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CLINICOPATHOLOGICAL PROFILE OF ANEMIA AMONG ADULT PATIENTS ATTENDING A TERTIARY CARE CENTER

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Abstract
Anemia is a common hematological condition with diverse nutritional, inflammatory, renal, and chronic disease-related causes. Complete blood count parameters are useful for initial anemia screening, severity assessment, and red cell index-based classification. To assess the clinicopathological profile of anemia among adult patients using an open-access complete blood count dataset. This secondary data analysis used the Complete Blood Count Anemia Diagnosis dataset. Adult patient records aged 18 years and above were included after data cleaning. Variables analyzed included age, sex, hemoglobin, red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width, total leukocyte count, and platelet count. Anemia was classified according to hemoglobin-based severity and red cell index-based morphology. Descriptive statistics, chi-square test, Kruskal-Wallis test, and correlation analysis were applied. A total of 338 adult records were analyzed. Anemia was present in 196 patients (57.99%). Mild anemia was observed in 93 patients (27.51%), moderate anemia in 88 patients (26.04%), and severe anemia in 15 patients (4.44%). Normocytic morphology was predominant, seen in 264 patients (78.11%), followed by microcytic and macrocytic patterns. Hemoglobin showed strong positive correlations with packed cell volume and red blood cell count, while red cell distribution width showed a negative correlation with hemoglobin. CBC parameters provide useful preliminary information for anemia severity and morphological classification. However, etiological confirmation requires clinical evaluation and biochemical investigations.

Keywords: *Anemia; Complete blood count; Hemoglobin; Red cell indices.*

1. Introduction

Anemia is a prevalent hematological abnormality in the entire world and continues to be a significant clinical and a general health concern. Generally, it is described as a decrease of hemoglobin level beneath predetermined age-, sex-, and physiological-status-specific levels, leading to a decline in the oxygen carrying capacity of the blood. Hemoglobin estimation is a key aspect of anemia evaluation as hemoglobin-based cut-offs are extensively applied in screening, diagnosis, and severity classification in adults (World Health Organization, 2024). Though anemia is usually considered as one clinical disorder, it is a final common expression of a number of underlying nutritional, inflammatory, renal, genetic, infectious and hematological disorders.

Despite the progress in diagnosis and treatment, the burden of anemia in the world is so high. According to the recent estimates of the Global Burden of Disease framework anemia still impacts a significant percentage of the global population and is a major cause of years lived with disability, particularly in women, children, and low- and middle-income countries (Gardner et al., 2023). Previous comparative burden studies also revealed that iron deficiency and hemoglobinopathies, malaria, chronic kidney disease, and inflammatory disorders have been causes of regional differences in prevalence and severity of anemia (Kassebaum et al., 2014). The continuation of anemia in various population groups underscores the importance of further clinical and epidemiological evaluation with the help of available laboratory predictors.

Anemia is a significant health issue in India. The National Family Health Survey-5 reported that the prevalence of anemia was high in children, women, and men, which means that anemia does not only concern traditionally high-risk groups but also the rest of the adult population (International Institute for Population Sciences & ICF, 2021). There are several overlapping determinants of the Indian burden, such as nutritional deficiencies, socioeconomic factor, menstrual and reproductive health, infections, chronic diseases, and differences in accessibility to health care. Balarajan et al. (2011) noted that biological, dietary, infectious, and social determinants of anemia in low- and middle-income countries interact in complex way and hence prevention and management of anemia is difficult.

One of the most significant causes of anemia worldwide has been iron deficiency. It could be due to poor food intake, poor absorption, excess physiological need or chronic blood loss. Pasricha et al. (2021) emphasized the key position of iron deficiency in the global burden of anemia and the clinical and population health importance. Iron-deficiency anemia is associated with the loss of iron stores, a decrease in iron supply to support erythropoiesis, and the ultimate occurrence of microcytic hypochromic red cell changes at the pathophysiological level (Camaschella, 2015). Nevertheless, modern knowledge about iron deficiency also acknowledges the role of functional iron deficiency, in which iron stores can be available but cannot be utilized in erythropoiesis because of the inflammatory control of iron metabolism (Camaschella & Girelli, 2020).

Absolute nutritional deficiency is not the only cause of anemia. Chronic disease and chronic inflammation may cause anemia via hepcidin-mediated iron restriction, weakened erythropoietin response and abnormal macrophage iron processing. According to Ganz and Nemeth (2015), hepcidin is a key iron homeostasis regulator and a significant biological bridge between inflammation and iron-restricted erythropoiesis. These processes have clinical importance since inflammatory anemia or chronic illness can have normocytic or slightly microcytic indices and can be challenging to differentiate with a complete blood count parameter only.

