

## ORIGINAL ARTICLE

# DISTRIBUTION OF NON-MALIGNANT HEMATOLOGICAL DISORDERS BY SEX, AGE GROUPS AND TYPE OF DISEASE BASED ON BONE MARROW ASPIRATION IN POPULATION OF KHYBER PAKHTUNKHWA, PAKISTAN

Mohammad Riazuddin Ghor<sup>1</sup>, Hamzullah Khan<sup>1</sup>, Muhammad Marwat<sup>2</sup>

<sup>1</sup>Department of Pathology, Nowshera Medical College, Nowshera, <sup>2</sup>Department of Ophthalmology, Gomal Medical College, D.I.Khan, Pakistan

## ABSTRACT

**Background:** The distribution of non-malignant hematological disorder varies across globe by sex, age groups and type of disease. The objectives of this study were to determine distribution of non-malignant hematological disorders by sex, age groups and type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan.

**Material and Methods:** This cross-sectional study was conducted in Department of Pathology, Khyber Teaching Hospital, Peshawar, Pakistan from Jan.-Dec. 2014. 116 cases with non-malignant hematological disorders were selected. Sex, age groups and type of disease were analyzed by count and percentage with confidence intervals for proportions. Chi-square goodness-of-fit test was used to testify two hypotheses.

**Results:** Out of 116 cases, 63(54.31%, 80%CI 48.38-60.24) were men and 53(45.69%, 80%CI 39.76-51.62) women. Age groups wise; 31(26.72%, 80%CI 21.46-31.99) were child ( $\leq 17$  years), 57(49.14%, 80%CI 43.19-55.09) young adult (18-35 years), 19(16.38%, 80%CI 11.98-20.78) middle-aged adults (36-55 years) and nine (7.76%, 80%CI 4.57-10.94) older adults ( $\geq 56$  years). Frequency of type of disease was; hemolytic anemia 17(14.66%, 80%CI 10.45-18.86), megaloblastic anemia 16(13.79%, 80%CI 9.69-17.9), bone marrow hypoplasia 14(12.07%, 80%CI 8.19-15.95), iron deficiency anemia 13(11.21%, 80%CI 7.45-14.96), mixed deficiency anemia 9(7.76%, 80%CI 4.57-10.94), ITP 9(7.76%, 80%CI 4.57-10.94), aplastic anemia 8(6.89%, 80%CI 3.88-9.91), bi-lineage cytopenia 7(6.03%, 80%CI 3.2-8.87), erythroid hyperplasia 3(2.59%, 80%CI .7-4.47) and malaria 2(1.72%, 80%CI 0.18-3.27). In 18(15.52%, 80%CI 11.21-19.83) cases the bone marrow was diluted. Null hypothesis for distribution of sex ( $p=.3532$ ) was accepted while that for age groups was rejected ( $p=<.00001$ ).

**Conclusion:** Hemolytic anemia was the most common disorder followed by megaloblastic anemia and bone marrow hypoplasia based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan.

**KEY WORDS:** Bone marrow aspiration; Hematological disorders; Hemolytic anemia; Megaloblastic anemia; Iron deficiency anemia; Aplastic anemia; Malaria.

**This article may be cited as:** Ghor<sup>1</sup> MR, Khan H, Marwat M. Distribution of non-malignant hematological disorders by sex, age groups and type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan. Gomal J Med Sci 2019 Apr-Jun;17(2):29-36. <https://doi.org/10.46903/gjms/17.02.1926>

## Corresponding Author:

Dr. Hamzullah Khan  
Associate Professor, Department of Pathology  
Nowshera Medical College,  
Nowshera, Pakistan

E-mail: hamzakmc@gmail.com

**Date Submitted:** 16-4-2018

**Date Revised:** 27-1-2019

**Date Accepted:** 11-2-2019

## INTRODUCTION

**1.1 Background:** Hematological disorders are frequent in pediatric and adult population. In pediatric age, iron deficiency anemia is more common. Similarly the frequency of various hematological disorders is different in the developing countries than the developed world.<sup>1</sup> In majority of the hematological cases, diagnosis is made by clinical examination and smear study, but for confirmation the bone marrow

is the gold standard. Bone marrow examination is though an invasive procedure but is well tolerated by the patients. It helps in many hematological disorders to reach final diagnosis within a short time span. Bone marrow aspiration provides reliable information regarding bone marrow cellularity, its architecture and the stage of maturation of different blood cells.<sup>2</sup>

Regarding the frequency of non-malignant hematological disorders in bone marrow, a study by Munir, et al.<sup>3</sup> from Kohat, Pakistan reported megaloblastic anemia in 27.27% (27/99) cases as most common followed by idiopathic thrombocytopenic purpura (ITP) in 15.15% (15/99), iron deficiency anemia (IDA) in 14.14% (14/99) cases and aplastic anemia in 13.13% (13/99) cases. A study by Kibria, et al.<sup>4</sup> from Faridpure, Bangladesh reported aplastic anemia as the second most common non-malignant disorder.

