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"Prevalence of anemia and its associated risk factor of Iron deficiency among children aged 9 months attending primary care in Ibri Oman"

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ABSTRACT

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INTRODUCTION

Anemia is a condition in which the number of red blood cells or the hemoglobin concentration with in them lower than normal. Hemoglobin is a protein that lets red blood cells carry oxygen to other cells in the body. The optimal hemoglobin concentration is required to meet the physiologic needs varies by age, sex, elevation of residence, smoking and pregnancy status.1

Iron is an essential trace element that is used to form molecules in the body, such as hemoglobin. Ferritin is the protein within the body that stores iron and releases it through channels in a controlled fashion.2

Childhood anemia is a condition where a child has an insufficient hemoglobin (Hb) level to provide adequate oxygen to the body tissues. For children between 6 and 59 months (generally referred to as under-fives), the threshold Hb level for being nonanemic is 11.0 grams per deciliter (g/dl). Hemoglobin (Hb) concentration alone cannot be used to diagnose the cause of anemia.3-4Although many indexes are available, determination of Iron status by using Serum Ferritin (SF) concentrations is the most commonly deployed strategy used in clinical and public health settings.17(Hypoferritinemia means low iron storage in the ferritin form, Hypoferritinemia diagnosed when the level of serum ferritin reduced below 12 (µg/L) in the target age group in our institute's reference range.18

Anemia has numerous potential etiologies followed by acute blood loss and heredity or acquired diseases, the most common cause of anemia in young children is caused by iron-poor diet, rapid growth (in the first year of life and in adolescence), or the inability of the body to absorb iron such as with cow's milk (toddlers who drink too much cow's milk may also become anemic if they are not eating other healthy foods that have iron). Iron deficiency anemia during pregnancy adversely affects the iron level of the infant at birth. In the first 6 months of age, iron stores are dependent on what has occurred during pregnancy. The fetus extracts iron in amounts proportional to the levels available in the mother. Infants of mothers with moderate and severe anemia have significantly lower cord serum ferritin levels and poor iron stores at birth. Iron deficiency commonly develops after six months of age if the complementary foods do not provide sufficient absorbable iron, even for exclusively breastfed infants.13 These conditions most often lead to iron deficiency anemia. In children iron deficiency develops slowly and produces few acute symptoms. As the deficiency worsens children become pale and weak, eat less, and tire easily. They gain weight poorly, have frequent respiratory and intestinal infections, and may develop pica. The most worrying association is that between iron deficiency and impaired development in behaviors, cognition, and psychomotor skills. Over the past three decades many studies have confirmed this relation, but whether iron deficiency is the sole cause of these deficits remains unclear.5

Anemia is highly prevalent globally. WHO estimated the worldwide prevalence of anemia latest in 2019, global anemias prevalence was 39.8% (95% UI 36.0%, 43.8%) in children aged 6-59 months, equivalent to 269 million children with anemia? The study shown that the world bank low-income group of African countries are highly prevalent ranging from 60-80 % among all Mali 79% and in middle-east Yamen 79.5% was highest. The high-income group countries America was lowest 6.1%, Canada 13.2%, Australia 13.3%, France 14.7%, Korea 15.0%, Germany 15.10%, New Zealand 15.3%. UK 15.5%, Japan 16.70%, Oman 24.30% (20-40%) was highest in this group. Upper middle-income group was like Brazil 11.60%, China 18.80%, Argentina 19.0%, Russian federation 21.90 %, Malaysia 24.60%, South Africa 44.40% is highest. In lower middle- income group was Philippines 13.50% Iran 26.0%, Egypt 32.20%, Algeria 34.30, Bangla dash 43.10%, Pakistan 53.0%, India 53.40% was highest in this group.6

A severe public health problem exists when anemia prevalence is >40% in any group.19

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Anemia Prevalence	Public Health Significance
≥40%	Severe
20-30%	Moderate
5-19%	Mild
O-4.9%	Normal

Research Questions:

What is being investigated?

The main objective of the study is to estimate the prevalence of IDA among nine-month-old children attending child screening in primary health care at Ibri Extended health center Oman. APRIL 2022-23.[16]

Why is the problem important? Has anyone else said so? A briefly review on literature review.

