# Prevalence and Profile of Microcytic Hypochromic Anemia in the Pediatric Population in a Tertiary Hospital

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**ABSTRACT**

**Background**: Microcytic hypochromic anemia may be attributed to a defect in heme synthesis or in globin synthesis. The most common causes of microcytic anemia in children are Iron Deficiency Anemia (IDA) and thalassemia.

**Objective**: This study aimed to determine the prevalence and profile of pediatric patients with microcytic hypochromic anemia in a tertiary hospital.

**Methods**: This study is a single center, descriptive cross-sectional study of patients ages 6 months to less than 19 years old diagnosed with microcytic hypochromic anemia in a tertiary in Quezon City from 2012-2019.

**Results**: This study shows the prevalence of IDA and thalassemia patients with 0.03% and 0.04% respectively among pediatric patients ages 6 months to less than 19 years old seen from 2012-2019. Patients with thalassemia had a mean age of 8.9 years (± 0.19) and 64.29% with family history of thalassemia. Sixty percent (60%) of patients with thalassemia were diagnosed as Alpha thalassemia and forty percent (40%) were Beta thalassemia. Patients with IDA had a mean age of 6.7 years (± 0.12) and majority were female (n=33, 69%). Majority presented with No stunting and No wasting among those with IDA or thalassemia. Thalassemia patients had lower mean hemoglobin (9.64 g/dL ± 1.02) and red cell indices; MCV (66.64 fL ± 8.42), MCH (21.68 pg ± 3.22) and MCHC (31.62 g/dL ± 1.93). Thalassemia patients had normal RDW-SD (35-56 fL) while those with IDA showed increased RDW-SD (>56 fL).

**Conclusion**: Thalassemia was more prevalent than IDA as the cause of microcytic, hypochromic anemia among the pediatric population seen in this tertiary hospital . Most patients with thalassemia had family history of thalassemia and majority were male whereas in IDA, majority were female. Both thalassemia and IDA showed decreased MCV, MCH and MCHC but lower values in thalassemia were observed. Patients with IDA showed increased in RDW and a normal RDW for patients with thalassemia.

**Key words**: Iron deficiency anema (IDA), thalassemia, anemia

Anemia is a worldwide problem affecting all age groups. Anemia is a condition in which the body does not produce enough red blood cells that contain hemoglobin which carries oxygen to the different organs and tissues. There are several pathophysiologic processes that cause anemia, most common of which is deficiency of iron which is necessary for the formation of normal hemoglobin. Anemia constitutes the world's problem of great magnitude and children represent one of highest population groups although some studies have suggested a decline in its prevalence. The cause of anemia varies with age. Anemia can be due to either decreased production which can be seen in nutritional deficiencies, bone marrow failure and aplasia or increased destruction as seen in congenital hemolytic anemias, autoimmune hemolytic anemia, drugs or microangiopathies.

Microcytic hypochromic anemia may be attributed to a defect in heme synthesis or in globin synthesis. In pediatrics, the differential diagnosis is generally limited to one of four diagnoses – iron deficiency, thalassemia, lead poisoning, or anemia of inflammation. It is defined as anemia with low mean

corpuscular volume (MCV) for age, race and sex. Studies have shown that the most common cause of microcytic anemia in children is secondary to iron deficiency anemia and thalassemia.[1] Many children who have microcytic anemia are symptomatic. It is usually detected as part of other screening programs or when blood count is obtained for another illness. Older children may present with pallor, fatigue, and irritability. Physical examination may show tachycardia at rest and a flow murmur, splenomegaly or bony deformation for cases of thalassemia. In the Philippines, iron deficiency anemia is the most alarming of the micronutrient deficiencies affecting a considerable proportion of infants (56.6%), pregnant women (50.7%), lactating women (45.7%) and male older persons (49.1%).[2]

