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Predictors of anemia among infants at the age of one year attending health centers in the West Bank/Palestine: a retrospective study

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Abstract

Background Anemia is a major problem among infants aged under 1 year. There are limited studies in Palestine about anemia among infants. Thus, this study aimed to address this gap.

Methods A retrospective study was conducted. A review of 1249 infants recorded in primary health centers of the West Bank, Palestine was performed during the period from January to December 2022. The collected data included sociodemographic factors, feeding practices, and hemoglobin levels. Descriptive statistics, correlations, and binary logistic regression were performed to analyze the data.

Results The findings showed that 35.2% of infants were anemic, of which 67.2% had mild anemia. The detrimental predictors for anemia were introducing complementary feeding earlier than six months of age, receiving exclusive bottle feeding with complementary feeding (solid or semisolid) at 12 months, and low family income. While receiving exclusive breastfeeding and complementary feeding at 12 months was a protective predictor.

Conclusion Healthcare professionals should develop intervention programs to enhance hemoglobin levels and decrease anemia among infants while considering correlating factors.

Keywords Anemia, Feeding practices, Hemoglobin level, Infants

Introduction

Anemia is a condition characterized by a low level of hemoglobin (Hgb) concentration and/or a reduced number of red blood cells (RBCs) in the blood, in which

this level or number is inadequate to meet physiological needs [1]. Anemia is caused by many factors including nutritional deficiencies, such as iron deficiency [1]. Unfortunately, children under 5 years are the most affected group of anemia in low- and middle-income countries, especially infants [1, 2]. Anemia is reported to cause increased morbidity and mortality along with poor developmental outcomes among infants [3–5].

Many factors correlate with anemia among infants, including younger age, delayed initiation of complementary feeding (CF) (solid or semisolid), poor socioeconomic status [6–8], and under-nutrition [6, 9–11]. The World Health Organization (WHO) and other health organizations recommend exclusive breastfeeding for the first six months of the infant's life [12, 13]. At the beginning of the sixth month, breast milk is no longer enough to meet the nutritional needs of infants;

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therefore, CF should be started immediately [13]. According to the Palestinian Central Bureau of Statistics [14], 43.3% of infants under the age of 5 months were exclusively breastfed. Also, 90.9% of breastfeeding infants aged six to eight months received CF. However, the time of starting CF and its quality can be affected by socioeconomic characteristics, such as income [15, 16].

The report of the Palestinian Center for Human Rights in 2020 indicated that nearly a third of the population (29.2%) suffered from poverty, with its rate in the Gaza Strip reaching 53%, and 13.9% in the West Bank [17]. The National Palestinian Survey in 2021 found that 30.4% of the investigated infants at the age of 12 months or younger had anemia in the West Bank [18]. Similarly, another study in 2022 found that the prevalence of anemia among infants aged 12 months or younger in the West Bank was 29.1% [19].

The Palestinian Ministry of Health, which is the main healthcare provider in the country, is responsible for diagnosing anemia among infants by assessing Hgb levels in primary healthcare centers. The Palestinian Ministry of Health's strategy to prevent and combat anemia includes distributing iron supplements to children free of charge from six months to two years of age which can be extended to three years if the child is suffering from anemia [18]. Moreover, a screening blood test for anemia is performed on all infants at 12 and 18 months of age while attending the primary healthcare centers to obtain immunization.

Palestine suffers from unstable political conditions and ongoing war situations which predispose its population to extreme challenges such as difficulty accessing health services [20, 21]. In addition, the limited available financial resources that are allocated for healthcare negatively affect the availability of iron supplements and screening blood tests for anemia. Moreover, the recurrent armed conflicts have led to an increase in unemployment rates among Palestinians and severely limited the availability of food [22]. Due to these factors, it is important to examine the prevalence of anemia and the associated feeding practices among Palestinian infants. Currently, there is a lack of studies on this topic, which is what this study aimed to address. The findings of this study can help policymakers and healthcare professionals develop appropriate strategies to improve Hgb levels at any early age to minimize the negative consequences of anemia. Also, healthcare providers can enhance mothers' awareness of this critical problem by providing health education about anemia, its correlating factors, and the importance of following up their infants' nutritional needs. Thus, this study aimed to answer the following questions:

- 1 What is the prevalence of anemia among infants aged 12 months in Palestine?
- 2 What are the relationships between select sociodemographic factors (e.g., sex, family income/month, and childbirth order), feeding practices, and anemia among participants?
- 3 What are the predictors of anemia among participants?