The aim of screening IDA in children is the prompt identification and therefore early treatment of anemia, which may improve health outcomes including growth, cognitive, psychomotor, and neurodevelopmental outcomes, mortality, and quality of life. Most infants with no risk factors such as prematurity or low birth weight are at low risk of iron deficiency during the first six months of life, due to iron stores from the perinatal period. This explains why screening programme usually focus on children from 9 months of age.[11] (The American Academy of Pediatrics recommends that all infants be tested for iron deficiency anemia starting between ages 9 months and 12 months and, for those who have risk factors for iron deficiency, again at later ages).[12]

The childhood anemia remains one of the most salient nutritional disorders facing mothers and children. Iron deficiency, linked to low nutritional iron consumption is one of the critical causes of childhood anemia. The analysis of the research will reveal the status of maternal and child health care. [10]

There are many researches have been published worldwide on the similar research topic but there is no published data related to Ibri polyclinic catchment area of primary health care in Oman.

An extensive literature review was carried out by retrieving articles from various databases like Google search, Google scholar, Pub med, Science direct, World Bank and WHO databases. In addition to these different reports were also being studied including World Health Organization and World Bank reports also MOH Oman Health protocol for screening of anemia. The relevant articles were retrieved from different databases by using following text words and phrases: 'Anemia', 'Child hood anemia', 'Hb', 'S. Iron', 'Ferritin', 'Iron deficiency', 'Epidemiology', 'Etiology', 'AAP', 'Biostatistics'.[7]

What this research contributes? How is this research different from what has done before?

Babies are born with iron stored in their bodies because they grow rapidly infant and toddler need to absorb a lot of iron each day. Iron deficiency anemia most commonly affects babies 9 through 24 months old.[8]There are now convincing data to show that iron deficiency in infancy and early child hood is causally associated with developmental delay.[9]Anemia is associated with many other disadvantages such as poverty, low birth weight, malnutrition, poor education among mothers, and lack of stimulation in the home all of which also affect child development. Screening of children at the age of 9 months is good for well-being and development of the child.[5]

Earlier published studies related to this topic are based on hemoglobin estimation only and different ages 9, 12 months and so on till 56 months.

The scope of this present study will emphasize the importance of screening for anemia in children by Hb estimation and Serum Ferritin level for anemic individuals at 9 months of age for early detection and prevention of IDA in infants and introduction of iron-rich complementary food.

METHODOLOGY

Research Design and Procedure:

This is a cross-sectional, descriptive, retrospective study.[13-15](NEDARC- Descriptive, Retrospective) (M AL Alawi et al Bahrain).

The range of hemoglobin < 11.0 g/dl and serum ferritin level <12 (µg/L) for the anemic children for the diagnosis of iron deficiency in this target age group.

A statistically significant sample size of **368** children with an anticipated attrition of 18% to follow-up yielded a total of **434** children has been determined using the statistical power analysis formula (Daniel, 1999) is used.[4-14] (Kebo D, Petrucka, 2018 Feb 5th "Prevalence and predictors of anemia among children under 5 years of age in Arusha" District, Tanzania). (Daniel WW, editor. 7th ed. New York: John Wiley & Sons; 1999. Biostatistics: a foundation for analysis in the health sciences).

The statistical power analysis formula (Daniel, 1999).[4-14]

$n= z^2p(1–p)/d^2$

where n = sample size, p = prevalence of anemia 40%

(20-40% in Oman as per latest WHO data) z = z-value at 95% confidence (=1.96), d = level of significance (=5%),

Inclusion and Exclusion criteria:

Inclusion: Children at the age of 9 months only included for Hb estimation.

Anemic children are included for Ferritin level estimation to confirm the IDA

Exclusion: Children with Pre term birth, G6PD deficiency, Sickle cell anemia, Beta thalassemia, Fanconi anemia and other known anemic conditions are excluded.

Operational Framework:

The sampling frame with convenience sample was designed to include all 9-month-old children's born in August 2021 and after that visited in Ibri Extended Health Centre, Oman for Primary Health Care during April 2022 and go on check for Hemoglobin levels in CBC also serum Ferritin level for the anemic children have included in the study.

Instrumentation and Data Analysis:

Venous blood was collected under aseptic conditions with parent consent. The EDTA anticoagulant tube for CBC and SSB tube for serum Ferritin level.

CBC performed for Hemoglobin estimation on the CELL-DYN Ruby Automated Hematology Analyzer by Abbott.

Serum Ferritin level done on Roche Elecsys 2010 Immunology. automated analyzer.

Statistical data analysis done by IBM SPSS software.

Data Sources:

The data of 434 children's checked for Hb and available Serum Ferritin value for the anemic children have gathered from computerized AL-SHIFA-3 Hospital Information System and Laboratory Information System of the Ibri Polyclinic Laboratory.

