Screening for double burden of infant's anemia and micronutrient deficiencies in urban, Semi-urban and rural clinics in Umuahia North, Abia State, Nigeria.

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Abstract

Introduction: This randomized study was to evaluate for anemia prevalence, micronutrient status and co-existence of double burden in infants (0 to 5 years) of Urban, semi-urban and rural clinics in Umuahia North Local Government Area, Abia State, Nigeria.

Methods: One hundred and fifty (150) consenting infants were used for the study. A semi-structured interviewer administered questionnaire was used to obtain information on socio-demographic and socioeconomic factors associated with the infants. Blood samples were collected under sterile condition and haemoglobin concentrations, packed cell volume, red blood cell, mean corpuscular volume, platelets, iron, vitamins A and B12 were determined.

Results: Showed that vitamin A, vitamin B12 and iron concentrations of infants examined in Urban (FMC) were significantly ($p<0.05$) higher than those examined in Semi-urban (Anelechi hospital) and Rural (Healing cross hospital). Results showed that infants examined at Urban and Semi-urban areas had significantly ($p<0.05$) higher haemoglobin concentration (Hb), Packed Cell Volume (PCV) and Red blood cell (RBC) compared to those who were examined at Rural area while the Mean Corpuscular Volume (MCV) of infants examined at Semi-urban area was significantly higher ($p<0.05$) than those examined at Urban and Rural areas. The prevalence of anemia among infants in Urban, Semi-urban, Rural is 18%, 4%, and 32% respectively.

Discussion and Conclusion: The prevalence of anemia was higher in Rural than Urban and Semi-urban infants. There is a coexistence and complex interaction between micronutrient deficiencies, infectious diseases and anemia. The prevalence of anemia was found to be low among infants in this study compared to similar studies already carried out.

Keywords: *Anemia, Micronutrient, Infants, Prevalence, Double burden.*

Accepted on July 13, 2020

Introduction

Anemia was recently quantified to account for close to 9% of the total global disability burden from all conditions and thus has significant consequences for human health as well as social and economic development [1]. Anemia has been associated with negative outcomes in several population groups including maternal mortality, low birth weight and premature birth, as well as delayed child development; yet, a causal link has not been established for all outcomes, despite strong biological plausibility. In addition, studies have shown Iron deficiency causes alterations to brain structure and function, which may be irreversible even with iron treatment, particularly if the deficiency occurs during infancy when neurogenesis and differentiation of different brain regions are occurring [2].

Nevertheless, a clear causal relationship has not been established between iron-deficiency anemia and delayed cognitive or behavioral development [3]. Malaria disturbs iron metabolism in multiple ways and the mechanism for malaria-related anemia is probably related to both increased hemolysis (erythrocyte destruction) and decreased production of red blood cells [4,5]. Micronutrient deficiencies that can cause anemia can easily develop during these situations, or become worse if they are already present, particularly for those groups with greater nutrient needs and higher risk of anemia (particularly children aged under 2 years, and pregnant and lactating women) [6].

It has since been established that the complex, integrated immune system needs multiple specific micronutrients, including vitamins A, D, C, E, B6, and B12, folate, zinc, iron, copper, and selenium, which play vital, often synergistic roles at every stage of the immune response [7]. Thus, the randomized evaluation or screening for anemia prevalence, micronutrient status and possible co-existence of double burden on infants in Urban, semi-urban and rural clinic in Umuahia North.

Materials and Methods

Study area

The study was carried out in Umuahia North, Abia State. Three hospitals namely; Federal medical Centre (Urban area), Anelechi (Semi-urban area) and Healing Cross Hospitals (Rural area) were randomly selected from the Local Government Area of the study (Figure 1).

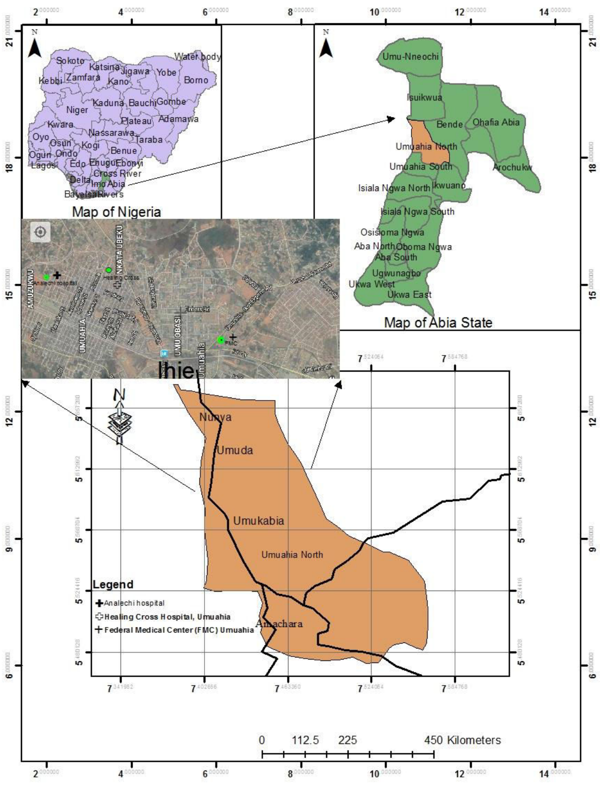

Figure 1: Map of the study locations.