The most available and common initial examination of anemia is complete blood count. It gives hemoglobin level, red blood cells count, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin level, red cell distribution width, leukocyte count, and platelet count. The parameters enable early categorizing of anemia based on severity and morphology and inform the necessity to conduct further tests. According to Buttarello (2016), both the older and more recent red cell parameters play a significant diagnostic role in the diagnosis and assessment of anemia. Equally, CBC-based clinical data have already been applied to diagnose and classify the severity of anemia in an outpatient context, indicating the utility of hematological indices to perform screening and stratification (Vohra et al., 2022).

Mean corpuscular volume is one of the red cell indices that are regularly used to categorize anemia as microcytic, normocytic, or macrocytic. This categorization is advantageous as it gives a preliminary diagnosis path. Microcytosis can indicate iron deficiency or thalassemia trait, macrocytosis may indicate vitamin B12 or folate deficiency and others, and normocytosis can be observed in chronic disease, kidney disease, acute blood loss, and initial deficiency conditions. Nevertheless, MCV-guided classification has weaknesses due to mixed deficiencies, early pathology, inflammation and comorbidity can result in overlapping patterns. Schop et al. (2021) have underlined that MCV-based interpretation is helpful but not to be used instead of the etiological assessment by means of relevant clinical and biochemical examination.

It is against this background that the current study was carried out to evaluate the clinicopathological profile of anemia in adult patients using an open-access complete blood count dataset. The research is oriented towards the demographic distribution, the severity of anemia, morphological pattern determined by red cell index, and correlation between hemoglobin and other hematological variables. The aim of this analysis is to prove the usefulness of CBC-derived indices in preliminary anemia profiling but acknowledge that confirmatory clinical and biochemical testing is required.

2. Materials and Methods

2.1 Study Design

The current research was developed as a secondary data analysis based on a complete blood count data set on an open-access database. The study was based on an observational and analytical design since no primary data were gathered directly among the patients. The purpose of the analysis included the evaluation of the clinicopathological profile of

anemia in adult patients with a focus on the demographic distribution, grading of severity, and hematological pattern according to red cell indices.

2.2 Data Source

The dataset that was used in the study is the publicly available Complete Blood Count Anemia Diagnosis that was uploaded in Mendeley Data by Vohra et al. (2021). The dataset comprises of complete blood count parameters of patients who have taken hematological testing. It involves variables pertinent in the assessment of anemia which include age, sex, hemoglobin, red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width, white blood cell count and platelet count. This dataset was chosen based on the fact that it offers objective laboratory parameters that can be used to classify anemia and hematological profile.

2.3 Study Population

The research population comprised the patients who had been registered in the open-access dataset and had been tested in complete blood count. In the current analysis, only the adult patients who were 18 years and over were eligible. The inclusion criteria of patients were not limited in terms of sex as long as the necessary hematological variables could be analyzed. The investigators did not perform any direct patient recruitment or clinical examination since it was a secondary analysis.

2.4 Inclusion and Exclusion Criteria

The inclusion criteria included patient records that were 18 years or older, records of hemoglobin values and records of essential complete blood count parameters needed to classify anemia. Missing hemoglobin values, missing essential hematological values, duplicated records, and biologically implausible values were not included in the analysis. To limit the analysis to the adult population, patients younger than 18 years were excluded. When the data did not have pregnancy status, then the pregnant women could not be identified separately, and this was deemed a methodological limitation.

2.5 Study Variables

The variables used in the analysis were classified into demographic and hematological variables. The demographic factors were age and sex. The hematological variables were hemoglobin levels, red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, width of red cells distribution, white blood cell count, and platelet count. Based on red cell indices, derived variables were formed on age groups, anemia status, anemia severity and morphological pattern of anemia.

2.6 Operational Definitions

Hemoglobin concentration was used to define anemia based on standard criteria of adults. Adult males whose hemoglobin was less than 13 g/dL and adult females who were not pregnant and whose hemoglobin was less than 12 g/dL were considered anaemic. Severity of anemia was further classified into mild, moderate and severe based on hemoglobin-based severity levels. Red cell indices, especially mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration were used to perform morphological classification. Anemia was categorized into microcytic, normocytic and macrocytic based on mean corpuscular volume. The mean corpuscular hemoglobin or mean corpuscular hemoglobin concentration was found to be low, which was regarded as indicative of a pattern of hypochromycin. Red cell distribution width was applied to determine the variation in red cell size, as well as to aid in interpretation of anisocytosis or potential mixed red cell populations.