Data Analysis:

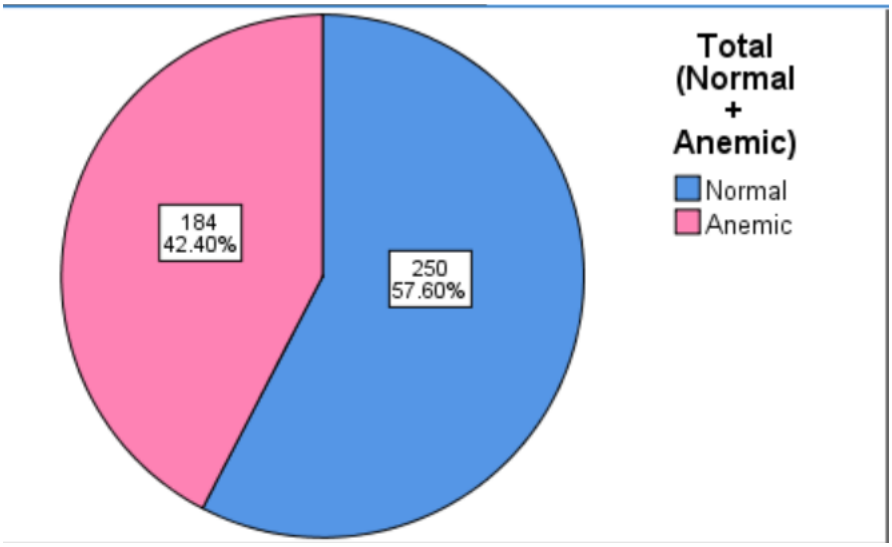
Statistical Data analysis done by IBM SPSS version 25. The outcome variable will be classified as categorical variable are anemic or nonanemic, and the Hb, serum ferritin level will be as continuous variables.

The Prevalence of anemia presented by descriptive and inferential statistics with chi-square (X^2) test, correlation analysis of anemia and hypoferritinemia.

Descriptive Statistics

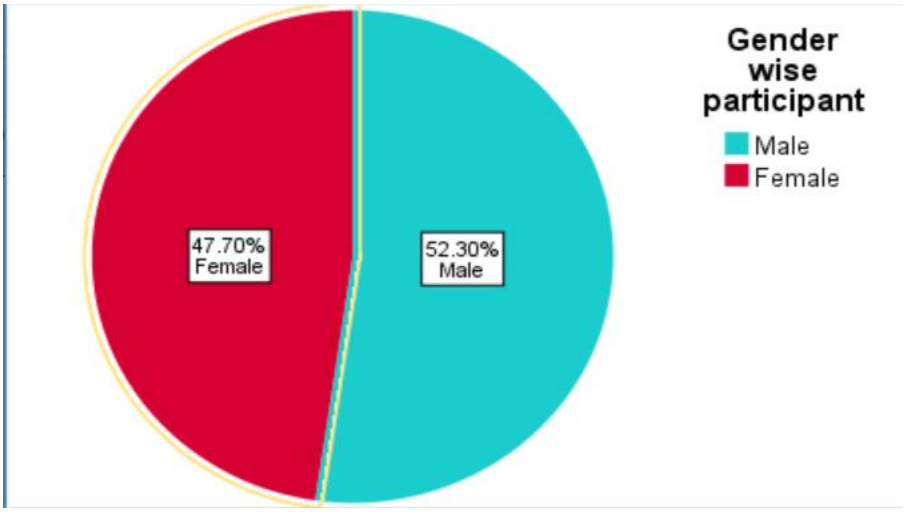
	N	Minimum	Maximum	Mean	Std. Deviation
Total (Normal + Anemic)	434	1	2	1.42	.495
Hb value	434	6.58	13.86	10.8281	1.00571
Low Hb	184	6.58	10.66	9.9244	.72087
Low Ferritin	184	1.20	27.60	7.8634	2.90997
Valid N (listwise)	184				

The analysis includes a total of 434 individuals categorized into normal (250) and anemic) group (184), with a mean Hb value 10.83. The low Hb/Ferritin for the 184 participants identified with low Hb or low Ferritin, the mean Hb value was 9.92 and the mean ferritin level was 7.86