Method of data collection

The research method adopted an independent random sampling and information of the infants (respondents) were obtained using 50 copies of questionnaires each in the Urban, Semi-urban, and Rural locations respectively, with the assistance of laboratory technicians across the designated hospitals were the study was carried out. This summed up to a total of 150 respondents. The use of laboratory technicians helped immensely in fast-tracking the administration and collection of questionnaires and blood samples.

Sample collection and processing

Venous blood samples were collected from the respondents (infants) using syringe and needle, into bottles containing anticoagulant (EDTA) for haematological assay. The blood samples for other biochemical studies were collected in plain bottles. The blood samples were allowed to clot for 25 minutes and then centrifuging at 3000 rpm for 10 minutes. The serum was aspirated using a Pasteur pipette into clean dry sample bottles.

Biochemical analyses

Determination of haematological parameters

This was determined using automated heamolyzer using manufacturer's operational guidelines as described by [8]. The automated heamolyzer counted and sized red blood cells (RBC) and platelets (PLT) using electronic resistance detection. Hemoglobin (HGB) is converted to methemoglobin and read photometrically at 555 nm. The automated heamolyzer directly measured the RBC, HGB, HCT, PLT. The remaining parameter such as MCV was calculated as follows:

MCV=(Hematocrit (%) ×10)/RBC count (millions/mm3 blood)

Determination of vitamin B12

Vitamin B12 concentration was determined by plasma microplate enzyme immunoassay, as described by [9]. Vitamin B12 determination is based on competitive ELISA for its quantitative measurement.

Determination of iron

Serum iron concentration was estimated spectrophotometrically using the Tulip diagnostic kit as described by [10]. Iron bound to transferrin is released in an acidic medium and the ferric ions are reduced to ferrous ions. The Fe (III) ions react with ferrozine to form a violet coloured complex. Intensity of the complex formed is directly proportional to the amount of iron present in the sample.

Determination of vitamin A (vitamin A)

Vitamin was determined by the method described by [11]. Vitamin A determination was based on Reverse-Phase HPLC method of vitamin A analysis.

Statistical analysis

In this study, the descriptive analysis (frequency, simple percentage) was used to analyze the response of the respondents. Data from biochemical analysis were analysed using One-Way ANOVA with $p<0.05$ considered as statistically significant using Duncan's-test.

Results

Table 1, below shows socio-demographic characteristics of the respondents. All the respondents were between 0-5 years. Out of the 150 respondents across the three different clinics (Urban, Semi-Urban and Rural), 85 females and 65 males took part in the study. The mother of the respondents examined in the Urban area Federal medical centre are more educated as compared to mothers of those who were examined at Anelechi and Healing Cross Hospitals.

However, the mothers of the respondents who attended Healing cross hospital are less educated. Out of the total 150 respondents, majority (144) of the respondents' fathers' ethnicity happened to be Igbo, 2 from Hausa, 3 from Yoruba and 1 from other ethnic groups. A similar number (144) was also observed for mothers of the respondents (Table 1).

Results (Table 2) showed that vitamin A, vitamin B12 and iron concentrations of infants examined in Urban area were significantly ($p<0.05$) higher than those examined at both Semi-urban and Rural areas while the Semi-urban was higher than the Rural, though, no significant ($p>0.05$) differences were observed.

Results (Table 3) showed that infants examined at Urban and Semi-urban areas had significantly ($p<0.05$) higher haemoglobin concentration (Hb), packed cell volume (PCV) and Red blood cell (RBC) compared to those who were examined at Rural area while the mean corpuscular volume (MCV) of infants examined at Semi-urban area was significantly higher ($p<0.05$) than those examined at Urban and Rural areas.

Below Table (4a, b and c) indicates the percentage prevalence of anemia based on the assayed haemglobin values in the urban, semi-urban and rural areas respectively.

Table 1: Socio-Demographic characteristics of respondents.