2.7 Data Cleaning and Processing

The data were downloaded to the open-access repository and filtered prior to analysis. Missing values, duplicate records and inconsistent or implausible measurements were checked against records. They eliminated patients under the age of 18 years. The continuous variables were checked in terms of range and distribution. Adult age groups, the severity of anemia and the morphological classification using red cell index were categorized into new nominal variables. Statistical analysis was done on the final cleaned dataset.

2.8 Statistical Analysis

The analysis of data has been performed with Python. Frequencies and percentages were used to summarize categorical variables. The continuous variables were summarised with the mean and standard deviation (normally distributed), with median and interquartile range (skewed distribution). The severity of anemia was evaluated on the basis of the age group and sex. Independent t-test, one-way analysis of variance, Mann-Whitney U test or Kruskal-Wallis test were used to compare hematological parameters across groups with varying degrees of anemia depending on the data distribution and the number of comparison groups. Associations between categorical variables (sex, age group, morphological type, and anemia severity) were evaluated using the chi-square test. The correlation analysis was done to investigate the relationship between hemoglobin and the following selected hematological parameters including red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and red cell distribution width. The p-value of below 0.05 was deemed to be statistically significant.

3. Results

3.1 Study Sample

Following data cleaning and the use of the eligibility criteria, 338 records of adult patients were included in the final analysis. Ages of the participants were between 18 and 89 years old with a mean age of 47.25 and standard deviation of 17.41 years. The proportion of the study population that was male was slightly greater than that of females with 184 males (54.44%) and 154 females (45.56%) included in the analysis.

3.2 Demographic Profile of the Study Population

The age group with the greatest number of patients was the age group of between 18-30 years, with 82 cases (24.26%), then the age group of between 51-60 years with 67 cases (19.82%). Patients aged over 70 years had the least level of representation with 35 cases (10.36%). Table 1 shows the age distribution but Figure 1 shows the age distribution.

Table 1. Age and sex distribution of adult patients

Variable	Category	Frequency	Percentage
Age group	18-30 years	82	24.26
	31-40 years	60	17.75
	41-50 years	46	13.61
	51-60 years	67	19.82
	61-70 years	48	14.20
	>70 years	35	10.36
Sex	Male	184	54.44
	Female	154	45.56

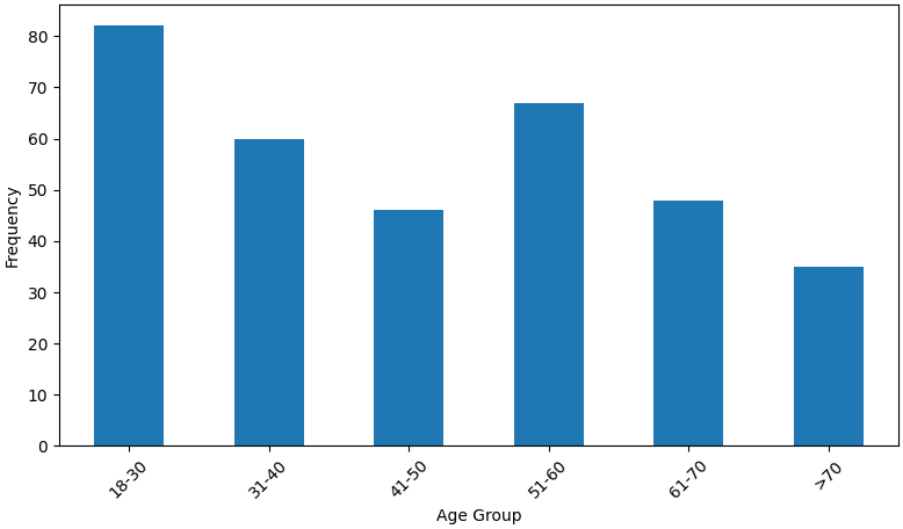

Figure 1. Age group distribution of adult patients.

The distribution showed maximum representation in the 18-30 years age group, followed by patients aged 51-60 years.

3.3 Hematological Profile of the Study Population

The average hemoglobin concentration of the population under study was 11.86 ± 2.18 g/dL with a range of 4.20 to 16.20 g/dL. The mean RBC count was 4.25 ± 0.81, while the mean packed cell volume was 36.62 ± 6.81%. Mean MCV was 87.78 fL + 9.46 fL, which was indicative of the fact that the sample red cell volume distribution was mostly within the normocytic range. Table 2 presents the descriptive statistics of the hematological parameters.