Iron Deficiency Anemia (IDA) is the most common of nutritional deficiencies in childhood, affecting all socioeconomic levels. The global prevalence of anemia in young children is 43%. The Pakistan nutrition survey found that 65% of children between the ages 7-60 years old had IDA. Other studies have shown a prevalence rate of 75-78%. Factors leading to Iron deficiency in children are worm infestation, increased requirement to rapid growth and development, malabsorption, gastrointestinal and urinary losses.[3] Hemoglobinopathies are diverse group of inherited recessive disorders that include thalassemia and sickle cell disease. Thalassemia is among the most common genetic disorders worldwide. About 4.83% of the world population carry globin gene variants which include 1.67% of population heterozygous for α and β thalassemia, with high prevalence in Asia including Pakistan comprising of nine million carriers.[4]

In a study by Habib MA, et al., the prevalence of IDA was 33.2% (n=2372). Cross-sectional studies have shown that 77%-79% of pediatric cases with microcytic, hypochromic anemia were attributed to iron deficiency anemia while 13.5% -21% of cases were secondary to thalassemia.[1,5] Both iron-deficiency anemia and thalassemia co-existed in 5.5% of children.[1] Majority of children with microcytic, hypochromic anemia were males (53%- 60%).[1,4,5.6] It was reported to be most common in children 5-11 years old[1] in one cross-sectional study. Iron deficiency anemia was most common in children 1-6 years old,[4,7] in males (51.7%, n=3, 699) and in the lower socio economic status scale (SES) (58.5%, n=234).[7] Majority of children with iron-deficiency anemia were asymptomatic (69.9%, n=5, 022) to.[4] In another cross-sectional study, majority (85%, n=34) of children with iron-deficiency anemia had no history of bleeding whereas the remaining 15% n=6) had history of bleeding through rectum. Among 40 infants, 15 (37.5%) of them had positive occult blood in stool. Moreover, 30 (75%) had no history of parasitic infestation, whereas 10 (25%) were positive for either Entamoeba histolytica (vegetative form) (7/40), ascaris (2/40), or giardia (1/40).[6]

The mean (SD) of hemoglobin concentration in iron deficiency anemia was 8.34 (2.2 g/dl) and 8.44 (1.61) g/dl in thalassemia. While mean (SD) of MCV in iron deficiency anemia was 68.66 (11.23) fl and 51.22 (11.89) fl in thalassemia and mean (SD) of MCH in iron deficiency anemia was18.42 (4.39) pg and 16.23 (5.21) pg in thalassemia. On the other hand, mean (SD) of MCHC in iron deficiency anemia was 27.74 (10.34) g/dl and 26.05 (5.66) g/dl in thalassemia. Lastly, mean (SD) of RDW in iron deficiency anemia was 18.27 (2.83)% and 13.06 (1.11)% in thalassemia.

Currently, there is no local data available regarding the prevalence and profile of microcytic, hypochromic anemia among the pediatric population in a tertiary hospital. Hence, the results of this study provide a baseline reference for future research undertaking. Children are mostly undiagnosed and progress to develop permanent sequelae especially those in underdeveloped and developing countries The characteristic profile of these affected children can guide healthcare providers in early identification and proper management to prevent cognitive effect and associated health conditions. It will also impact on the community if the nutritional status of children and adolescents is addressed, that will lead to reduced morbidities and hospitalization and decreased healthcare costs among others.

This study aimed to determine the prevalence and clinical and hematological profile of microcytic hypochromic anemia, specifically iron-deficiency anemia and thalassemia, in the pediatric population in a tertiary hospital. where anticipatory guidance is included in the management of well and sick pediatric patients.

## MATERIALS AND METHODS

### Study Design

The study is a single-center descriptive cross sectional study of pediatric patients with microcytic hypochromic anemia for the years 2012-2019.

**Study Population**

Included were pediatric patients, 6 months to less than 19 years old, diagnosed with microcytic hypochromic anemia at FEU- Nicanor Reyes Medical Foundation from 2012-2019. Excluded were those with blood transfusion for the past six months and incomplete medical chart information.

**Sampling Methodology**

All charts of included patients were given designated numbers. Random selection of charts was done using random number generator- stat trek accessible at https://stattrek.com/statistics/random-number-generator.aspx.

