



Serological Detection of Human Parvovirus B19 Infection in various types of leukemia Using ELISA Among Iraqi Patients

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Abstract

Background and Aim

The association of parvovirus B19 with various blood disorders is a major concern for many cancer researchers. This study demonstrated the relationship between parvovirus B19 infection and different types of leukemia in Iraqi patients.

Method

A cross-sectional study was conducted at a hospital, involving 80 individuals aged 16–70 years. They underwent testing for parvovirus B19 using an ELISA assay. The study was based on inclusion and exclusion criteria. Inclusion criteria included a confirmed diagnosis of leukemia and the provision of voluntary informed consent. Exclusion criteria included co-infection with other known hematological or viral diseases, pregnancy, serious underlying medical conditions, patients who had undergone hematopoietic stem cell transplantation or other treatments, and patients who chose not to participate or withdrew their consent. The study was conducted after obtaining ethical approval from the university's ethics committee and according to the Helsinki declaration.

Results

Laboratory tests reveal high levels of importance for the data, with no correlation between pressure, heart rate, and white blood cells. The rate of improvement, risk rate, and quality of life are also significant, with the second group showing the best improvement at 32%. The highest risk rate was in the first group at 15%, followed by the third group at 14%, the second group at 10%, and the third group at 9%. The average quality of life rate was highest in the second group at 38%. The data is statistically significant and can be relied upon, indicating its importance in the treatment of leukemia.

Conclusion

Acute myeloid leukemia patients have moderate associations with B19 virus and antibodies, with B19 virus being more prevalent than other conditions.

Keywords: Parvovirus B19, Leukaemia, AML, ALL, CML, CLL .

Introduction

The human parvovirus B19 is the only member in the *Parvoviridae* family and belongs to the *Erythrovirus* genus. (Schultheiss et al., 2021). Parvovirus B19 is the smallest single-stranded DNA virus, and it is one of the main causes of disease in red cell precursors, especially in younger children. (CNC Garcia & Leon, 2021) Parvovirus B19 infection presents with the classic signs of a systemic viral illness or reticulocytopenia but may have diverse and atypical clinical symptoms in different patient groups (Brown, 2022). Besides the characteristic "slapped-cheek" face, it is not rare that adults infected with B19 virus may develop infectious arthritis, occasionally hepatitis, cardiac inflammatory complications, or associated asthmatic bronchitis (Sharma & Sharma, 2022). There is also evidence supporting the association of myocarditis with parvovirus B19 infection. Recent studies showed the relationship of acute myocarditis in adults and the B19 seropositivity rate, and several data confirm the correlation between the B19 virus antigenemia levels in the myocardium and the development of chronic progressive heart failure. (Khatami et al., 2022).

Leukemia is a malignant progressive disease caused by abnormalities in the maturation process of the white blood cells. It is managed through a multimodal treatment protocol. (Foucar, 2023). The study of the effects of parvovirus B19 infection in various groups of leukemia will be helpful for epidemiologists, diagnostic specialists, and hematologists in this field for the possibility of early detection of asymptomatic carriers of the virus in order to control the complications of infection, especially in immunosuppressed patients caused by the progression of the underlying disease or as a result of the course of treatment. (CNC Garcia & Leon, 2021)

The concept of chronic leukemia with chronic tissue involvements first appeared a century ago, producing evidence that parvovirus B19 is etiologically associated with a rapidly growing list of human diseases. We aimed to determine the frequency of past parvovirus infection of parvovirus immunoglobulin G (IgG) and to detect recent parvovirus infection of parvovirus immunoglobulin M (IgM) in children with acute and chronic leukemia compared with healthy children. (Alves et al.2020; Bouraddane et al.2021)

Leukemia, a blood cancer, originates from the impaired development of the cells in the bone marrow. The bone marrow begins to produce abnormal WBCs and reduced red blood cells with impaired hemostatic function. Leukemia is divided into "Acute Lymphoblastic Leukemia" (ALL) and "Acute Myeloid Leukemia" (AML) (Safiyanu et al., 2021). ALL starts in the immature lymphoid cells and blast cells in the bone marrow, causing rapid growth that hinders the production of normal cells. (Pastorcza et al., 2021). Common signs and symptoms include swollen lymph nodes, enlarged liver or spleen, feeling weak and tired, fever, night sweats, and weight loss. AML is an aggressive leukemia also developing in the blood and bone marrow. Recent research shows that environmental exposure to solvents, radiation, and chemotherapy increases the possibility of AML (Mundt et al., 2021). Common signs and symptoms of AML include fever, sweats, flu-like symptoms, and easy bruising or bleeding. It reveals that recurrent genetic mutations result in the rapid growth of immature myeloid cells in the bone marrow. (Khouri et al., 2022)