Methods

Design, setting, and sample

A retrospective design was adopted to conduct this study. This study included primary health centers affiliated with the Ministry of Health in the West Bank, Palestine where there are 11 governorates. The Nablus Governorate was selected because it houses residents from all regions of Palestine. A cluster random sampling method was adopted to recruit the sample, in which the Nablus Governorate was divided into four areas: west, east, north, and south. Two primary health centers were randomly selected from each area.

The G*power program was used to calculate sample size with an alpha of 0.05, small effect size of 0.02, and a power of 0.95 with regression analysis. A minimum sample of 1099 was needed to achieve this study. According to the Palestinian Ministry of Health protocol, Hgb is checked for children at 12 and 18 months of age in congruence with obtaining vaccines in the primary health centers. The blood sample for examining Hgb is taken from brachial veins and analyzed using CBC machines. The results of Hgb and other related data including sociodemographic characteristics are recorded in electronic medical records. For this study, the researchers designed an electronic record using Microsoft Excel to register all the information about eligible participants. The eligibility criteria included 12-month-old infants who were born after full-term gestation (38–42 weeks) with normal body weights at birth (2.800–4.00 kg).

The third and fourth researchers met with the managers and head nurses of the selected primary health centers. Then, the head nurses arranged meetings between the two researchers and the maternal and child health (MCH) nurses to clarify this study's purposes and protocol, and explain their participation in data recording. The MCH nurses accessed the records of infants. After applying the inclusion criteria, the required data were extracted and coded in a secure electronic file. To ensure accurate recording, the same two researchers followed up the processes of data coding. The data were collected during the period from January to December 2022.

Outcome measures

Three types of data were collected: sociodemographic factors, feeding practices, and anemia status. The sociodemographic factors included sex, mothers' educational levels, family income/month, and childbirth order. The feeding practices data were obtained from the participants' files and included the age of introducing CF (WHO recommended administering CF at six months of age and not earlier) [13], receiving exclusive breastfeeding with CF at 12 months, and receiving exclusive bottle feeding with CF at 12 months. Only the anemia caused by nutritional deficiency was recorded. It was assessed by Hgb concentration adjusted for altitude using the anemia threshold suggested by the WHO [1] for infants, which is < 11.0 g/dL. Anemia status was categorized according to the WHO criteria as follows: ≥ 11.0 g/dL = no anemia, 10.0–10.9 g/dL = mild anemia, 7.0–9.9 g/dL = moderate anemia, and < 7.0 g/dL = severe anemia [1]. The Hgb level was measured from venous blood samples.

Ethical considerations

An ethical approval was obtained from institutional review board (IRB) at Arab American University with reference No# R- 2021/A/136 N. Also, permissions were obtained from the Palestinian Ministry of Health and the selected centers. The legal guardians agreed to participate in the study. All ethical principles were maintained during all stages of this study.

Data analysis

The Statistical Package for Social Sciences (SPSS) version 26 was used to run descriptive and inferential statistical analyses on the study variables. Descriptive statistics (e.g., frequency, percentage, mean, standard deviation, and range) were calculated to describe the characteristics of the sample. The relationships between study variables and anemia were examined using both bivariate correlation analysis and multivariate binary logistic regression analysis. Bivariate correlation analysis was used to identify the relationship between each individual predictor and anemia. Multivariate binary logistic regression analysis was used to identify a predictive model regarding risk factors of anemia. There were no missing values in the data. The p-value was significant at ≤ 0.05 .

Results

A total of 1249 infants were reviewed from eight centers. The findings revealed that 51.1% of the sample were males and 48.9% were females. The mean monthly family income was almost 674.72\$ (SD = 11.2), which is

considered below the poverty line. A total of 57.0% of the mothers completed secondary education or less. The median of the birth order was child number three.