Non-malignant hematological disorders spectrum shows that megaloblastic anemia is on the top causing anemia due to immature production of DNA. It is followed by aplastic anemia, myelodysplastic syndrome and paroxysmal nocturnal hemoglobinuria present with high MCV.<sup>5</sup>

IDA is a global issue more common in the third world countries including Pakistan. IDA is the major cause of anaemia in paediatric age group (1-10 years).<sup>6</sup> Iron deficiency and IDA can affect an infant's emotion, cognition, and development as iron is responsible for many enzymatic activities of the body and related to development of normal mile stones.<sup>7</sup>

Megaloblastic anemia that usually results from B12 or folate deficiency, is major cause of nutritional deficiency anemias.<sup>8</sup> Studies on relative frequencies of various non-malignant hematological disorders diagnosed based on bone marrow aspiration reported that iron deficiency concomitant with megaloblastic anemia was the major hematological disorder. Other hematological disorders diagnosed were ITP, severe aplastic anemia, visceral Leishmaniasis, isolated megakaryocytic depression, pure red cell aplasia, lipid storage diseases, sideroblastic anemia and congenital dyserythropoietic anemia.<sup>9</sup>

## 1.2 Research Problems, Knowledge Gaps & Research Questions:

We have adopted an innovative eight steps "Marwat's Logical Trajectory of Research Process" in this project as developed by our third author Muhammad Marwat.<sup>10-11</sup>

Unawareness of distribution of various non-malignant hematological disorders by sex, age groups and type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan were our three research problems.

We searched for original articles, reviews and theses/ dissertations on net on various databases/ search engines like PubMed, PubMed Central, ScienceDirect, Open Access Theses and Dissertations, Pakistan

Research Repository, Google Scholar and Google. Absences of recent studies on these problems for our population were our three knowledge gaps. To fill these gaps was the rationale/ justification of our project.

How is the distribution of various non-malignant hematological disorders by sex, age groups and type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan were our three research questions.

## 1.3 Research Objectives:

1. To determine the distribution of various non-malignant hematological disorders by sex based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan
2. To determine the distribution of various non-malignant hematological disorders by age groups based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan
3. To determine the distribution of various non-malignant hematological disorders by type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan
4. To compare the distribution of various non-malignant hematological disorders by sex in sample versus population based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan
5. To compare the distribution of various non-malignant hematological disorders by age groups in sample versus population based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan

**1.4 Research Hypotheses (Null):** Hypotheses are the tentative answers for research questions. Based on literature search, following hypotheses were proposed to answers our research questions.

**H<sub>0</sub>1:** The expected distribution of non-malignant hematological disorders by sex in the population of Khyber Pakhtunkhwa, Pakistan is same as observed in the sample based on bone marrow aspiration. (Objective 4)

**H<sub>0</sub>2:** The expected distribution of non-malignant hematological disorders by age groups in the population of Khyber Pakhtunkhwa, Pakistan is same as observed in the sample based on bone marrow aspiration. (Objective 5)

**1.5 Significance of study:** As we have specified our population, drawn a sample, described the sample and then population and then compared the expected population parameters against the observed sample statistics for proportion with statistical inference. Hence our study will generate valid, reliable, verifiable and replicable data, results and methodology to be used by other researchers on this topic and also in any other discipline/ subject,

investigating distribution of any disease/ problem in any population.

### 1.6 Operational definitions

**Child:** Article 1 of The United Nations Convention on the Rights of the Child defines a child as “for the purposes of the present Convention, a child means every human being below the age of 18 years unless under the law applicable to the child, majority is attained earlier”.<sup>12</sup>

**Adult:** Young adult 18-35 years, middle-aged adult 36-55 years and older adult > 55 years.<sup>13</sup>

## MATERIALS AND METHODS

**2.1 Design, Duration & Settings:** This cross-sectional study was conducted in the Department of Pathology, Khyber Teaching Hospital, Peshawar, Pakistan from Jan. 2014 to Dec. 2014.