Table 2. Descriptive statistics of complete blood count parameters

Parameter	Mean ± SD	Median	Minimum	Maximum
Age, years	47.25 ± 17.41	47.00	18.00	89.00
Hemoglobin, g/dL	11.86 ± 2.18	12.00	4.20	16.20
RBC count	4.25 ± 0.81	4.32	1.36	6.90
PCV, %	36.62 ± 6.81	36.60	13.10	52.20
MCV, fL	87.78 ± 9.46	88.10	55.70	124.10
MCH, pg	28.34 ± 3.94	28.40	14.70	41.40
MCHC, g/dL	32.09 ± 2.82	31.70	23.60	50.20
RDW, %	15.16 ± 2.22	14.80	10.60	29.20

TLC	8.96 ± 4.80	8.06	2.00	42.42
Platelet count	224.84 ± 97.80	210.00	24.00	589.00

3.4 Distribution of Anemia Status and Severity

There were 338 adult patients out of which 196 patients (57.99%) were anemic and 142 patients (42.01%) were non-anemic. Mild anemia was seen in 93 patients, moderate in 88 patients, and severe anemia in 15 patients out of the entire study population (27.51%, 26.04%, and 4.44% respectively). The severity of anemia is given in Table 3 and graphically depicted in Figure 2.

Table 3. Distribution of anemia status and severity

Category	Frequency	Percentage
Non-anemic	142	42.01
Mild anemia	93	27.51
Moderate anemia	88	26.04
Severe anemia	15	4.44
Total anemic cases	**196**	**57.99**

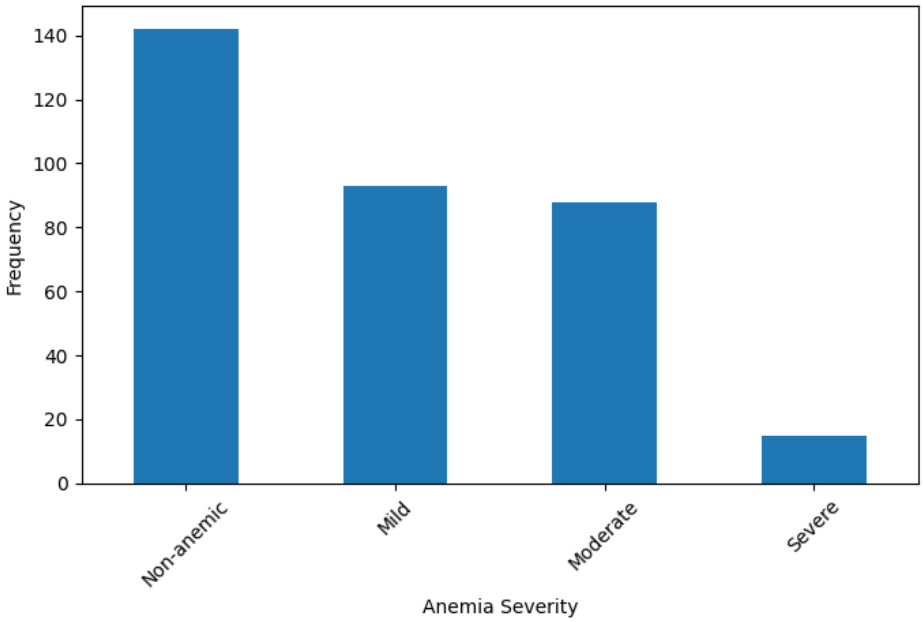

Figure 2. Distribution of anemia severity.

Non-anemic patients formed the largest single category, followed by mild and moderate anemia. Severe anemia represented the smallest group.

3.5 Morphological Classification Based on Red Cell Indices

According to the MCV-based classification, the most frequent pattern was the normocytic, which was found in 264 patients (78.11%). Microcytic anemia was identified in 51 patients (15.09%), and macrocytic anemia was identified in 23 patients (6.80%). It was reported that 198 patients (58.58% MCH and/or MCHC based) had a hypochromic pattern and 193 patients (57.10% raised RDW) indicating anisocytosis or red cell size variation. The morphological distribution is presented in Table 4 and illustrated in Figure 3.