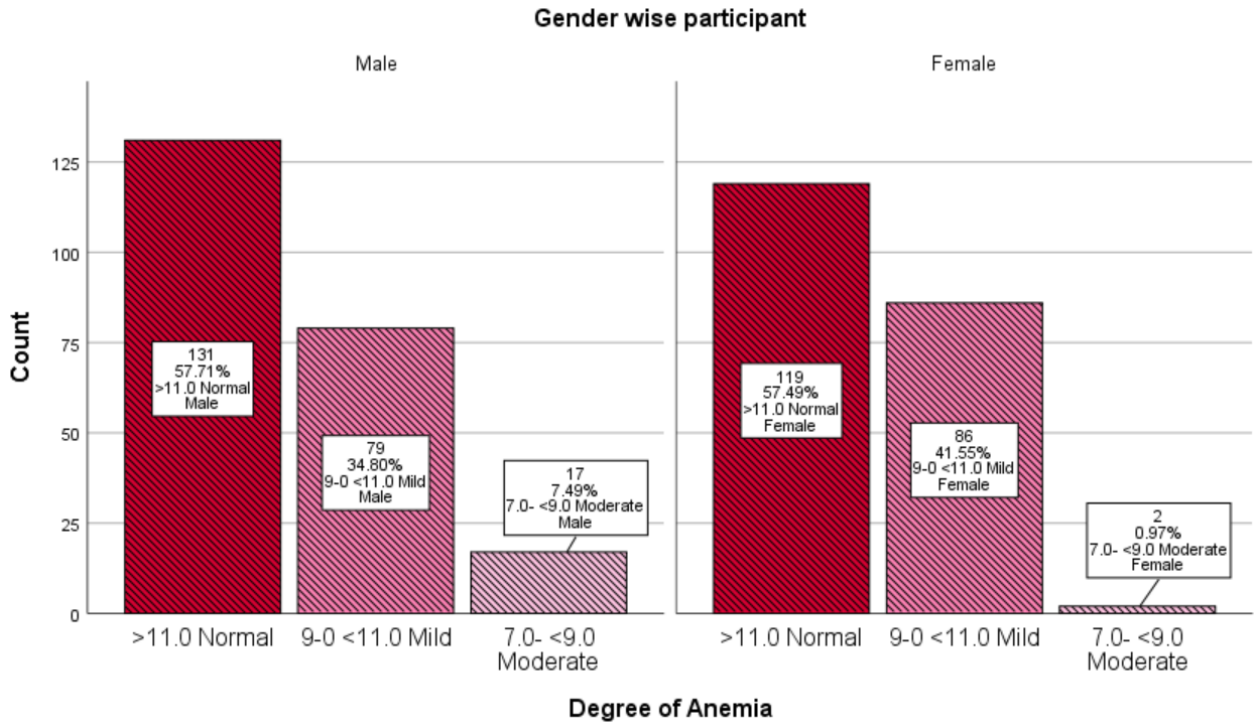


Total Participant Gender Wise

Total	Male	Female
434	**227**	**207**



The gender wise participant group is relatively well- balanced between males and females out of 434 the males was 227 with the 52.30 % and 207 was female with 47.70%.



The degree of anemia among all the participant by gander 57.71 % Normal male with 34.80% mild anemia and 7.49% moderate anemia, in the female group 57.49% normal with 41.55% mild and 0.97% moderate anemia, **overall male individuals have higher % of moderate level of anemia in comparison of female group.**

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Name of the month Hb Tested * Degree of Anemia	434	100.0%	0	0.0%	434	100.0%

Name of the month Hb Tested * Degree of Anemia Crosstabulation

Count

		Degree of Anemia			
		>11.0 Normal	9-0 <11.0 Mild	7.0- <9.0 Moderate	Total
Name of the month Hb Tested	April	28	20	6	54
	May	36	24	7	67
	June	35	23	2	60
	July	18	16	0	34
	August	25	14	0	39
	September	23	18	1	42
	october	27	20	1	48
	Novem	39	12	0	51
	dec	19	18	2	39
Total		250	165	19	434

Cross tabulation between month of testing and degree of anemia shows highest number of tests done in the month of May (67) followed by June (60) cases.

The highest number of mild to moderate anemia saw in April (26) followed by May (31) then in June (25) cases

Moderate cases of anemia were relatively low overall, peaking in April (6) and May (7) with several months (July, August, November) recorded zero moderate cases.

Chi-Square test

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender wise participant * Degree of Anemia	434	100.0%	0	0.0%	434	100.0%

Gender wise participant * Degree of Anemia Crosstabulation					
Count					
		Degree of Anemia			
		>11.0 Normal	9-0 <11.0 Mild	7.0- <9.0 Moderate	Total
Gender wise participant	Male	131	79	17	227
	Female	119	86	2	207
Total		250	165	19	434

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.819[a]	2	.003
Likelihood Ratio	13.504	2	.001
N of Valid Cases	434		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.06.