Concerning feeding practices, the mean age of introducing CF was 5.24 months (SD ± 1.05), with a range from three to eight months. A total of 27.5% received exclusive breastfeeding with CF at 12 months, and 54.1% received exclusive bottle feeding with CF at 12 months. The remaining 18.4% received breast and bottle feedings with CF at 12 months. A total of 35.2% of the sample had anemia of which 67.2% was mild anemia. All infants (100%) included in the study were supplemented with iron (Table 1).

Table 2 shows the results of the bivariate correlation analyses between sex, infant's childbirth order, mothers' educational level, monthly family income, age of introducing CF, receiving exclusive bottle feeding with CF at 12 months, and receiving exclusive breastfeeding with CF at 12 months. The age of introducing CF had the strongest significant positive correlation ($r = 0.14$, $p < 0.001$) with anemia, followed by receiving exclusive bottle feeding with CF at 12 months ($\phi = 0.12$, $p < 0.001$). In contrast, receiving exclusive breastfeeding with CF at 12

Table 1 Characteristics of the study participants (N = 1249)

Variables	Mean (SD)	Range	n (%)
Sex			
Male			638 (51.1)
Female			611 (48.9)
Family income/month (\$)	674.72 (11.2)	352–1480	
Mothers' educational level			
Secondary and less			712 (57.0)
Higher than secondary			537 (43.0)
Infant's birth order Median = 3		1–9	
Age of introducing CF (months)	5.24 (1.05)	3–8	
Receiving exclusive breastfeeding and CF at 12 months			
Yes			344 (27.5)
No			905 (72.5)
Receiving exclusive bottle feeding and CF at 12 months			
Yes			676 (54.1)
No			573 (45.9)
Hemoglobin (Hb) level (at 12 months)			
Not anemic (Hb ≥ 11 g/dl)			809 (64.8)
Anemic (Hb < 11 g/dl)			440 (35.2)
Anemia Categories (WHO)			
Mild-anemia (Hb 10–10.9 g/dl)			270 (67.2)
Moderate-anemia (Hb 7.0–9.9 g/dl)			128 (31.8)
Severe-anemia (Hb < 7.0 g/dl)			4 (1.0)

M Mean, SD Standard Deviation, n number, % percentage

CF Complementary feeding (Solid or semisolid)

\$: Family income in American Dollar

Table 2 Bivariate correlations of sociodemographic and feeding practices and anemia

Variables	Anemia	
	Phi coefficient (ϕ)	Point biserial r
Sex	0.03	-
Mothers' educational level	- 0.05	-
Receiving exclusive bottle feeding with CF at 12 months	0.12**	-
Receiving exclusive breastfeeding with CF at 12 months	- 0.13**	-
Infant's birth order	-	- 0.01
Age of introducing CF	-	0.14**
Family income/month	-	- 0.12**

CF Complementary feeding (Solid or semisolid)

** Significant at $p < 0.01$ (two-tailed)

months had the strongest significant negative correlation with anemia ($\phi = -0.13$, $p < 0.001$), followed by monthly income ($r = -0.12$, $p < 0.001$). However, sex, infant's child-birth order, and mothers' educational level were not significantly correlated with anemia.

A multivariate binary logistic regression was carried out, where all seven predictors (sex, family income/month, mothers' educational level, childbirth order, age of introducing CF, receiving exclusive breastfeeding with CF at 12 months, and receiving exclusive bottle feeding with CF at 12 months) were entered simultaneously in one step. A test of the full model compared with a constant-only or null model was statistically significant ($\chi^2_{(7)} = 18.55$, $p < 0.001$). The amount of variance between anemia and all predictors was good, with Cox and Snell's $R^2 = 0.05$ and Nagelkerke's $R^2 = 0.07$. Moreover, the Hosmer and Lemeshow goodness-of-fit test was used to evaluate whether there was a significant difference between

the predicted and observed values and the model, the results indicated that the model was not significant ($\chi^2_{(7)} = 11.09$, $p = 0.06$).