Variables	Urban		Semi-urban		Rural	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Age						
0-5 years	50	100	50	100	50	100
Sex						
Male	27	54	23	46	15	30
Female	23	46	27	54	35	70
Total	50	100	50	100	50	100
Area of upbringing						
Rural	13	26	18	36	31	62
Urban	37	74	32	64	19	38
Total	50	100	50	100	50	100
Mothers' Level of Education						
Primary School	4	8	1	2	9	18
High school	7	14	37	74	17	34
College/University	39	78	12	24	14	48
Total	50	100	50	100	50	100
Mothers' Ethnicity						
Igbo	46	92	49	98	46	90
Hausa	1	2	1	2	1	2
Yoruba	3	6	-	-	3	6
Others	-	-	-	-	1	2
Total	50	100	50	100	50	100
Fathers' Ethnicity						
Igbo	50	100	49	98	45	90
Hausa	-	-	1	2	1	2
Yoruba	-	-	-	-	3	6
Others	-	-	-	-	1	2
Total	50	100	50	100	50	100

Table 2: Result for vitamin and mineral status assay for infants.

Category	Vitamin A (µg/dl)	Vitamin B12 (pg/dl)	Iron (µg/dl)
Semi-urban	36.05ab ± 14.54	770.90b ± 289.04	82.90b ± 35.52
Urban	37.85a ± 10.00	912.86a ± 198.39	106.92a ± 26.13
Rural	31.27b ± 15.28	675.14b ± 294.66	71.98b ± 42.93
p-value	0.044	0	0
Note: Data are mean ± SD. Mean in the same column with different superscript letters are significantly different, p<0.05 (One-Way ANOVA followed by Duncan post-hoc test).			

Table 3: Result for hematology status assay for infants.

Category	Hb (g/dl)	PCV (%)	MCV (fl)	Platelet (103mm3)	RBC (106mm3)
Semi-urban	14.67a ± 3.12	35.06a ± 7.56	95.76a ± 5.15	237.88b ± 59.09	4.00a ± 0.86
Urban	14.27a ± 2.02	35.30a ± 4.48	91.19b ± 8.42	312.62a ± 35.60	4.14a ± 0.46
Rural	12.54b ± 2.88	30.86b ± 5.46	93.78ab ± 4.60	237.42b ± 74.65	3.59b ± 0.60
p-value	0	0	0.015	0	0
Note: Data are mean ± SD. Mean in the same column with different superscript letters are significantly different, p<0.05 (One-Way ANOVA followed by Duncan post-hoc test).					

Table 4a: Prevalence of anemia among infants in Urban.

Hemoglobin (g/dl)	Frequency	Prevalence (%)
6.00 – 10.99	9	18
11.00 – 15.99	19	38
16.00 – 20.99	22	44
Total	50	100
Note: Hb level< 11g/dl is considered anemic using World Health Organization criteria (Ubike et al., 2013)		

Table 4b: Prevalence of anemia among infants in Semi-urban.

Hemoglobin (g/dl)	Frequency	Prevalence (%)
9.80 – 10.99	2	4
11.00 – 12.18	6	12
12.19 – 13.37	9	18
13.38 – 14.56	8	16
14.57 – 15.75	13	26
15.76 – 16.94	6	12
16.95 – 18.53	6	12
Total	50	100
Note: Hb level< 11g/dl is considered anemic using World Health Organization criteria (Ubike et al., 2013)		

Table 4c: Prevalence of anemia among infants in Rural.

Hemoglobin (g/dl)	Frequency	Prevalence (%)
6.00 – 10.99	9	18

11.00 – 15.99	19	38
16.00 – 20.99	22	44
Total	50	100

Note: Hb level<11g/dl is considered anemic using World Health Organization criteria (Ubike et al., 2013).

Discussion

Although, the association between anemia and gender was not determined in this study, the influence of gender on anemia shows conflicting results, as other studies found no association between gender and anemia, whereas other authors reported that anemia is more common in boys [12-14].

