 mg/dl (5) attending the well-baby clinic at PHCCs, Makkah Al-Mokarramah, in January 2018. The independent variables include the possible factors associated with the anaemia of infants who had hemoglobin level less than 10.5 mg/ dl [5], 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, anaemia or postpartum depression after delivery of infant's mother, medical illnesses and iron deficiency anaemia 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 hemoglobinopathies, maternal and paternal genetic hemoglobinopathies, 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 25). 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) [4].

Pilot Study/Pretesting. A pilot study was conducted at Al-Ka'akyah 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 Makkah 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.

3. Results

3.1. Socio-Demographic Characteristics of Mothers and Infants

Ninety-nine (1 year old) infants have included in the study wherein males represent 54.5% of them (Table 1). 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 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).

3.2. Distribution of Anaemia-related Factors among Mothers and Infants

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 anaemia. 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 anaemia was reported by only one mother (1%) whereas family history of iron deficiency anaemia was reported among 14 mothers (14.1%). Only one mother (1%) had Parental hemoglobinopathies.

3.3. Nutritional Information

With 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 3. Distribution of anaemia-related factors among infants (n=99)

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 4. Distribution of anaemia-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	14	14.1
No	73	73.8
Don't know	12	12.1
Parental hemoglobinopathies		
Yes	1	1.0
No	65	65.7
Don't know	23	33.3

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

3.4. Social Information

The presence of household maid was reported by 33.3% of the participating mothers (Table 6). Majority of the participants (96%) live in flats. More than half of them (58.6%) attended Alkaakyah PHCC whereas the remaining 41.4% attended AlKhaldyah PHCC. Family income exceeded 10000 SR/month among more than half of the participants (54.5%). Majority of them (92.9%) were of last birth order. Number of children in the family was reported to be 5 or less among majority of the participants (98%), out of which 64.6% were 2 years old. The rate of parental smoking was found to be 45.5%, out of which 35.4% was among fathers only and 10.1% among both parents. History of taking essential vaccines was reported among most of the infants (76.8%).

Table 6. Social information of the participants (n=99)

Characteristics	Frequency	Percentage
Household maid		
Yes	33	33.3
No	66	66.7
Type of residence		
Flat	95	96.0
Villa	4	4.0
Attending PHC center		
AlKhaldyah	41	41.4
Alkaakyah	58	58.6
Family income (SR/month)		
<5000	6	6.1
5000-10000	39	39.4
>10000	54	54.5
Birth order		
First	6	6.1
Middle	1	1.0
Last	92	92.9
Number of children in the family		
≤5	97	98.0
>5	2	2.0
Number of children aged ≤5 years		
1	19	19.2
2	64	64.6
>2	16	16.2
History of parental smoking		
Yes, Father	35	35.4
Yes, Both	10	10.1
No	54	54.5
Regular intake of essential vaccines of infants		
Yes	23	76.8
No	76	23.2

3.5. Association between Mother/Infant-related Factors and Anaemia

Using Chi-square and Fischer exact test, anaemia 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 7. On the other hand, anaemia 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 anaemia compared to others (11.1% versus 30.6%, $P=0.038$) as a result of Fischer exact test (Table 8). All infants with history of chronic diseases and chronic use of medications compared to 22.9% of those without these histories had anaemia ($P=0.015$). 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 anaemia ($P=0.001$). History of congenital hemoglobinopathies was significantly associated with anaemia among infants ($P=0.002$). Infants who had history of hospital admission were more likely to develop anaemia 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 anaemia ($P<0.001$ and 0.001), respectively. Infants with history of exclusive breast feeding were more likely to develop anaemia 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 anaemia.

Concerning the mother-related factors, anaemia 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 9. History of postpartum anaemia/depression among mothers was significantly associated with anaemia among infants ($P<0.001$). Infants whose mothers had history of chronic illness were more likely to have anaemia compared to those without such history (71.4% versus 20%, $P=0.001$). Both maternal and family histories of iron deficiency anaemia and parental hemoglobinopathies were significantly associated ($P=0.005$, $P<0.001$, $P=0.003$) with the anaemia of the participants, respectively.

Table 7. Association between socio-demographic characteristics of mothers and development of anaemia 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)	0.002*
Intermediate school (n=15)	6 (40.0)	9 (60.0)	
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)	0.021*
Worker, <8 hours/day (n=15)	8 (53.3)	7 (46.7)	
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 8. 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)	0.015**
No (n=96)	74 (77.1)	22 (22.9)	
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)	0 (0.0)	1 (100)	0.253**
Normal (3-97% percentile) (n=98)	74 (75.5)	24 (24.5)	
Head circumference growth rate based on Saudi growth chart for head circumference			
<3% percentile (n=2)	0 (0.0)	2 (100)	0.062**
Normal (3-97% percentile) (n=97)	74 (76.3)	23 (23.7)	
Exclusive breast feeding			
Yes (n=19)	7 (36.8)	12 (63.2)	<0.001*
No (n=80)	67 (83.8)	13 (16.2)	

* Chi-square test, **Fischer exact test.