Table 4. Red cell index-based morphological profile

Classification	Category	Frequency	Percentage
MCV pattern	Normocytic	264	78.11
	Microcytic	51	15.09
	Macrocytic	23	6.80
Chromia pattern	Hypochromic pattern	198	58.58
	Non-hypochromic pattern	140	41.42
RDW pattern	Raised RDW	193	57.10
	Normal RDW	145	42.90

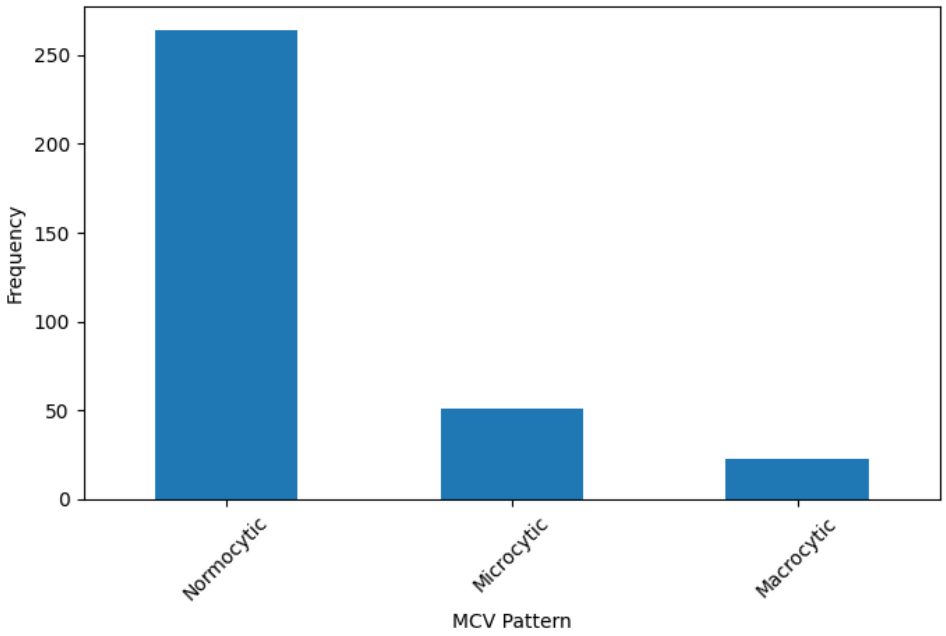

Figure 3. MCV-based morphological classification of anemia.

Normocytic morphology was the predominant pattern, followed by microcytic and macrocytic patterns.

3.6 Anemia Severity According to Sex and Age Group

Sex-wise distribution indicated that females had a higher incidence of anemia as compared to males. Among females, 109 of 154 patients (70.78%) were anemic, whereas among males, 87 of 184 patients (47.28%) were anemic. Females were more likely to have moderate anemia than males with a case of 60 among 28 cases respectively. Mild anemia was found in 52 and 41 males and females respectively and severe anemia was almost equivalent in numbers and was 7 and 8 cases respectively.

An analysis in terms of age indicated that there were the highest number of anemic patients in the 18-30 years group, with 48 anemic cases out of 82 patients. A relatively high percentage of anemia was observed in patients who were older than 70 years, 26 anemic cases were noted in 35 patients. The distribution of anemia severity by sex and age group is shown in Table 5.

Table 5. Distribution of anemia severity according to sex and age group

Variable	Category	Non-anemic	Mild	Moderate	Severe	Total
Sex	Female	45	41	60	8	154
	Male	97	52	28	7	184
Age group	18-30 years	34	17	29	2	82
	31-40 years	28	16	14	2	60
	41-50 years	26	12	6	2	46
	51-60 years	23	25	17	2	67
	61-70 years	22	14	10	2	48
	>70 years	9	9	12	5	35

3.7 Hematological Parameters Across Anemia Severity Groups

Mean hemoglobin experienced a continuous decrease between anemia categories with 13.79 ± 0.97 g/dL in non-anemic, 11.77 ± 0.57 g/dL in mild anemia and 6.55 ± 1.29 g/dL in severe anemia. Figure 4 also displays this trend.

The other red cell parameters also differed among different groups of anemia severity. The mean RBC count decreased to 2.86 ± 0.95 in severe anemia compared to 4.77 ± 0.58 in the non-anemic patients. Likewise, mean PCV dropped to 22.67 ± 5.37% in severe anemia compared to 41.77 ± 4.87% in non-anemic. There was an increase in RDW as the severity of anemia increased, as was observed in non-anemic patients and in severe anemia, RDW was 14.51 ± 1.58% and 18.50 ± 4.10% respectively. Table 6 shows the hematological comparison between the groups of anemia severity.