**2.2 Population & Sampling:** Assuming 1% prevalence of non-malignant hematological disorders to be subjected to bone marrow aspiration in general population; a reference population of 100,000 patients was estimated to reside in the catchment area of our hospital, belonging to province of Khyber Pakhtunkhwa, Pakistan. All the patients with non-malignant hematological disorders (disorders related to the abnormal/ deficient production of red blood cells and platelets precursors) were eligible for inclusion. All cases with leukemia and myeloproliferative disorders (haemo-oncological cases) were excluded. A sample size of 116 was calculated through Raosoft®14, an online sample size calculator, with margin of error of 1.81%, confidence interval of 95%, population size of 100,000 and estimated prevalence of non-malignant hematological disorders to be subjected to bone marrow aspiration in general population of Khyber Pakhtunkhwa, Pakistan as 1%. The sample was selected through consecutive, non-probability technique.

**2.3 Conduct of Procedure:** Bone marrow aspiration was done under aseptic conditions. Site was properly covered with only working area posterior superior iliac spine exposed and dressed with pyodine. Majority of the aspirated samples were collected from the posterior superior iliac spine. In pediatric cases especially in age less than ten years the bone marrow aspiration was done from anterior superior aspect of shin bone. Initially skin and periosteum were anesthetized by local anesthesia. Bone marrow was aspirated by proper aspiration needles for different ages and then aseptic dressing was done. 10-12 slides were prepared and stained with Giemsa and iron (Persian blue) stains for proper study. Where any suspicion in cell morphology was expected then Leukocyte peroxidase (POX) stain was used to differentiate myeloid series pathology from lymphoid one. Hemolytic anaemias were further confirmed on iron staining. All the slides were reported by a consultant

hematologist. All patients' reticulocytes count was also calculated using retic stain.

**2.4 Data Collection Plan:** The demographic variables were sex and age groups, while the research variable was type of disease. Age groups were; child ( $\leq 17$  years), young adult (18-35 years), middle-aged adults (36-55 years) and older adults ( $\geq 56$  years).<sup>12-13</sup> Type of disease was categorized into 11 diseases. Sex and type of disease were measured on nominal scale while age groups on ordinal scale.

### 2.5 Data Analysis Plan

**2.5.1 Descriptive Statistics and Estimation of Parameter:** Sex, age groups and type of disease were described by count and percentage for the sample. Then interval estimate for population was calculated as CI (confidence interval) for proportion at 80% CL (confidence level) using the normal distribution approximation for the binomial distribution through an online statistical calculator.<sup>15</sup>

**2.5.2 Hypotheses Testing:** Both the hypotheses were substantiated through chi-square goodness-of-fit test<sup>16-17</sup> at alpha .05 using an online statistical calculator.<sup>18</sup> Observed counts, expected counts, their difference, square of their difference, test statistics, degree of freedom and significance (p value) are given.

## RESULTS

### 3.1 Descriptive Statistics and Estimation of Parameter:

**3.1.1** Out of 116 patients of non-malignant hematological disorders, 63 (54.31%) were men and 53 (45.69%) were women. The men dominated the women in count. (Table No 3.1.1)

**3.1.2** Out of 116 patients of non-malignant hematological disorders, 57 (49.14%) were from age group 18-35 years (young adult), the modal group. (Table 3.1.2)

**3.1.3** Out of 116 patients of non-malignant hematological disorders, 17 (14.66%) were having hemolytic anemia, the modal group. (Table 3.1.3)

### 3.2 Hypotheses Testing

**3.2.1  $H_01$ :** Here the equal expected distribution of non-malignant hematological disorders by sex in the population was compared and verified against their observed distribution in the sample through chi-square goodness-of-fit test. As p-value was more than alpha, so  $H_01$  was accepted, showing that the statistical model of the population fits the observations. In simple words the distribution of non-malignant hematological disorders for men and women in the population was similar to their observed distribution in the sample. (Table 3.2.1)

**3.2.2  $H_02$ :** Here the equal expected distribution of non-malignant hematological disorders for four age groups in the population was compared and verified

against their observed distribution in the sample. As p-value was less than alpha, so  $H_0$  was rejected, showing that the statistical model of the population doesn't fit the observations. In simple words the

distribution of non-malignant hematological disorders for four age groups in the population was not similar to their observed distribution in the sample. (Table 3.2.2)

**Table 3.1.1: Distribution of non-malignant hematological disorders by sex based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan**

S.No.	Variable	Sample Statistics		80 % CI for Population	
		Count	Percentage	Lower	Upper
1	Men	63	54.31	48.38	60.24
2	Women	53	45.69	39.76	51.62
	Total	116	100		

**Table 3.1.2: Distribution of non-malignant hematological disorders by age groups based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan**