The association between Parvovirus B19 and different types of blood disorders is a main concern of many cancer researchers. In which, a few publications reported the association between fetal stage of leukemia and Parvovirus B19 (Gigi and Anumba., 2021). In 2006, the detection of this virus in patients already diagnosed with acute lymphoblastic leukemia proposed a possible role in its development. (Zajac-Spychala et al., 2022). In 2007, the observations of Parvovirus B19 virus replication in leukemia cells showed membrane depletion with extensive formation of empty non-enveloped capsids was also detected in leukemia CRL-2522 cells. The non-enveloped B19-viral protein (VP) was mainly displayed as intranuclear inclusion bodies. (Jordan, 2020)

Parvovirus B19 belongs to the genus *Erythroparvovirus*. This virus contains one molecule of linear, single-strand DNA which has the ability to infect humans. (Ning et al., 2022) Parvovirus B19 is able to infect both hematopoietic stem cell (HSCs) and erythrocytes. It possesses the common cellular pathway, which is frequently used by many other viruses. It follows the lytic infection process of the bone marrow, where hematopoietic injury is carried out under any stressful condition such as erythropoiesis dysfunction and sees hematopoietic stem cell death (Katoh et al., 2020).

Later on, the human parvovirus B19 has been observed to express its tropism in the bone marrow and in the modest and severe erythropoiesis. Close to 98% of adults are seropositive, particularly at young ages and more evident in the old adults. There is no specific drug provided to beat this virus acceptance. Management only deal with reactivity of the human immune system when fifers manifest temporarily in blood and saliva. (CNC Garcia & Leon, 2021).

This study aims at investigating the correlation between Parvovirus B19 Infection in different types of Leukaemia in Iraqi Patients

Method

Study design

A cross sectional study was conducted at hospital in Iraq during the study period from May 2024 to December 2024. this research was done to investigation the present of Parvovirus B19 among patient with different type of leukaemia.

Participants

80 patients were randomly selected to assure the correct representation of the study cohort according to the following inclusion and exclusion criteria. Participants were tested for the presence of Parvovirus B19 using ELISA test. A method for the detection of specific IgM and IgG antibodies against human parvovirus B19 (anti-B19 IgM and IgG) and B19 antigen is outlined. ELISA can detect anti-B19 IgM for a duration of up to 20 weeks following viraemia. Four to five months post-B19 infection, anti-B19 IgG titers range from 10^{-6} to 10^{-7} . The ELISA kit (ab178651) was obtained from abcam company.

Inclusion Criteria:

1. participants must have a confirmed diagnosis of one type of leukemia based on standard diagnostic criteria.
2. ages of 16 and 70 years to maintain consistency in the study population.
3. Participants or their legal guardians must provide voluntary informed consent.

The exclusion criteria

1. Co-infection of other known blood or viral diseases that could potentially affect the results of the study. Examples of such diseases include HIV, hepatitis B, and hepatitis C.
2. Pregnancy
3. Patients with severe underlying medical conditions that could affect their ability to participate in the study or influence the results, such as end-stage renal disease or congestive heart failure, are considered to have severe comorbidities.
4. Patients who have undergone hematopoietic stem cell transplantation or other experimental therapies that could potentially affect the accuracy of the results.
5. These are patients who choose not to take part in the study or who decide to withdraw their consent.

Ethical approval:

The study was conducted after obtaining the ethical approval from the committee of ethics at Al Mustansiriyah university, Iraqi Center for Cancer and Medical Genetics Research that the study was conducted at and according to Helsinki declaration.

Results

The 80 patients were divided into four groups: the first group had acute lymphoblastic leukemia (ALL), the second group had acute myeloid leukemia (AML), the third group had chronic lymphocytic leukemia (CLL), and the fourth group had chronic myeloid leukemia (CML) as shown in Table 1.