A Chi-Square test was performed to determine, if there is a significant association between gender and anemia severity based on the counts provided, Chi- Square **(χ2) 11.82**, degree of freedom **(df): 2,**

P-value: **0.003** since the p value is less than the typical significance level **(α=0.05)** so the null hypothesis rejected. This indicates a statistically significant association between gender and the degree of anemia in this dataset. Specially, males appear to have a higher number of moderate anemia cases compared to females.

Pearson Correlation Between Low Ferritin and Low Hb			
		Low Ferritin	Low Hb
Low Ferritin	**Pearson Correlation**	**1**	**.408****
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	1542.352	156.188

	Covariance	8.428	.853
	N	184	184
Low Hb	Pearson Correlation	.408**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	156.188	95.097
	Covariance	.853	.520
	N	184	184
**. Correlation is significant at the 0.01 level (2-tailed).			

The Pearson correlation is **0.408**, indicating a moderate positive relationship. As ferritin levels increase Hb also tend to increase.

The P-value (Sig. 2- tailed) is ,**0.000,** which is less than **0.01**. This means the correlation is statistically significant at 99% confidence level, as denoted by double asterisks (**)

Limitation:

The limitation of this study is serum ferritin has measured only in anemic infants so the iron deficient, non-anemic infants who may benefit from iron supplementation cannot be detected.

Determination of hemoglobin is not the optimal way to identify children at risk from effects of iron deficiency as it fails to identify patients who are iron-deficient but are not anemic.[12](M Kohli-Kumar · 2001 "Screening for anemia in children: AAP recommendations").

Serum ferritin is an acute-phase reactant that becomes elevated in response to inflammation, complicating the diagnosis.

The seasonal variation contributes to low Hb level in children. It is hot and dry season April to Sept.

Anticipated outcomes:

The analysis of the research reveals the progress of the national screening programme in the catchment area of Ibri Polyclinic, Ibri.

This research study helps to understand the health care and nutritional status of children at the age of 9 month.

It reveals early detection and prevention of IDA in infants and introduction of iron-rich complementary food.

Education on healthy food habits at weaning with emphasis on increased consumption of foods that enhance iron absorption should be included in any health and nutrition education program.

The study extends more attention should be given to health education in the media and in child and maternity clinics.

Mothers should receive appropriate advice on the benefits and side-effects of iron supplementation.

Research and Key Findings:

This research included a total of 434 individuals categorized into normal (250) and anemic group (184), with a mean Hb value 10.83. The low Hb/Ferritin for the 184 participants identified with low Hb or low Ferritin, the mean Hb value was 9.92 and the mean ferritin level was 7.86. The total anemic individual found to be 42.40%.

The gender wise participant group was relatively well- balanced between males and females out of 434 the males was 227 with the 52.30 % and 207 was female with 47.70%.

The degree of anemia among all the participant by gander 57.71 % Normal male with 34.80% mild anemia and 7.49% moderate anemia, in the female group 57.49% normal with 41.55% mild and 0.97% moderate anemia, overall male individuals have higher % of moderate level of anemia in comparison of female group.

Months wise Physiological variation of anemic cases noted, the highest number of mild to moderate anemia saw in month of April (26) followed by May (31) then in June (25) cases.

Moderate cases of anemia were relatively low overall, peaking in April (6) and May (7) with several months (July, August, November) recorded zero moderate cases.

A Chi-Square test was performed to determine, if there is a significant association between gender and anemia severity based on the counts provided, Chi- Square (χ2) 11.82, degree of freedom (df): 2,

P-value: 0.003 since the p value is less than the typical significance level (α=0.05) so the null hypothesis rejected. This indicates a statistically significant association between gender and the degree of anemia in this dataset. Specially, males appear to have a higher number of moderate anemia cases compared to females.

The Pearson correlation is 0.408, indicating a moderate positive relationship. As ferritin levels increase Hb also tend to increase, vice versa.

The P-value (Sig. 2- tailed) is ,0.000, which is less than 0.01. This means the correlation is statistically significant at 99% confidence level, as denoted by double asterisks (**)

Conclusion:

In year April 2022-23 the estimated prevalence of "Iron Deficiency Anemia" among 9-month-old children attended child screening in primary health care at **Ibri Polyclinic Ibri, Oman was 42.40 %.** The study reveals that the targeted child age group consistent with 2% increased with latest reference of WHO 2019 Oman prevalence data of 20-40 %.

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