Table 6. Hematological parameters according to anemia severity

Parameter	Non-anemic, Mean ± SD	Mild, Mean ± SD	Moderate, Mean ± SD	Severe, Mean ± SD
Age, years	45.68 ± 15.82	49.67 ± 17.18	45.85 ± 18.90	55.40 ± 21.68
Hemoglobin, g/dL	13.79 ± 0.97	11.77 ± 0.57	9.74 ± 0.87	6.55 ± 1.29
RBC count	4.77 ± 0.58	4.20 ± 0.48	3.68 ± 0.72	2.86 ± 0.95
PCV, %	41.77 ± 4.87	36.33 ± 3.22	30.98 ± 4.08	22.67 ± 5.37

MCV, fL	89.59 ± 7.21	87.59 ± 7.53	86.21 ± 11.61	81.09 ± 18.03
MCH, pg	29.27 ± 2.98	28.40 ± 3.03	27.37 ± 4.80	24.85 ± 7.25
MCHC, g/dL	32.52 ± 2.44	32.33 ± 2.64	31.49 ± 3.20	30.15 ± 3.76
RDW, %	14.51 ± 1.58	14.58 ± 1.43	16.24 ± 2.45	18.50 ± 4.10
TLC	9.14 ± 4.35	8.76 ± 5.23	8.66 ± 3.94	10.17 ± 9.22
Platelet count	217.11 ± 83.80	222.15 ± 98.55	238.57 ± 112.12	234.07 ± 125.07

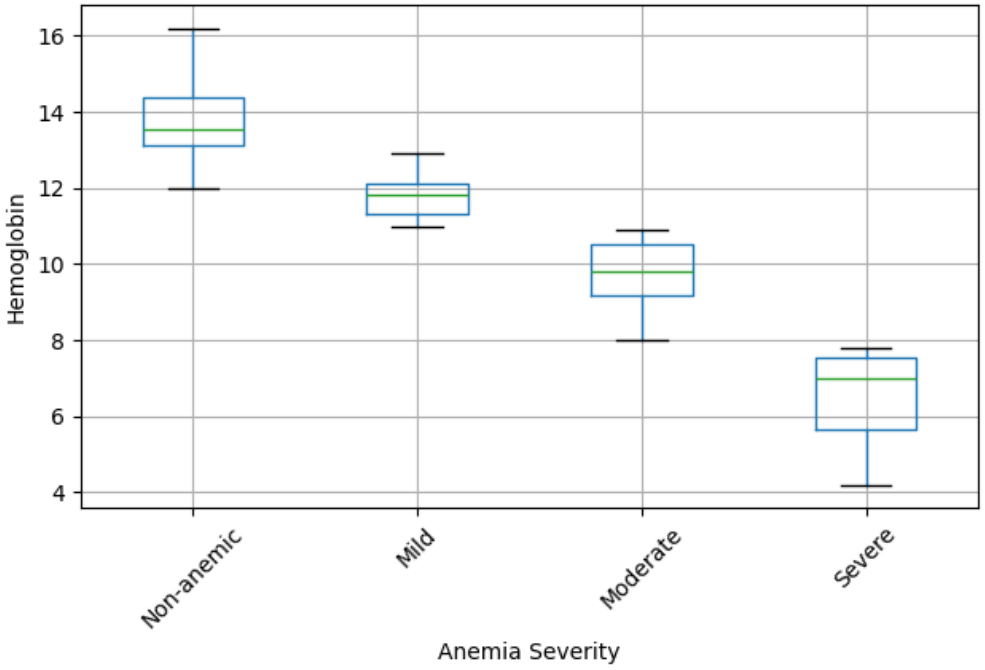

Figure 4. Hemoglobin distribution by anemia severity.

The box plot shows a stepwise decline in hemoglobin concentration from the non-anemic group to the severe anemia group.

3.8 Statistical Association and Group Comparison

Chi-square test revealed that there was a statistically significant correlation between sex and the severity of anemia. Moderate anemia was more common among females than it was among the males. Age group was also evaluated in comparison to the severity of anemia and the proportionate burden of anemia was higher amongst older patients especially above 70 years.

Krustal-Wallis test indicated statistically significant differences in the severity groups of anemia in terms of RBC count, PCV, MCV, MCH, MCHC and RDW. There were no statistically significant differences between TLC or platelet count according to categories of anemia severity. Table 7 displays the results of group comparison.

Table 7. Kruskal-Wallis comparison of CBC parameters across anemia severity groups

Parameter	Test statistic	p-value	Interpretation
RBC count	146.809	<0.001	Significant
PCV	201.082	<0.001	Significant
MCV	14.285	0.00254	Significant
MCH	22.853	<0.001	Significant
MCHC	22.618	<0.001	Significant
RDW	58.460	<0.001	Significant
TLC	2.069	0.55816	Not significant
Platelet count	1.144	0.76651	Not significant

3.9 Correlation Between Hemoglobin and CBC Parameters

Correlation analysis showed that hemoglobin had a strong positive correlation with PCV and RBC count. The strongest correlation was observed between hemoglobin and PCV, with $r = 0.851$, $p < 0.001$, followed by RBC count, with $r = 0.736$, $p < 0.001$. Hemoglobin also showed weak but statistically significant positive correlations with MCV, MCH, and MCHC. RDW showed a moderate negative correlation with hemoglobin, with $r = -0.470$, $p < 0.001$, indicating that lower hemoglobin levels were associated with greater red cell size variation. TLC and platelet count did not show statistically significant correlations with hemoglobin. These findings are summarized in Table 8.

