Original Article

Association between Refractive Errors and Anemia: A Cross Sectional Study in Basra, Iraq

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Submission: July 27, 2024 Accepted: August 23, 2024 Published: September 30, 2024

Abstract

Background: anemia is a major global health problem that has major effects on human vision. **Objectives:** a concurrent presence of refractive errors has been identified in anemic children, which requires investigating this intriguing association. **Material and Methods:** this study used 100 children through clinical evaluations to establish whether they had refractive errors or not besides checking their anemic states. **Results:** this study found that children with anemia are 4.31 times more likely to develop refractive errors than those who do not have (95% CI: [confidence interval], $p < 0.05$), which means there is strong statistical evidence for this claim. **Conclusion:** there could be some connection between anemia and refractive errors thus challenging the idea of mere coincidence. Therefore, further investigation has been carried out to find out what exactly causes such correlations between these two conditions.

Keyword: Anemia, Myopia, Hypermetropia.

Introduction

Anemia has been considered a major public health issue that affects 1.62 billion people (24.8%) worldwide. [1] Anemia can cause an economic burden for individuals and their families. [2] Previous studies have reported that anemia is related to ocular changes. For example, retinal vascular tortuosity was directly associated with the severity of anemia. [3] Anemia with hemoglobin (Hb) concentrations less than 8 g/dL patients increased the prevalence of retinopathy. [4] As a type of anemia, iron deficiency anemia (IDA) increases concentrations of hemoglobin A1c (HbA1c) levels. [5-8] HbA1c concentrations are associated with refractive error, especially myopia. [9,10] Moreover, IDA patients had a significantly decreased choroidal thickness, [11] which is associated with myopia. [12]

Several studies have demonstrated the relationship between anemia and eye-related problems; [3,4,11] however, there were few studies investigating the relationship between anemia and refractive errors. When examining several children both their visual acuity (VA) as well as their hemoglobin level, we noticed that those with refractive error were more often suffering from anemia as well.

Anemia is defined as having a low mean value of less than two standard deviations (SD) of Hb, hematocrit (Hct) or red blood cell values according to age and gender in humans, [13-15] occurs when the equilibrium is disturbed between blood loss and blood production, [13] although decrease in Hb is often with the decrease in the number of red blood cells, the number of red blood cells may sometimes remai-

n normal despite the decreased Hb levels, as well as in iron deficiency anemia (IDA). [16] WHO standards define anemia as a level below 12 g/dl for pediatric age group males and females. [17] Refractive error is a condition in which parallel light rays falling on the light-sensitive layer of the retina are not focused. [18] Various types of refractive error are myopia, and hypermetropia. [18] The prevalence of refractive error has been reported at 25% to 71% in different studies. [19-22] It has been reported to be the leading cause of moderate visual impairment. If left untreated, the main cause of blindness is unrecognized and remains a major problem. [23-25]

Although anemia and refractive errors have been reported as the most common disorders in children and adolescents, a search of the published literature reveals very few studies investigating the relationship between these conditions. [26] Therefore, the study aims to determine whether our observation was just a coincidence or whether is there a real relationship between anemia and refractive error. Therefore, this study was designed to fully explore whether there is an association between these conditions, without going into detail about types or severity.

Materials and Methods

This cross-sectional analytical study was conducted on 100 children. After obtaining approval from the institutional ethics committee and informed consent, the recruited children were screened for the presence of anemia and assigned to the anemia group (Group 1) or the non-anemic group (Group 2). These groups were further examined for the presence of refractive error. The odds ratio for the presence of a refractive error in the two groups was calculated.

One hundred (100) children were selected to participate in the study. Exclusion criteria were: history of blood transfusion/hematinics therapy in the previous 4 months; History of significant blood loss, a visit for more than ten days to any area whose altitude exceeds 6,000 feet above mean sea level, history of eye injury or surgery, history of glaucoma or history of diabetes.

The mean (SD) age of the participants was 10.68 (2.87) years. Age was recorded as the number of completed years at the nearest birthday. The sex distribution was 64% (64/100) males and 36% (36/100) females.

Hb concentration measurements were made using a sodium lauryl sulfate method with an automated hematology analyzer XE-2100D (Sysmex, Kobe, Japan). As per the WHO standards, anemia was diagnosed at a level below 12 g/dl. [27] The participants were assigned to either an anemic group (Group 1) or a non-anemic group (Group 2).

- Group 1 comprised of the 65 participants. The sex distribution of this group was 63% (41/65) males and 37% (24/65) females.
- Group 2 comprised of the 35 participants. The sex distribution of this group was 66% (23/35) males and 34% (12/35) females.

All participants were examined by a consultant ophthalmologist at Insight Eye Center using a slit lamp to examine the anterior segment of the eye and direct ophthalmoscopy of the posterior segment. Participants were screened for refractive error. Visual acuity for each eye was measured at a distance with and without correction. Distant vision acuity was determined using the Snellen chart test, and if worse than 6/6 in one eye, we performed refraction by auto-refractometer to determine the type of refractive error as myopia or hyperopia. Myopia and hyperopia were defined as a sphere power of −0.50 D or worse and +0.50 D or greater, respectively, in either or both eyes. Any improvement in distant vision acuity with a

specific refractive error is recorded. If a participant already wore glasses, we checked these glasses and whether there were any changes in refractive error.