S.No.	Variable	Sample Statistics		80 % CI for Population	
		Count	Percentage	Lower	Upper
1	≤17 years (Child)	31	26.72	21.46	31.99
2	18-35 years (Young adult)	57	49.14	43.19	55.09
3	36-55 years (Middle-aged adult)	19	16.38	11.98	20.78
4	≥56 years (Older adult)	09	07.76	04.57	10.94
	Total	116	100		

**Table 3.1.3: Distribution of non-malignant hematological disorders by type of disease based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan**

S.No.	Variable	Sample Statistics		80 % CI for Population	
		Count	Percentage	Lower	Upper
1	Hemolytic anemia	17	14.66	10.45	18.86
2	Megaloblastic anemia	16	13.79	09.69	17.90
3	Bone Marrow hypoplasia	14	12.07	08.19	15.95
4	Iron Deficiency anemia	13	11.21	07.45	14.96
5	Mixed Deficiency anemia	09	07.76	04.57	10.94
6	ITP	09	07.76	04.57	10.94
7	Aplastic anemia	08	06.89	03.88	09.91
8	Bi-lineage cytopenia	07	06.03	03.20	08.87
9	Erythroid hyperplasia	03	02.59	00.70	04.47
10	Malaria	02	01.72	00.18	03.27
11	Diluted bone marrow	18	15.52	11.21	19.83
	Total	116	100		



**Table 3.2.1: Expected versus observed distribution of non-malignant hematological disorders by sex based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan**

Sex	O	E	O-E	(O-E)2	(O-E)2/E	$\chi^2$	d.f.	P-value
Men	63	58	5	25	0.431	0.862	1	.3532
Women	53	58	-5	25	0.431			
Total	116	116	Chi-square goodness-of-fit			H <sub>0</sub> 1 accepted at $\alpha$ .05		

O= Observed count, E= Expected count, d.f. =degree of freedom,  $\chi^2$ = chi-square value

**Table 3.2.2: Expected versus observed distribution of non-malignant hematological disorders by age groups based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan**

Age groups	O	E	O-E	(O-E)2	(O-E)2/E	$\chi^2$	d.f.	P-value
≤17 years (Child)	31	29	02	004	00.14	44.41	3	<.00001
18-35 years (Young adult)	57	29	28	784	27.03			
36-55 years (Middle-aged adult)	19	29	-10	100	03.45			
≥56 years (Older adult)	09	29	-20	400	13.79			
Total	116	116	Chi-square goodness-of-fit			H <sub>0</sub> 2 rejected at α.05		

O= Observed count, E= Expected count, d.f. =degree of freedom,  $\chi^2$ = chi-square value

## DISCUSSION

**4.1** Research is an activity to solve a problem for a specified population. Hereby we specified/ defined/ identified our population of interest, draw a sample, described our sample by count and percentage for the distribution of the disease of interest by sex, age groups and type of the disease as variables (descriptive statistics). Then we described our population by inferring our sample results on to the population (estimation of parameter- inferential statistics) through confidence interval (CI) for proportion at 80% confidence level (CL). Next we compared the expected population parameters for proportion against observed sample statistics to see if the distribution of the disease is same in the population versus sample by sex and age groups through two null hypotheses using chi-square goodness-of-fit test.

In discussion, the author is supposed to compare his population results to other populations; local, national, regional and global to see which populations match and which don't match to his results. But the available literature on the topic shows that almost all studies have started research from the sample and ended on the sample, with no mention of their specified population, no mention of CI for proportion or hypothesis testing for their populations. Then we have no way but to compare our sample results to the sample results of other relevant studies, considering sample statistics as point estimates for their populations.

**4.2** Like our study, many studies have combined data for non-hematological disorders with non-malignant

hematological disorders; few studies have analyzed these two separately. In such cases like reference No. 19, we have counted these collectively as a denominator for calculating percentages for those studies for comparison to our study as we have analyzed data for both these collectively. In other studies, malignant hematological cases are included with non-malignant hematological cases; we have separated non-malignant cases for calculating counts and percentages from malignant hematological cases for comparison to our study.

### **4.3 Distribution of non-malignant hematological disorders by sex based on bone marrow aspiration (Objective 4, $H_0$ 1)**

**4.3.1** Regarding sex, the prevalence rate of non-malignant hematological disorders in our sample and population was higher for men 54.31% (80% CI 48.38-60.24%) than women 45.69% (80% CI 39.76-51.62%).