3.6. Association of Nutritional Factors and Anaemia

As shown in Table 10, most of infants who had a history of food introducing at age of 9 months (79.2%) developed anaemia compare to those whose age of introducing food was 4 months ($P<0.001$). Rate of anaemia was lowest among infants with mixed feeding compared to those on exclusive breast or artificial milk

alone ($P=0.005$). Anaemia was more significantly observed among infants under vegetables or fruits diet compared to those on mixed food (37.1% versus 5.4%, $P<0.001$). Anaemia was less significantly reported among infants whose food was prepared 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 anaemia of infants.

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

* Chi-square test.

Table 10. 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.

3.7. Association of Social Factors and Anaemia

As observed in Table 11, infants who attended Alkaakyah PHCC were more likely to have anaemia compared to those attended AIKhaldyah 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 anaemia 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 anaemia ($P<0.001$). More than half (56.5%) of infants who did not take essential vaccination compared to 15.8% of those who took them were anaemic, 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 anaemia among infants ($P>0.01$).

Table 11. Association between social factors and development of anaemia among infants

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

* Chi-square test, **Fischer exact test.

4. Discussion

In this study, the prevalence of anaemia among infants aged one year was found to be 25.3%. This figure is almost half of that reported prevalence of iron deficiency anaemia (49%) among infants aged between 6 and 24 months from Northwest Saudi Arabia [2]. 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%) [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.

When it comes to socio-demographic characteristics, anaemia 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 anaemia among mothers was significantly associated with anaemia among infants aged 6-12 months [12]. 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 [13] and Semba and co-workers in Indonesia [14]. Weiss and Goodnough [15] 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 anaemia, weight growth rate based on Saudi growth chart for weight was significantly associated with anaemia as it was more reported among <3% percentile infant. This finding contradicts to what has been observed in two USA studies [16,17], mentioning that overweight infants and children (1-3 years) were more susceptible to iron deficiency anaemia 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 anaemia and infants body mass index based on a study in Qatar [8].

In assessing mother-related factors and anaemia, the current study shows that anaemia 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 [18-20] 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 anaemia were more likely to have anaemia. This is supported by the study describing that anaemia in infants is an adverse consequence of maternal chronic illness [21]. Moreover, infants with history of parental haemoglobinopathies or congenital hemoglobinopathies were at higher risk for developinanaemia. The same has been mentioned by Ghosh and colleagues [22] who recommended screening and early diagnosis of hemoglobinopathies.

Relating the nutritional factors and anaemia, food/vitamin supplementation was found to be not significantly associated with the anaemia of infants. However, it is well-established that the supplementation of iron is beneficial on the iron storage in infants [23-28]. 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 anaemia compared to none of those whose age of introducing food was 4 months. In another Qatari study [8], the prevalence of iron deficiency anaemia 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 [26,29,30]. When it comes to mode of income feeding, the prevalence of anaemia 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 anaemia in this study. In Qatari study [8], frequency of breast feeding and continued breast feeding at 1 year were significantly associated with anaemia. In another study conducted in Estonia [30], the prevalence of anaemia 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 anaemia 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 anaemia 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 [31]. Moreover, the present study showed that the rate of anaemia 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 anaemia was lowest among infants fed on both breast and artificial milk. 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 [23,24,25,27,28]. Concerning food lifestyle, anaemia 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 anaemia consumed less iron-rich vegetable compared with those without anaemia. 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 [10,32].

Regarding social factors, maternal smoking was a significant factor for developing anaemia of infants in the present study. Pateva and others [33] 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 of the first birth order in the present study were less likely to develop anaemia compared to others. This is related to the published work Ray and colleagues [35] in which it is reported that with increasing in birth order, the hemoglobin level decreases. When it comes to PHCC attendance, the present study reveals that infants who attended Alkaakyah PHCC were more likely to have anaemia 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 anaemia 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 anaemia. On the other hand, this study has some important limitations. First, conducting the study in only two PHCCs could greatly affect the generalizability of results, however these two centers were chosen because they have available facilities to conduct the hemoglobin at limited study time. Second, the cross-sectional design with its inherited problem of lack of temporality in association between studied variables. Third, assessing feeding practices retrospectively is subjected to recall bias. Fourth, selection of subjects was done by using a non-random convenience sampling technique. However, the use of this technique is due to shortage of eligible cases. Finally, including single parameter for diagnosis of anaemia (Hb) is another limitation. Despite those limitations, the results of this study could fill the gap in anaemia-related knowledge concerning infants and can help the decision makers to execute a more effective public health interventions in both regional and nation levels.

Implementing counselling program to mothers was proven to be effective in reducing the rate of anaemia among infants. In fact, a study in USA shows that the rate of anaemia 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].

5. Conclusions

Anaemia is a common problem among infants aged one year in Makkah Al-Mokarramah which affects almost one-quarter of them. In this study, the prevalence of anaemia among infants aged one year attending the well-baby clinic at PHCCs in Makkah Al-Mokarramah was reported to be 25.3%. 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 anaemia, health problems and iron deficiency anaemia, family history of iron deficiency anaemia, 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 anaemia-related knowledge concerning infants and can help the decision makers to execute a more effective public health interventions in both regional and nation levels.

6. Recommendations

Based on the result of study, supplementation with iron to infants is highly recommended, particularly for exclusive breastfeeding infants. It is also recommended that counselling 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 anaemia 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 Makkah Al-Mokarramah.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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