Table 3 summarizes the raw scores of the multivariate binary logistic regression coefficients. Wald statistics and the estimated change in odds along with a 95% CI were significant for four factors (i.e. predictors) which were: receiving exclusive bottle feeding with CF at 12 months ($B = 0.28$, $\chi^2_{(1)} = 4.38$, $p < 0.05$), age of introducing CF ($B = 0.24$, $\chi^2_{(1)} = 19.03$, $p < 0.001$), receiving exclusive breastfeeding with CF at 12 months ($B = -0.53$, $\chi^2_{(1)} = 13.95$, $p < 0.001$), and family income ($B = -0.001$, $\chi^2_{(1)} = 7.30$, $p < 0.01$). Additionally, the odd ratio of anemia among those receiving exclusive bottle feeding with CF at 12 months was 1.32 (> 1) with a 95% CI = 1.02–1.71, indicating that receiving exclusive bottle feeding with CF at 12 months led to a high likelihood of anemia among infants. Moreover, receiving exclusive bottle feeding with CF at 12 months was the highest risk factor for anemia. The odds ratio of receiving exclusive breastfeeding with CF at 12 months, family income, and age of introducing CF were 0.59 (< 1) with a 95% CI = 0.45–0.78; 0.98 (< 1) with a 95% CI = 0.97–0.99 and 0.72 (< 1) with 95% CI = 0.55–0.95 respectively, indicating that receiving exclusive breastfeeding with CF at 12 months, high family income, and later age of introducing CF led to a less likelihood of anemia.

Discussion

This study assessed the feeding practices and anemia prevalence among infants aged 12 months in the West Bank, Palestine. This study revealed that more than one-third of the sample had anemia, which is higher than the 30.4% reported in 2021 on similar participants in Palestine [18], and it is also higher than other

Table 3 Predictors of anemia: multivariate binary logistic regression

Predictor	β	Wald chi-square test	p	Odds Ratio	95% CI	
					Lower	Upper
Infant's birth order	- 0.02	0.56	0.46	0.98	0.92	1.04
Sex	0.11	0.77	0.38	1.11	0.88	1.41
Mothers' educational level	- 0.025	0.033	0.86	0.98	0.75	1.28
Receiving exclusive breastfeeding with CF at 12 months	- 0.53	13.95	< 0.001	0.59	0.45	0.78
Receiving exclusive bottle feeding with CF at 12 months	0.28	4.38	0.036	1.32	1.02	1.71
Age of introducing CF	0.24	19.03	< 0.001	1.27	1.14	1.42
Family income	- 0.001	7.30	0.007	0.98	0.97	0.99

Overall model (Cox & Snell's $R^2 = 0.05$; Nagelkerke's $R^2 = 0.07$, $p < 0.001$)

CF Complementary feeding (Solid or semisolid)

international studies in China and several developed countries such as Australia and U.S [23–26]. The current finding can be related to worsening nutritional practices, declining families' financial status, and increased difficulties in accessing healthcare services due to the ongoing armed conflict in Palestine [22, 27]. These factors may have led to poor dietary intake of some micronutrients (such as iron) that are essential for erythropoiesis and related body processes [22, 28]. Therefore, it is important to focus on prevention and accessing nutritious foods among the most disadvantaged groups with higher poverty rates.

The results of this study showed that most of the anemia was mild, which is congruent with the findings of previous studies conducted in Palestine [18] and neighboring Jordan [29]. Also, this result is consistent with previous studies conducted in Africa and India [9, 30–32]. This confirms the widespread of mild anemia in developing countries which is mainly attributed to iron deficiency, economic constraints, and parasitic infections [1].

This study showed that the age of introducing CF was a significant predictor for anemia. Infants who were introduced to CF at six months and not earlier had clinically higher levels of Hgb and experienced fewer anemias. This result is consistent with previous studies which reported that children who started early introduction (< six months) of CF had a higher prevalence of anemia [9, 11, 33, 34]. CF may contain large amounts of nutrients like proteins, lipids, and carbohydrates which require a large number of enzymes to be digested. These enzymes may not be sufficiently available in younger infants, aged less than six months, which can influence the absorption of iron and vitamins required for erythropoiesis and related processes resulting in anemia [35]. Furthermore, CF needs preparation, which can be associated with food contamination that leads to diarrheal diseases, malabsorption, and consequently anemia [9, 36]. This study highlights the importance of initiating CF at six months and not earlier to decrease the risk of anemia and to facilitate a safe administration of enriched nutrients according to the infants' age. The European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) recommends starting CF that is iron-rich or iron-fortified at 6 months of age [37].