**4.3.2** Regarding  $H_0$ 1, we expected equal frequency (count) i.e. 1:1 relationship of men to women of non-malignant hematological disorders in our population. It will be 58:58 for men versus women for a sample of 116. The observed counts for sample were 63:53 for men versus women. These counts for population were compared to sample through chi-square goodness-of-fit test. P-value of .3532 was more than alpha value of .05, so  $H_0$ 1 was proved to be true and hence accepted, showing that the statistical model of the population fits the observations. In simple words the distribution of non-malignant hematological disorders for men and women in the

population was similar to their observed distribution in the sample.

**4.3.3** Similar to our study, higher prevalence rate for men 54.76% (92/168) than women 45.24% (76/168) was noted by Anjum, et al.<sup>19</sup> for the years 2011-2013 from Abbottabad, Pakistan, by Gandapur, et al.<sup>20</sup> men 66.66% (380/570) versus women 33.34% (190/570) for the years 2007-2012 from Abbottabad, Pakistan, by Chowdhury, et al.<sup>21</sup> men 61.84% (94/152) versus women 38.16% (58/152) for the years 2012-2017 from Savar, Bangladesh, and by Kibria et al.<sup>4</sup> men 62.71% (111/177) versus women 37.29% (66/177) for the years 2007-2009 from Faridpure, Bangladesh.

Almost equal prevalence rate for men 49.3% (73/148) and women 50.7% (75/148) was given by Munir, et al.<sup>3</sup> for the years 2011-2013 from Kohat, Pakistan.

Higher prevalence rate for women 45.22% (71/157) than men 54.78% (86/157) was published by Munir, et al.<sup>22</sup> for the year 2013 from Peshawar, Pakistan and by Ranabhat, et al.<sup>23</sup> women 56% (89/159) versus men 44% (70/159) for the years 2013-2015 from Chitwan, Nepal.

#### **4.4 Distribution of non-malignant hematological disorders by age groups based on bone marrow aspiration (Objective 5, H<sub>0</sub>2)**

**4.4.1** Regarding the age groups, the prevalence rate of non-malignant hematological disorders in our sample and population was highest for age group 18-35 years (young adult) i.e. 49.14% (80% CI 43.19-55.09%) than the other three age groups.

**4.4.2** Regarding H<sub>0</sub>2, we expected equal frequency (count) i.e. 1:1:1:1 relationship for four age groups of non-malignant hematological disorders in our population. It will be 29:29:29:29 for four age groups for a sample of 116. The observed counts for sample were 31:57:19:09 for four age groups. These counts for population were compared to sample through chi-square goodness-of-fit test. As p-value of <.00001 was less than alpha value of .05, so H<sub>0</sub>2 was proved to be false and hence rejected, showing that the statistical model of the population doesn't fit the observations. In simple words the distribution of non-malignant hematological disorders for four age groups in the population was not similar to their observed distribution in the sample.

**4.4.3** We have four meaningful age groups. Many studies show some other number of age groups, hence not comparable to our study. But still we are giving the age groups with highest and lowest prevalence rates from other studies. Anjum, et al.<sup>19</sup> showed the highest prevalence rate of 20.83% (35/168) for age group 21-30 years and lowest 4.17% (7/168) for age group 91-100 years out of 10 groups for the years 2011-2013 from Abbottabad, Pakistan. Chowdhury, et al.<sup>21</sup> showed the highest prevalence rate of 42.76% (65/152) for age group >45 years and lowest 10.53% (16/152) for <15 years out of

four age groups for the years 2012-2017 from Savar, Bangladesh. Kibria et al.<sup>4</sup> showed the highest prevalence rate of 19.21% (34/177) for age group 20-29 years and lowest 3.39% (6/177) for >70 years out of seven age groups for the years 2007-2009 from Faridpure, Bangladesh. Munir, et al.<sup>3</sup> showed the highest prevalence rate of 22.3% (33/148) for age group <10 years and lowest 7.4% (11/148) for both 40-49 and 50-59 years out of seven age groups for the years 2011-2013 from Kohat, Pakistan. Ranabhat, et al.<sup>23</sup> showed the highest prevalence rate of 49.1% (78/159) for age group 26-40 years and lowest 3.8% (6/159) for >56 years out of four age groups for the years 2013-2015 from Chitwan<sup>23</sup>, Nepal.

#### **4.5 Distribution of non-malignant hematological disorders by type of disease based on bone marrow aspiration (Objective 3)**

**4.5.1** The prevalence rate of hemolytic anemia in our sample and population was 14.66% (80% CI 10.45-18.86%) respectively.