Results

The values of the Hb level and VA were collapsed into categorical, dichotomous scales, based on the presence or absence of anemia and refractive error. The improvement or otherwise in the VA with spectacles or pinhole was recorded on a categorical dichotomous scale.

The odds of the presence of refractive error in Group 1 and Group 2 were determined and subjected to the test of statistical significance of difference. Statistical analysis was done using the SPSS v. 26 program. A chi-square test was used for categorical variables, and Pearson correlation analyses were used in the statistical evaluation of the data. Table 1 shows the prevalence of refractive error in group 1 was higher as compared to that in group 2.

Table 1: Comparison of prevalence of refractive error in Group 1 and Group 2.

Group Type	No. of participants with refractive error (percent)	No. of participants without refractive error (percent)	Total no. of Participants	P value
Group 1.	45/65 (69.2%)	20/65 (30.8%)	65	0.001
Group 2.	12/35 (34.3%)	23/35 (65.7%)	35	
All participants	57/100 (57%)	43/100 (43%)	100	

Statistical analysis revealed that the odds of refractive error co-existing in the anemic participants were 4.31 times as compared to those in the non-anemic. Odds ratio 4.31; p =0.001. This relationship was statistically significant.

Between the sexes (Table 2 and 3), there was no statistically significant difference in the prevalence of anemia [odds ratio 1.21; p=0.793] or that of refractive error [odds ratio 2.72; p=0.059]. This assures that our findings were not attributable to a mismatch of sex distribution in the two groups.

Table 2: Comparison of prevalence of both sexes in Group 1 and Group 2.

Group Type	Anemia (percent)	Normal (percent)	Total no. of participants	P value
Male	41/64 (64.1%)	23/64 (35.9%)	64	0.793
Female	24/36 (66.7%)	12/36 (33.3%)	36	
All participants	65/100 (65%)	35/100 (35%)	100	

Table 3: Comparison of prevalence of both sexes and refractive errors.

Group Type	No. of participants with refractive error (percent)	No. of participants without refractive error (percent)	Total no. of participants	P value
Male	**32/64 (50%)**	**32/64 (50%)**	**64**	**0.059**
Female	**25/36 (69.4%)**	**11/36 (30.6%)**	**36**	
All participants	**57/100 (57%)**	**43/100 (43%)**	**100**	

Discussion

Anemia is recognized as an important health problem in childhood because it has negative effects on mental and physical development. Twelve percent of children <5 years ago in developed countries and 51% of children in the same age group in developing countries are anemic. [28] Anemia is a disease, which affects many hematologic and non-hematologic systems. It has effects on biochemical changes of cellular functions, growth, psychomotor development, behavior, mental development, immune system, physical capacity, gastrointestinal system, and thermo regulation. [29]

Few studies have directly observed that anemia affects visual acuity, although the mechanism of anemia that affects eyes remains unclear, several mechanisms can be suggested. First, low Hb

concentrations may reduce choroidal thickness and cause myopia. Hb concentrations and choroidal thickness were significantly correlated in women with IDA, and those patients had significantly reduced choroidal thickness. [11,30] Highly myopic patients tended to have thinner choroidal thickness compared to controls. [31] The choroid receives the greatest ocular blood flow and supplies oxygen to the outer layers of the retina. [32] Simsek *et al.* [30] suggested that IDA leads to decreased iron and ferritin levels and hypoxia, which can interrupt the choroidal structure that blood flow to the eye, and such interruption may affect other forms of ocular disorders. Second, increased HbA1c levels in anemic people may contribute to the development of myopia. In iron deficiency status, the HbA1c level is elevated due to the red cell production rate decreasing. [33] A previous study showed that IDA and iron-deficient state women had significantly higher HbA1c levels than normal iron-state women. [34] In late pregnancy, HbA1c levels were elevated due to iron deficiency. [5] Elevated HbA1c levels may increase the isk of myopia. [9] Another study showed that patients with HbA1c levels ≥8.8 had a 60% increased risk for myopic shift compared to HbA1c levels <8.8. [35,36]

The result is comparable with the study conducted in India, [37] otherwise; there would be no more data available to compare with, regarding the relationship between the incidence of anemia and refractive error. The novel study question, appropriate study design, and absence of dropouts are the strengths of our study. The small study population and lack of sufficient comparable data for similar studies are the mentioned limitations. Given the nature of this study, it is only possible to conclude that there is a relationship between the two conditions. Any causal relationship remains to be explored.

Traditionally, refractive error was generally thought to be a genetically determined condition that could not be prevented. A debate on "nature versus nurture" ensued. Recently the focus has shifted in favor of environmental factors, especially in light of the dramatic increases in the prevalence of myopia that have occurred in East Asia. Refractive error is linked to anemia, a preventable and treatable condition that should be thought-provoking.

Conclusions

Observation of frequent co-occurrence of anemia and refractive error amongst medical students is not just a chance occurrence. This pioneering study points to a real association between anemia and refractive error in the study group. The phenomenon needs to be studied in larger studies in the general population. Further, work needs to be undertaken to probe the cause-effect relationship between anemia and refractive error.

The observation of the frequent occurrence of anemia and refractive errors among children is not just a coincidence. This study indicates a real relationship between anemia and refractive error in the study population. This phenomenon needs to be studied in larger studies on the general population. Furthermore, work needs to be done to explore the cause-and-effect relationship between anemia and refractive error.

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