Table (1): Comparison between all studied groups according to demographic data

Demographic characteristics	total patients	G1(AML patients)	G2(ALL patients)	G3(CML patients)	G4(CLL patients)	F	P-VALUES
	(n=80)	(n=24)	(n = 35)	(n = 5)	(n = 16)		
	%	%	%	%	%		
Sex							
Male	34.00%	58.40%	%48.60	%40	%44		
Female	%66.00	41.60%	%51.40	%60	56%		
Age (years)							
Min. – Max.	13.0 –67.0	14.0 – 67.0	13.0– 62.0	34.0 – 51.0	310 – 67.0		
Mean ± SD.	46.6 ± 11.9	46.4 ± 11	43.3 ±8.03	45.56 ± 4.54	42.2± 4.2	1.122	0.048
Median (IQR)	48(45-55)	48(45-55)	44(40-50)	45(40-50)	40 (40–52)		

G1: group 1

G2: group 2

G3: group 3

G4: group 4

IQR: Inter quartile range

SD: Standard deviation

F: F for One-way ANOVA test p: p-value for comparing between the three studied groups

Table No. 1 shows a comparison between the four groups in terms of demographic characteristics, sex and gender. It is also clear from the table that in the total number of patients, which amounted to 80 people, the percentage of females was 66%, while the percentage of males was 34%. As for the first group, which included patients with acute myeloid cancer, which numbered 24 people, the percentage of females was 41% and the percentage of males was 58.4%. As for the second group, which includes patients with acute lymphoblastic cancer, which numbered 35 patients, the percentage of males was 48.4% and the percentage of females was 51.6. As for the third group, which includes patients with chronic myeloid cancer, which numbered 5, the percentage of males was 40%, while the percentage of females was 60%. As for the group that includes patients with chronic lymphocytic cancer, the percentage of males was 44%, while the percentage of females was 56%. As for me, the average age of all patients was 46.6 years, with a standard deviation of 11.9 years. As for me, the average age for the first group is 46.4 years, with a standard deviation of 11 years. As for me, the average age for the second group is 43.3 years, with a standard deviation of 8.03 years. As for me, the average age for the third group is 45.56 years, with a standard deviation of 4.54 years. As for me, the average age for the fourth group is 42.2 years with a standard

deviation of 4.2 years. While the variance F equal to 1.122, Which means that the data is statistically significant While the p -value was $=0.048$, which is less than 0.05. Which means that the data is very important.

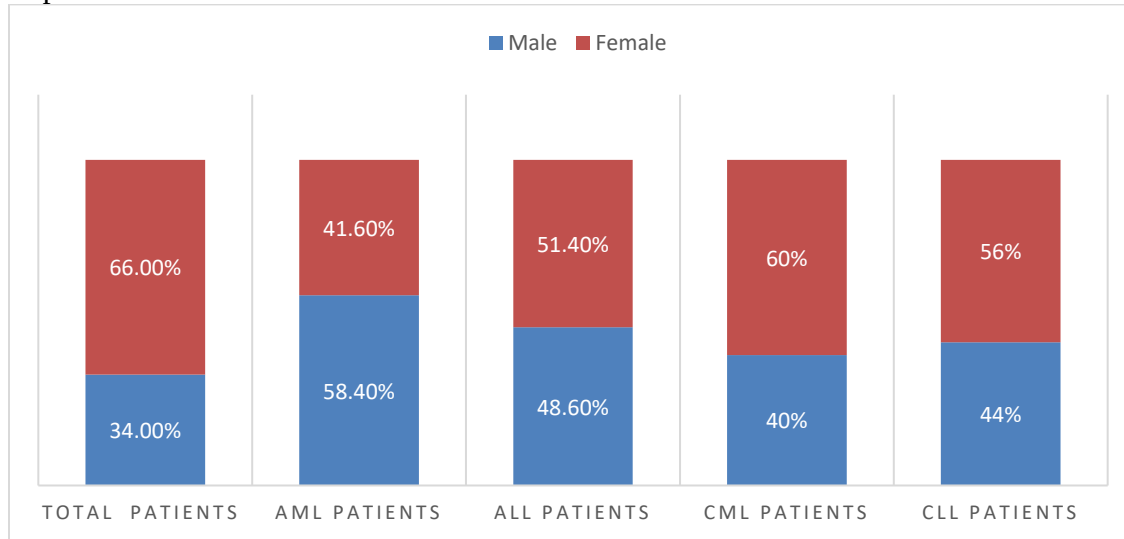


Figure 1: shows the Ratio of male and in all studied groups according to demographic data.

Figure (1) shows that the rate was higher in the first group, which includes patients with acute myeloid leukaemia, at a rate of 51.1%, while the highest rate for females was in the fourth group, which includes patients with chronic lymphocytic leukaemia, at a rate of 56%. While the lowest rate for males was in the third group, which included patients with chronic myeloid cancer, at 40%, and the lowest rate for women was in the first group, at 41.6%.