Lower rates were reported by Anjum, et al.<sup>19</sup> as 8.65% (9/104) for the years 2011-2013 from Abbottabad and by Gandapur, et al.<sup>20</sup> as 2.4% (10/417) for the years 2007-2012 from Abbottabad, Pakistan.

Zero cases were reported from Kohat<sup>3</sup>, Pakistan, Faridpure<sup>4</sup>, Bangladesh, Savar<sup>21</sup>, Bangladesh, and Chitwan<sup>23</sup>, Nepal.

No study could be found in literature having higher or equivalent prevalence rate to our population.

**4.5.2** The prevalence rate of megaloblastic anemia in our sample and population was 13.79% (80% CI 9.69-17.9%) respectively.

Higher rates were reported by Gandapur, et al.<sup>20</sup> as 31.41% (131/417) for the years 2007-2012 from Abbottabad, by Anjum, et al.<sup>19</sup> as 29.8% (31/104) for the years 2011-2013 from Abbottabad, Pakistan, and by Munir, et al.<sup>3</sup> as 27.27% (27/99) for the years 2011-2013 from Kohat, Pakistan.

Lower rate was published by Chowdhury, et al.<sup>21</sup> as 4.88% (4/82) for the years 2012-2017 from Savar, Bangladesh.

No study could be found in literature having equivalent prevalence rate to our population.

**4.5.3** The prevalence rate of bone marrow hypoplasia in our sample and population was 12.07% (80% CI 8.19-15.95%) respectively.

Lower rates were reported by Gandapur, et al.<sup>20</sup> as 7.19% (30/417) for the years 2007-2012 from Abbottabad, and by Anjum, et al.<sup>19</sup> as 1.92% (2/104) for the years 2011-2013 from Abbottabad, Pakistan.

Zero cases of bone marrow hypoplasia were reported from Kohat<sup>3</sup>, Pakistan, Faridpure<sup>4</sup>, Bangladesh, Savar<sup>21</sup>, Bangladesh, Peshawar<sup>22</sup>, Pakistan and Chitwan<sup>23</sup>, Nepal.

**4.5.4** The prevalence rate of iron deficiency anemia

in our sample and population was 11.21% (80% CI 7.45-14.96%) respectively.

Higher rates were published by Anjum, et al.<sup>19</sup> as 19.23% (20/104) for the years 2011-2013 from Abbottabad and by Gandapur, et al.<sup>20</sup> as 18.94% (79/417) for the years 2007-2012 from Abbottabad, Pakistan and by Munir, et al.<sup>3</sup> as 14.14% (14/99) for the years 2011-2013 from Kohat, Pakistan.

Zero cases of iron deficiency anemia were reported from Savar<sup>21</sup>, Bangladesh and from Chitwan<sup>23</sup>, Nepal.

**4.5.5** The prevalence rate of mixed deficiency anemia in our sample and population was 7.76% (80% CI 4.57-10.94%) respectively.

Similar rate was reported by Anjum, et al.<sup>19</sup> as 7.69% (8/104) for the years 2011-2013 from Abbottabad and lower rate was reported by Gandapur, et al.<sup>20</sup> as 0.48% (2/417) for the years 2007-2012 from Abbottabad, Pakistan.

Zero cases of mixed deficiency anemia were reported from Kohat<sup>3</sup>, Pakistan, Savar<sup>21</sup>, Bangladesh, Peshawar<sup>22</sup>, Pakistan and Chitwan<sup>23</sup>, Nepal.

**4.5.6** The prevalence rate of ITP in our sample and population was 7.76% (80% CI 4.57-10.94%) respectively.

Higher rates were published by Chowdhury, et al.<sup>21</sup> as 18.29% (15/82) for the years 2012-2017 from Savar, Bangladesh, by Munir, et al.<sup>3</sup> as 15.15% (15/99) for the years 2011-2013 from Kohat, Pakistan, by Gandapur, et al.<sup>20</sup> as 8.87% (37/417) for the years 2007-2012 from Abbottabad.

Lower rate was reported by Anjum, et al.<sup>19</sup> as 1.92% (2/104) for the years 2011-2013 from Abbottabad, Pakistan.

**4.5.7** The prevalence rate of aplastic anemia in our sample and population was 6.89% (80% CI 3.88-9.91%) respectively.

Higher rates were published by Chowdhury, et al.<sup>21</sup> as 28.04% (23/82) for the years 2012-2017 from Savar, Bangladesh and by Munir, et al.<sup>3</sup> as 13.13% (13/99) for the years 2011-2013 from Kohat, Pakistan.