**Data Collection**

After obtaining the approval by FEU-IRC, the principal investigator conducted the study. Data collection was done through review of medical records. Medical charts of all patients seen in FEU-NRMF Medical Center from 2012-2019 with microcytic hypochromic anemia were reviewed. The following data were collected: patient's age, sex, weight, height, nutritional status, peripheral blood examination composed of Hemoglobin, MCH, MCV, RDW-SD as well as result hemoglobin electrophoresis. Diagnosis of the patients was also included.

**Sample Size**

The sample size was estimated based on the reported prevalence of IDA in the Nutrition and Consumer Protection (2010) among infants. The minimum sample size required to determine an anticipated prevalence of 56.6% at 90 % confidence level and 7.5% margin of error was 118.

**Data Processing and Encoding**

Data was encoded using Microsoft Excel for tabulation and organization and statistical analysis was carried out using statistical tool SPSS.

**Data Analysis**

a. All data were analyzed using the statistical tool SPSS. The mean and SD were used for the analysis of age, hemoglobin, MCV, MCH, MCHC, RDW-SD. The frequency and proportion were used for a) age, which was categorized into 6-23 months, 2-4 years old, 5-11 years old, 12-14 years old and >15 years old, b) sex, c) nutritional status classified according to WHO's weight-for height or BMI-for age Z-score and height-for age or length-for-age Z score, d) presence or absence of family history of thalassemia, e) with or without intake of deworming drug, f) associated diagnosis and g) classification of patients as to Iron Deficiency Anemia, based on Mentzer's Index of > 13 or Thalassemia, further classified as alpha-thalassemia or beta-thalassemia, based on hemoglobin electrophoresis result

**Limitation of the Study**

The study was limited to a single-center, a tertiary private hospital in the outpatient and inpatient sections that cater mostly to low to middle class socioeconomic status.

**Ethical Consideration**

Research Ethics approval for this study was obtained from the FEU-IRC prior to the conduct of research. Data collection through review of medical records conformed with the Declaration of Helsinski Code of Ethics. Patient's information and personal data were secured by the researcher. All authors declared no conflict of interest. Since the study utilized review of medical charts, there were no anticipated risks and benefits for the patients, therefore no compensation was due for any patient. All information collected for this study was kept private and confidential. Their names did not appear in the analysis or in the reporting of the results. Confidentiality was ensured by concealing the identity of the patients through a code. Finally, all data records will be permanently deleted 3 months after completion of the study.

## RESULTS

Table 1 shows that the majority of the pediatric patients who were diagnosed with IDA were aged between 6 months to 11 years old, and this was followed by patients aged 12 to 14 (8.33%), and patients aged 15 and above being the least (4.16%). 68.75% of pediatric patients with IDA were female. Most of them were not stunted and not wasted

(81.25%), 5 (10.42%) were wasted and 4 (8.33%) were stunted. Majority of the patients had not taken a deworming agent in the past 6 months (72.92%), and 14.58% of the patients had other associated diagnoses.

On the other hand, among 118 pediatric patients with hypochromic, microcytic anemia, 70 (59%) of them were diagnosed with thalassemia. The majority of the patients were aged five to eleven years old (47.14%), and this was followed by patients in the age group of two to four years old (20%). Most of the patients with thalassemia were male (55.71%). About 72.86% of the pediatric patients were not stunted and not wasted, 11.43% were overweight, 7.14% were wasted, 5.71% were obese, and 2.68% were stunted. Meanwhile, 64.29% of the patients said that they have a family history of thalassemia, while 20% had no family history of thalassemia, and 12.86% had unknown family history. Majority of the patients did not take a deworming agent for the past 6 months (77.14%), and 8.57% of the total pediatric patients diagnosed with thalassemia indicated other associated diagnoses.

Table 2 shows that patients with IDA had a mean hemoglobin of 10.93 g/dL (± 1.13), a low MCV, a mean MCH of 22.92 pg (± 2.71), a mean MCHC of 31.75 (± 2.21%) and increased RDW.

Patients with thalassemia, on the other hand, had a mean hemoglobin of 70.99 fL (± 7.06) and a much lower mean hemoglobin count of 9.64 g/dl (± 1.02), a lower MCV with a mean of 66.64 fL (±1.02), a mean MCH of 21.68 pg (± 3.22), a mean MCHC of 31.62 (± 1.93%) and normal RDW-SD(35-56 fL).