Table 8. Correlation of hemoglobin with selected CBC parameters

Variable	Pearson correlation coefficient, r	p-value	Interpretation
RBC count	0.736	<0.001	Strong positive correlation
PCV	0.851	<0.001	Strong positive correlation
MCV	0.204	0.00016	Weak positive correlation
MCH	0.265	<0.001	Weak positive correlation
MCHC	0.213	0.00008	Weak positive correlation
RDW	-0.470	<0.001	Moderate negative correlation
TLC	-0.013	0.81071	Not significant
Platelet count	-0.077	0.15614	Not significant

It was found that 57.99% of the adult study population had anemia. Most anemic cases were mild and moderate with severe anemia being rather rare. The most common morphological pattern of the red cells was the normocytic cell index and then the microcytic and macrocytic cell indices. The levels of hemoglobin decreased steadily through anemia severity groups with matching decreases in the number of RBCs and PCV and an increment in the RDW. There was a strong correlation between hemoglobin and PCV and count of RBCs whereas a negative correlation existed between hemoglobin and RDW.

4. Discussion

The current secondary study focused on the clinicopathological presentation of the anemia in adult patients in complete blood count-based parameters. These results revealed that 57.99% of the analyzed adult records contained anemia, which implies that there was a significant number of low hemoglobin in the study population. The majority of anemic cases were mild or moderate with a smaller percentage of severe anemia. This trend is also clinically significant since mild and moderate anemia can be observed during routine laboratory analysis and is potentially indicative of nutritional deficiency, chronic inflammation, renal disease, occult blood loss, or mixed etiologies. Nevertheless, since the dataset was confined to CBC variables, the current study was able to categorize anemia based on the severity and red cell indices but was not able to determine definite underlying causes.

An important conclusion of this study was the fact that the prevailing morphology was normocytic in nature, and was seen in 78.11% patients. Normocytic anemia usually represents a manifestation of an early nutritional deficiency, anemia of chronic disease, renal failure, inflammation, marrow suppression, or acute blood loss. In CBC-only data a normocytic pattern must be treated with caution since it is a morphological pattern and not an etiological diagnosis. The fact that the majority of indices are normocytic in the current study can indicate that a significant percentage of patients were experiencing chronic disease-related anemia or inflammatory anemia. Fraenkel (2016) stressed that impaired iron homeostasis, effects of inflammatory cytokines on erythropoiesis, and decreased erythrocyte survival mediate anemia of inflammation. In the same vein, Weiss et al. (2019) also outlined anemia of inflammation as a common type of anemia in patients admitted to hospitals and with chronic illness, which is partially caused by hepcidin-mediated iron limitation and immune response activation. These mechanisms offer a reasonable explanation of how normocytic or slightly microcytic patterns can be confirmed, but would require ferritin, transferrin saturation, C-reactive protein, renal-function, and clinical-diagnosis information.

Morphology Microcytic was found in 15.09% of patients. Microcytosis is usually related to iron deficiency anemia, thalassemia trait, and certain chronic inflammatory conditions; however, the current dataset lacked iron profile, serum ferritin, transferrin saturation, or peripheral smear results. Thus, microcytic group cannot be viewed as established iron deficiency. The comparatively low percentage of microcytosis over normocytosis might be a characteristic of the diagnostic-center sample or the fact that the sample included non-anemic individuals or the fact that some were early or mixed anemia with MCVs still in the normal range.

In 6.80% of the patients, macrocytic morphology was identified. Macrocytosis can be brought about by megaloblastic anemia either as a result of vitamin B12 or folate deficiency, but also in liver disease, alcoholism, hypothyroidism, drug exposure, reticulocytosis and myelodysplastic syndromes. As Nagao and Hirokawa (2017) observed, macrocytic anemias need to be distinguished as megaloblastic and non-megaloblastic, as they have different treatment and clinical implications. The hematological significance of vitamin B12 deficiency and its non-uniform clinical picture, which includes the chance of neurological symptoms, even in cases where the traditional hematological results are not entirely obtained, were also emphasized by Green (2017). In the current case, it was impossible to etiologically classify macrocytosis due to the absence of vitamin B12, folate, liver function, thyroid profile, alcohol history and medication history.