Lower rate was noted by Anjum, et al.<sup>19</sup> as 5.77% (6/104) for the years 2011-2013 from Abbottabad and by Gandapur, et al.<sup>20</sup> as 2.4% (10/417) for the years 2007-2012 from Abbottabad, Pakistan.

**4.5.8** The prevalence rate of bi-lineage cytopenia in our sample and population was 6.03% (80% CI 3.2-8.87%) respectively.

Zero cases of bi-lineage cytopenia were reported from Kohat<sup>3</sup>, Pakistan, Faridpure<sup>4</sup>, Bangladesh, Abbottabad<sup>19-20</sup>, Pakistan, Savar<sup>21</sup>, Bangladesh, Peshawar<sup>22</sup>, Pakistan and Chitwan<sup>23</sup>, Nepal.

**4.5.9** The prevalence rate of erythroid hyperplasia in our sample and population was 2.59% (80% CI 0.7-4.47%) respectively.

Higher rate was published by Chowdhury, et al.<sup>21</sup> as

10.98% (9/82) for the years 2012-2017 from Savar, Bangladesh and similar rate to our study was published by Munir, et al.<sup>3</sup> as 3.03% (3/99) for the years 2011-2013 from Kohat, Pakistan.

Zero cases of erythroid hyperplasia were reported from Faridpure<sup>4</sup>, Bangladesh, Abbottabad<sup>19-20</sup>, Pakistan, Peshawar<sup>22</sup>, Pakistan and Chitwan<sup>23</sup>, Nepal.

**4.5.10** The prevalence rate of malaria in our sample and population was 1.72% (80% CI 0.18-3.27%) respectively.

Higher rate was published by Munir, et al.<sup>3</sup> as 4.04% (4/99) for the years 2011-2013 from Kohat, Pakistan and lower rate was published by Gandapur, et al.<sup>20</sup> as 0.72% (3/417) for the years 2007-2012 from Abbottabad.

Zero cases of malaria were reported from Faridpure<sup>4</sup>, Bangladesh, Abbottabad<sup>19</sup>, Pakistan, Savar<sup>21</sup>, Bangladesh, and Chitwan<sup>23</sup>, Nepal.

**4.5.11** The prevalence rate of diluted bone marrow in our sample and population was 15.52% (80% CI 11.21-19.83%) respectively.

Lower rate was noted by Anjum, et al.<sup>19</sup> as 0.96% (1/104) for the years 2011-2013 from Abbottabad, Pakistan.

Zero cases of diluted bone marrow were reported from Kohat<sup>3</sup>, Pakistan, Faridpure<sup>4</sup>, Bangladesh, Abbottabad<sup>20</sup>, Pakistan, Savar<sup>21</sup>, Bangladesh, Peshawar<sup>22</sup>, Pakistan and Chitwan<sup>23</sup>, Nepal.

## CONCLUSION

Hemolytic anemia was the most common disorder followed by megaloblastic anemia and bone marrow hypoplasia based on bone marrow aspiration in population of Khyber Pakhtunkhwa, Pakistan.

## REFERENCES

1. Young NS, Abkowitz JL, Luzzatto L. New insights into the pathophysiology of acquired cytopenias. *Hematology Am Soc Hematol Educ Program* 2000;18-38. <https://doi.org/10.1182/asheducation.V2000.1.18.18>
2. Bain BJ. Bone marrow biopsy morbidity: review of 2003. *J Clin Pathol* 2005; 58:406-8. doi:10.1136/jcp.2004.022178 <https://doi.org/10.1136/jcp.2004.022178>
3. Munir A, Shah SF, Ata T, Asim N Sajid M, Farooq M. Prevalence of non malignant hematological disorders in patients with pancytopenia/ bicytopenia: A bone marrow study of 148 cases in DHQ KDA Hospital and LMH Hospital, Kohat. *Pak J Med Health Sci* Apr-Jun 2014; 8(2): 438-9.
4. Kibria SG, Islam MDU, Chowdhury ASMJ, Ali MY, Haque MR, Mustanzid SM, et al. Prevalence of hematological disorder: a bone marrow study of 177 cases in a private hospital at Faridpure. *Faridpure Med Coll J* 2010; 5(1):11-3. <https://doi.org/10.3329/fmcj.v5i1.6806>
5. Iqbal W, Hassan K, Ikram N, Nur S. Aetiological