**Table 1.** Frequency and distribution of the demographic profile of pediatric patients at FEU-NRMF with microcytic hypochromic anemia from 2012 to 2019.

| Characteristics | IDA (n = 48) (100%) | Thalassemia (n = 70) (100%) |
|---|---|---|
| Age (Mean ± SD) | 9.6 ± 6.06 | 14 ± 11.47 |
| - 6 to 23 months | 14 (29.17%) | 13 (18.57%) |
| - 2 to 4 years old | 14 (29.17%) | 14 (20%) |
| - 5 to 11 years old | 14 (29.17%) | 33 (47.14%) |
| - 12 to 14 years old | 4 (8.33%) | 4 (5.71%) |
| - > 15 years old | 2 (4.16%) | 6 (8.58%) |
| Sex | | |
| - Male | 15 (31.25%) | 39 (55.71%) |
| - Female | 33 (68.75%) | 31 (44.29%) |
| Wasted (<-2) | 5 (10.42%) | 5 (7.14%) |
| Severely Wasted (<-3) | 0 (0%) | 0 (0%) |
| Stunting (<-2) | 4 (8.33%) | 2 (2.86%) |
| Severely Stunting (<-3) | 0 (0%) | 0 (0%) |
| Overweight (<+2) | 0 (0%) | 8 (11.43%) |
| Obese (<+3) | 0 (0%) | 4 (5.71%) |
| With wasting and stunting | 0 (0%) | 0 (0%) |
| No stunting, no wasting | 39 (81.25%) | 51 (72.86%) |
| Family history of thalassemia | | |
| - Yes | 0 (0%) | 45 (64.29%) |
| - No | 47 (98.57%) | 14 (20%) |
| - Unknown | 1 (1.43%) | 9 (12.86%) |
| Intake of deworming agent in past 6 months | | |
| - Yes | 13 (27.08%) | 16 (22.86%) |
| - No | 35 (72.92%) | 54 (77.14%) |
| Associated diagnosis | 7 (14.58%) | 6 (8.57%) |

**Table 2.** Hemoglobin and RBC indices of pediatric patients with microcytic, hypochromic anemia at FEU-NRMF from 2012 to 2019.

| Parameter | Iron Deficiency Anemia | Thalassemia |
|---|---|---|
| Hgb (g/dL) mean (SD) | 10.93 (± 1.13) | 9.64 (± 1.02) |
| MCV (fL) mean (SD) | 70.99 (± 7.06) | 66.64 (± 8.42) |
| MCH (pg) mean (SD) | 22.92 (± 2.71) | 21.68 (± 3.22) |
| MCHC (%) mean (SD) | 31.75 (± 2.21) | 31.62 (± 1.93) |
| RDW-SD n (%) | | |
| Normal (35-56 fL) | 5 (4%) | 43 (36%) |
| Increased (>56 fL) | 41 (41%) | 20 (17%) |
| Decreased (<35fL) | 1 (1%) | 8 (7%) |

Table 3 shows that majority of the patients experienced anemia due to thalassemia with 70 (59.32%) pediatric patients, followed by 48 (40.67%) pediatric patients with IDA. There were more female (68.8%) patients with IDA compared to male patients (31.2%). There were 42 patients (60%) diagnosed as alpha thalassemia with a mean age of 7.1 years (± 0.11). Of these, 23 (32.8%) were female and 19 (27.1%) were male. 28 (40%) patients were diagnosed as beta thalassemia with a mean age 5.4 years (±0.02), 20 (28.5%) of which were male and 8(11.4%) were female.

**Table 3.** Frequency and proportion of the causes of microcytic, hypochromic anemia in all pediatric patients at FEU-NRMF from 2012 to 2019.

| Causes | n (%) | Age in years mean (SD) | Male n (%) | Female n (%) |
|---|---|---|---|---|
| IDA | 48 (40.67) | 6.7 (± 0.12) | 15 (31.2%) | 33 (68.8%) |
| Thalassemia | 70 (59.32) | 8.9 (± 0.19) | 39 (55.7%) | 31 (44.3%) |
| Alpha Thalassemia | 42 (60) | 7.1 (± 0.11) | 19 (27.1%) | 23 (32.8%) |
| Beta Thalassemia | 28 (40) | 5.4 (± 0.02) | 20 (28.6%) | 8 (11.4%) |

Table 4 shows that the prevalence of patients ages 6 months - less than 19 years old with IDA is o.03% and thalassemia is 0.04% at a tertiary hospital from 2012-2019.