In Nigeria, micronutrient deficiency is believed to be a major risk factor for child survival [15]. The incidence of micronutrient deficiencies in Nigerian children under 5 years was documented 12 years ago by the Nigerian Food Consumption Survey as, 23.3%, 34.0%, 13.0%, and 20.0% for Vitamin A deficiency, iron deficiency anemia, IDDs, and zinc deficiency disorders, respectively [16]. According to, a prevalence of serum vitamin A<0.70 µmol/L (<20 µg/dL) >20% was suggested as defining public health problems related to Vitamin A deficiency (VAD). In the present study, vitamin A, vitamin B12, and iron were examined [17]. Vitamin A concentration observed for Urban was significantly ($p<0.05$) higher than Semi-urban and Rural. The mean serum vitamin A concentration for all children <5 y old surveyed (n=150) at the studied locations were observed to be higher than the cut-off point of 0.70 µmol/L, thus, values observed for vitamin concentration are classified as adequate. Results of this study corroborates with findings of who reported, in a study carried out in Nigeria, that mean concentration of vitamin A concentration for all children <5 y old surveyed (n=3099) at the national level was slightly higher than the cut-off point of 0.70 µmol/L [17]. However, they reported no significant difference in vitamin A concentration for Urban and Rural. The impact of vitamin A supplementation on infant and childhood mortality had been reviewed previously and it has been established that vitamin A has a definite role in reducing all-cause mortality in children older than six months of age [18]. Inadequate maternal vitamin B12 status during pregnancy places the fetus at risk for a neural tube defect before birth, and for anemia and neurological disorders following birth, infact, vitamin B12 accumulation in utero is the major determinant of vitamin B12 status in the newborn and throughout infancy [19-20]. In this study, vitamin B12 concentration of infants examined in Urban was significantly ($p<0.05$) higher than those examined at both Semi-urban and Rural areas. This could be attributed to dietary and oral maternal vitamin B12 supplementations to pregnant mothers during pregnancy, as fetal and maternal plasma concentrations of vitamin B12 are reported to correlate strongly. Report of suggests that supplementation with vitamin B12 during pregnancy is a strong determinant for infant vitamin B12 status and health outcomes [21]. In the present study, iron concentration of infants in Urban was significantly ($p<0.05$) higher than Semi-urban and Rural. This may be attributed to the high intake of iron rich foods as well as iron supplementations as compared to the other infants. Infancy is a period of rapid growth and consequently, high iron requirements [22]. Iron deficiency anemia is the most common pediatric hematologic disorder and the most frequent cause of anemia in childhood. The occurrence of iron deficiency anemia in infants has decreased in the United States due to iron fortification of infant formula and increased rates of breast feeding [23].

Evaluation of hematological parameters represents an important and relevant risk evaluation as the changes in hematological system have a longer predictor [24]. Red blood cells, hemoglobin concentration and packed cell volume (PCV) have been used to detect anemia and its severity and to monitor an anemic patient's response to treatment [25]. Results showed that infants in Urban and Semi-urban had significantly ($p<0.05$) higher hemoglobin (Hb) concentration, packed cell volume (PCV) and Red blood cell (RBC) compared to those in Rural. This suggests that anemia may not only have occurred as a result of low hemoglobin but may have been influenced by other factors (nutritional anemia due to poor complementary feeding practices, malaria infection with poor immunity to malaria among infants etc.), since, about 50% of the respondents (infants) in Rural claimed they received iron supplementation.

The prevalence of anemia among infants in Urban, Semi-urban, Rural are 18%, 4%, and 32% respectively. The prevalence of anemia was higher in rural than urban and Semi-urban settings. This result agrees with common findings suggestive of existence of deplorable health indicators in African rural settings. Results of the current study showed that more infants were anemic in the Urban compared to Semi-urban. This may be linked to the fact that even in Urban setting, children living in poorer households were at greater risk of having anemia than those from richer households as desperate migrations from rural to urban results to settling in poorly constructed houses in densely populated urban area. The result of this study is consistent with the reports of [26]. The anemia prevalence values reported in this study are significantly lower compared to the prevalence of anemia of 82.6% reported by [27]. Anemia is the result of a wide variety of causes and health determinants that often coexist together [28]. Iron deficiency is the most common cause leading to anemia including other factors, influence the progressive fall in hemoglobin observed during infancy such as stable malaria transmission, poor nutritional status, poor sanitation, micronutrient deficiencies, intestinal helminths, HIV infection, and hemoglobinopathies [29-33]. However, low haemoglobin is a non-specific indicator for anemia because it is also influenced by blood depleting parasites, chronic infections and haematological conditions [34].

Conclusion

There is double burden and complex interaction between micronutrient deficiencies, infectious diseases and anemia in the sampled population. However, there may be greater burden of both wasting and stunting coexisting in these infants and pregnant women who are exposed to give birth to children of lower weight – thus transmitting the adverse effects across generations. Therefore, a need to further identify the risk factors for anemia. There is need for a more effective infant nutritional policy and a comprehensive program that includes maternal and child health care delivery including Growth Monitoring and Promotion (GMP) and nutrition education, as well as the necessity to pay more attention to improving the health of these infants that have already been affected. Among other findings, the study showed that there was a relative compliance rate of adherence to iron and folic acid supplementation in the studied areas.

Acknowledgements

We acknowledge the support of all authors for their contributions.

Statement of Competing Interests

The authors have no competing interests.

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