- breakup in 208 cases of pancytopenia. *J Rawal Med Coll Jan-Jun 2001*; 5(1):7-10.
6. Molla A, Khurshid M, Molla AM. Prevalence of iron deficiency anemia in children of the urban slums of Karachi. *J Pak Med Assoc May 1992*; 42(5):118-21.
  7. Chen CM, Mu SC, Shih CK, Chen YL, Tsai LY, Kuo YT, et al. Iron status of infants in the first year of life in northern Taiwan. *Nutrients 2020 Jan 3*; 12(1):E139. <https://doi.org/10.3390/nu12010139>
  8. Dapus DO, Damen JG. Diagnostic outcome of bone marrow aspiration in a new centre in Nigeria. *Global Adv Res J Med Sci 2012*; 1:161-71.
  9. Ikram N, Hassan K, Bukhari K. Spectrum of hematological lesions amongst children, as observed in 963 consecutive bone marrow biopsies. *J Pakistan Inst Med Sci 2002*; 13: 686-90.
  10. Shah S, Basharat A, Shah M, Marwat M, Billah M, Ali SM. Frequency, distribution and presentation of hypocalcemia in  $\beta$ -thalassemia major. *Gomal J Med Sci Jan-Mar 2018*; 16(1):2-8. <https://doi.org/10.46903/gjms/16.01.1446>
  11. Shah HU, Gul H, Khan R, Marwat M. Urethrocutaneous fistula following Snodgrass versus two stage Aivar Bracka repair of distal penile hypospadias in male children: a randomized control trial. *Gomal J Med Sci Apr-Jun 2018(2)*; 16:54-8. <https://doi.org/10.46903/gjms/16.02.1284>
  12. Unicef UK. The United Nations Convention on the Rights of the Child [internet]. Unicef London: [cited 2019 Jan 13]. Available at: <https://www.unicef.org.uk/what-we-do/un-convention-child-rights/>
  13. Petry NM. A comparison of young, middle-aged, and older adult treatment-seeking pathological gamblers [internet]. *Gerontologist 2002* [cited 2019 Jan 13]; 42(1):92-9. <https://doi.org/10.1093/geront/42.1.92>
  14. Raosoft® sample size calculator [internet]. Seattle, WA, USA: Raosoft Inc.; 2004. [accessed 2019 Jan 13]. Available at: <http://www.raosoft.com/samplesize.html>
  15. Statistics Kingdom. Proportion confidence interval calculator [internet]. Statistics Kingdom; Melbourne, Australia 2007. [accessed 2019 Jan 13]. Available at: [http://www.statskingdom.com/41\\_proportion\\_confidence\\_interval.html](http://www.statskingdom.com/41_proportion_confidence_interval.html)
  16. Zar JH. *Biostatistical Analysis*. 5th ed. New York: Prentice-Hall, Inc.
  17. Daniel WW. *Biostatistics: A Foundation for Analysis in the Health Sciences*. 7th ed. Singapore: John Wiley; 2005.
  18. Jeremy Stangroom. Chi-Square Test Calculator. Social Science Statistics. [accessed 2018 Nov 13]. Available at: <https://www.socscistatistics.com/tests/chisquare2/Default2.aspx>
  19. Anjum MU, Shah SH, Khaliq MA. Spectrum of hematological disorders on bone marrow aspirate examination. *Gomal J Med Sci 2014*; 12(4):193-6.
  20. Gandapur ASK, Nadeem S, Riaz M, Mannan MU. Diagnostic importance of bone marrow examination in hematological malignant and non-malignant disorders. *J Ayub Med Coll Abbottabad 2015*; 27(3):692-4.
  21. Chowdhury MR, Rashid MH, Begum A. Diagnostic role of bone marrow examination in detecting hematological and nonhematological disorders. *Medicine Today 2019*; 31(1): 15-8. <https://doi.org/10.3329/medtoday.v31i1.40315>
  22. Munir AH, Qayyum S, Gul A, Ashraf Z. Bone marrow aspiration findings in a tertiary care hospital of Peshawar. *J Postgrad Med Inst 2015*; 29(4): 297-300.
  23. Ranabhat S, Maharjan S, Tiwari M, Bhandari A, Osti BP. Bone marrow aspiration cytology in the diagnosis of hematologic and non-hematologic diseases in a multi-specialty hospital in Nepal. *Int J Res Med Sci 2017 Mar*; 5(3):922-6. <https://doi.org/10.18203/2320-6012.ijrms20170637>

**CONFLICT OF INTEREST**  
Authors declare no conflict of interest.  
**GRANT SUPPORT AND FINANCIAL DISCLOSURE**  
None declared.

#### AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	MRG, HK
Acquisition, Analysis or Interpretation of Data:	MRG, HK, MM
Manuscript Writing & Approval:	MRG, HK, MM

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



Copyright © 2020 Mohammad Riazuddin Ghori, et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that original work is cited properly.