**Table 4.** Prevalence of IDA and Thalassemia patients at tertiary hospital from 2012 to 2019.

| Year | IDA | Thalassemia |
|---|---|---|
| 2012 to 2019 | 0.03% | 0.04% |

## DISCUSSION

Anemia in children is one of the major public health concerns affecting people across all ages. Several studies conducted about anemia have allowed the development of different programs and policies aimed to reduce the increasing number of pediatric patients with anemia. However, these studies remain insufficient, especially in the Philippines where to date, there are still no local data available regarding the prevalence and profile of microcytic, hypochromic anemia among the pediatric population.

Based on the findings of the present study, the primary cause of microcytic, hypochromic anemia in the pediatric population was thalassemia (59.32%), followed by Iron Deficiency Anemia (IDA). The findings of the present study support the claim of Aydogan et al[1], where the common causes of anemia in the pediatric population are IDA and thalassemia. Majority of the pediatric patients in the study were female, contrary to the study of Habib, et al[4] where majority of the patients diagnosed with anemia were male. In the current study, 64.29% of the patients with thalassemia had family history of thalassemia which supports the study of Habib et al[4], that thalassemia is among the most common genetic disorder worldwide, with 4.83% of the world's total population carrying globin gene variants of thalassemia and is more prevalent in Asia. This study was conducted in a tertiary hospital in the Philippines, and the same study findings were obtained. In the present study, patients with thalassemia had lower MCV, MCH and MCHC which supports the study of Zafar et al[5]. In this study, hemoglobin levels of patients with thalassemia were lower than those with IDA which opposses the study of Zafar, et al[5].

The study revealed that the profile of microcytic hypochromic anemia among the pediatric population: 54.2% were female and 45.8% were male, with a mean age of 9.6 (± 6.06) for patients with IDA and 14 (±11.47) for patients with thalassemia and for nutritional status, majority of IDA (81.25%) and thalassemia (72.86%) patients presented with no wasting and stunting. Some studies suggest a different outcome compared to present study findings, which may be due to certain limitations during the study period.

Note that the research was done in a single medical institution done within a specific period of time, a smaller sample size and investigated only two causes of anemia – IDA and thalassemia and therefore cannot fully represent the possible findings for other pediatric patients with microcytic, hypochromic anemia. While this study was conducted in the Philippines, there can be other external factors affecting the prevalence of anemia in specific regions. While the findings of the present study indicated sufficient information regarding the prevalence of anemia in the institution, the data may not be enough to generalize the prevalence for other population. Furthermore, with a margin of error set at 7.5%, the study results may not truly represent the prevalence and profile of patients with microcytic, hypochromic anemia.

## CONCLUSION AND RECOMMENDATION

This study showed that thalassemia was the most common cause of microcytic, hypochromic anemia among pediatric patients seen in this tertiary hospital. This was followed by Iron Deficiency Anemia (IDA), which was supported by a strong family history of thalassemia. This study also revealed that age, sex and family history of thalassemia can increase the risks of developing microcytic, hypochromic anemia. Both thalassemia and IDA showed decreased hemoglobin, MCV, MCH and MCHC but lower values were observed in thalassemia. Increased RDW-SD was seen in IDA patients and a normal RDW-SD for patients with thalassemia.

This study may be used to bridge the gap between the previous and current studies, and to also assess what programs or assistance can be provided in order to address microcytic, hypochromic anemia. The characteristic profile of these affected children can guide healthcare providers in early identification and proper management to prevent cognitive effect and associated health conditions. It will also impact on the community if the nutritional status of children and adolescents is addressed, that will lead to reduced morbidities and hospitalization and decreased healthcare costs among others. Further studies should be conducted in order to determine the progress and trends in pediatric diagnosis, treatment and management of anemia.

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