This study showed that infants who received exclusive breastfeeding with CF at 12 months had a lower risk of anemia, which is supported by previous studies [35, 38]. Therefore, exclusive breastfeeding with CF at 12 months of age or more should be recommended, especially in developing countries.

This study showed that infants aged 12 months with a high family income were less likely to have anemia than those with a low family income which is supported by previous studies [9, 11, 38–43]. It can be assumed that improving family income improves nutritional status which decreases the risk of anemia [9, 44].

Furthermore, this study found that receiving exclusive bottle feeding with CF at 12 months increased the likelihood of infants to develop anemia. This result is supported by previous studies [12, 38]. This result could be interpreted as bottle-fed 12-month-old infants tend to consume larger volumes of milk, which can interfere with iron absorption and intake of iron-rich foods. Although formulas are enriched with micronutrients like iron [38, 39], the iron in cow's milk is poorly absorbed by the body. The cow's milk negatively affects the absorption of iron as it contains excessive amounts of protein, lipids, and minerals (specifically calcium), and there are inadequate enzymes to digest all of these nutrients in 12-month-old infants [35].

Limitations of the study

Despite yielding significant results about identifying anemia in Palestine, this study has several limitations. This study was retrospective; thus, a prospective study is recommended to follow up on the status of infants with anemia and those at high risk for anemia. This study attributed anemia to nutritional deficiency and used Hgb as a measure of anemia, however, it did not look into other causes or used other measures of anemia. Additionally, this study did not investigate whether the anemia was due to iron deficiency or vitamin B12 deficiency. Therefore, future studies need to be conducted to address these issues. This study was conducted in only one governorate in Palestine which might limit the generalization of the findings. Also, this study focused on specific demographic data and feeding practices; thus, further studies should be conducted to study other variables, such as parents' awareness of anemia in different places.

Implications for practice

The results of this study can support policymakers and healthcare professionals in developing strategies and policies for enhancing Hgb levels and minimizing the prevalence of anemia among infants by taking into consideration the protective and detrimental factors. Such strategies should include raising awareness about the importance of breastfeeding in the first six months and not starting CF before this time. Using social media platforms to spread information related to anemia and proper feeding practices should be encouraged. Despite challenges to improving family income, governments and policymakers should develop programs to assist

families in enhancing their financial status to decrease the prevalence of anemia among infants.

Based on the findings of this study, nurses should develop and implement educational programs about anemia and the negative outcomes on infants in primary health centers while focusing on protective factors. Furthermore, it is necessary to guide mothers to begin CF at six months and provide them with booklets and brochures about the appropriate food selection at each age, for example at seven months, eight months, etc. Follow-up surveys should be recommended on infants who experience anemia to investigate their health and developmental status. Additionally, continuous surveys for Hgb levels among infants should be performed.

Conclusion

This study has indicated that more than one-third of infants experienced anemia, and the majority of them experienced mild anemia. Receiving exclusive breastfeeding with CF at the age of 12 months, introducing CF at the age of six months and not before, and having a high family income were protective factors against anemia, while receiving exclusive bottle feeding with CF at age of 12 months was a risk factor for anemia.

Abbreviation

CF Complementary Feeding

Authors' contributions

M.M. respectively conducted conceptualization. M.M. conducted data curation. M.M. and A.A. respectively conducted an investigation. M.M. E.A. and A.A. respectively conducted methodology. M.M. conducted project administration. M.M. conducted supervision. M.M. A.S. A.A. and E.A. conducted writing—original draft. M.M. A.A. and A.S. conducted writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Data availability

The datasets generated and/or analysed during the current study are not publicly available but are available from the corresponding author on a reasonable request.

Declarations

Ethics approval and consent to participate

Approval was obtained in accordance with the Declaration of Helsinki from the Helsinki Committee in Palestine, and the Institutional Review Board (IRB) at the Arab American University with reference No# R- 2021/A/136 N. Participants provided informed written consent. Confidentiality of the data was maintained throughout data collection and analysis.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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