Age pattern was also significant in the study. Though the highest proportion of patients was in the 18-30 years age bracket, the percentage of anemia among patients was especially high among patients over 70 years. It is in line with the rest of the literature that indicates that anemia in older adults is prevalent, multifactorial, and often under-diagnosed. According to Girelli et al. (2018), anemia among the elderly is a significant clinical problem related to multimorbidity, inflammation, nutritional deficiency, kidney disease, and clonal hematopoietic diseases. Stauder et al. (2018) also highlighted that older age-related anemia should be etiologically assessed with caution since the factors might include nutritional deficiency and kidney chronic diseases, as well as inflammation and bone marrow ailments. Even high proportional burden of anemia in

older patients, as the current observation, should be viewed as a clinically significant finding, although the data set was not able to provide any data on comorbidities. The high prevalence of anemia in older adults and the high rate of unexplained anemia in older adults was also reported by Guralnik et al. (2004) and confirmed the necessity of further assessment other than CBC parameters.

The other significant discovery was the positive correlation between the severity of anemia and RDW and the moderate negative relationship between RDW and hemoglobin. RDW is a measure of the heterogeneity of red blood cell size, and is traditionally a measure of anisocytosis. This analysis demonstrated an increase in RDW in 57.10% of the patients and found lower hemoglobin values related to a higher RDW. This trend could suggest a growing variability of red cell size in progression of anemia, which may be seen in iron deficiency, mixed nutritional deficiency, recovery states, inflammation, or marrow stress. Salvagno et al. (2015) highlighted that RDW is a cheap and easy-to-calculate hematological value indicating anisocytosis and diagnostic and prognostic values in a variety of clinical conditions. Thus, the results of the RDW in this work reinforce the importance of RDW in the anemia profiling using CBC.

The huge variations in the number of RBCs, PCV, MCV, MCH, MCHC, and RDW between groups of varying severities of anemia help to endorse the internal consistency of the categorization. Hemoglobin was positively correlated with PCV and RBC count with strong associations, as these variables report variables very similar to red cell mass. Conversely, neither TLC nor platelet count were significantly related to the severity of anaemia indicating that the significant hematological difference in this dataset was not found in leukocyte or platelet indices but in red cell parameters.

There are significant limitations of this study. First, it was founded on secondary data, thus there were no available clinical symptoms, physical examination, dietary history, menstrual history, comorbidity, medication exposure, and treatment history. Second, they did not include peripheral smear examination and confirmatory biochemical tests. Third, the data was based on a population of a diagnostic-center and might not be representative of the general community or all tertiary-care patients. Irrespective of these constraints, the analysis shows that CBC-derived parameters could represent a helpful first-level profile of the severity of anemia and red cell morphology. Further research is necessary to combine CBC results with peripheral smear, iron analyses, vitamin B12, folate, and inflammatory reactors, renal functional analysis, and clinical information to permit a more robust clinicopathological interpretation.

5. Conclusion

The current secondary analysis of a free full blood count dataset offers hematological portrait of anemia in adult patients. More than half of the study population was found to have anemia and mild and moderate anemia constituted most of the burden with a smaller proportion of severe anemia. The trend implies that many adult patients might have clinically significant anemia which can be identified by routine complete blood count test. Normocytic anemia was the most prevalent morphological pattern on the basis of red cell index followed by the microcytic and macrocytic patterns. This observation implies that anemia among the study population may not be solely due to nutritional deficiency but also chronic illness, inflammation, renal dysfunction, early deficiency stages, or a combination of etiologies. Nonetheless, this was not definitively etiologically interpretable due to the lack of peripheral smear, iron, ferritin, vitamin B12, folate, inflammatory, renal functional, and clinical history in this dataset. The progressive decrease in hemoglobin was observed in the anemia severity groups alongside the decreases in the number of the RBCs and the packed cell volume. RDW rose with the severity of anemia and was negatively correlated with hemoglobin, indicating more variability in the size of the red cell in patients with lower hemoglobin. These data confirm the applicability of CBC parameters, in particular, hemoglobin, RBC count, PCV, MCV, MCH, MCHC, and RDW, to initial anemia classification. In general, the article demonstrates the usefulness of complete blood count as an informative, convenient, and inexpensive screening and preliminary characterization tool of anemia. Further research must integrate hematological indicators with clinical data and confirmatory biochemical research to develop the underlying etiology and enhance the diagnostic precision.

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