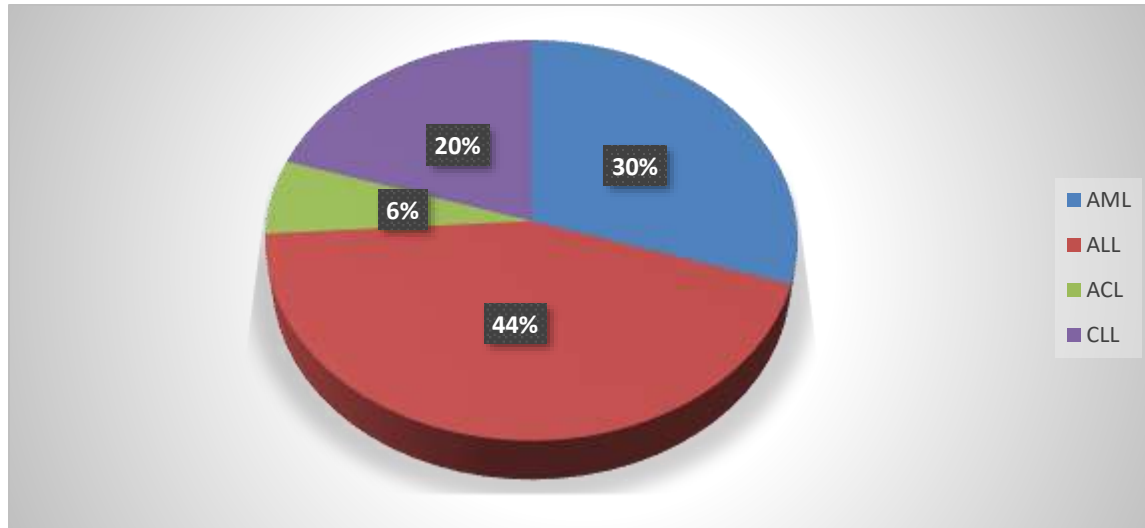


Figure 2: shows the Ratio of Each group to all the 80 patients

Figure (2) shows the percentage of patients in each group relative to the total number of patients (80). The percentage of patients in the first group was 30%, the second group represented 44% of the total number of patients, the third group represented 6% of the total number of patients, and the fourth group represented 20%. Of the total number of patients.

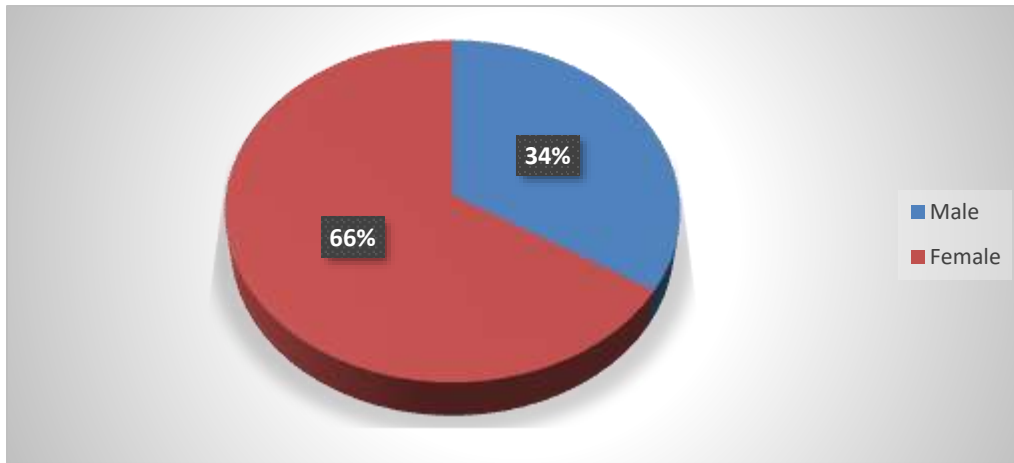


Figure 3: shows the Ratio of male and female in 80 patients

Figure No. 3 shows the percentage of the number of males and the number of females in relation to the total number of patients, where the percentage of males was 34%, while the percentage of female patients was 66%. That is, overall, the percentage of the number of female patients is higher than the percentage of the number of male patients, with a percentage ranging up to 22%.

Table 2: shows Laboratory outcome for all studied groups according to Laboratory data

	AML patients (n=24)	ALL patients (n = 35)	CML patients (n = 5)	CLL patients (n = 16)	F	P-VALUES
Demographic characteristics						
blood pressure(ml)						
Min. – Max.	55–100	52–102	70-86	52-102		
Mean ± SD.	12.13 ± 81.8	12.2 ± 79.9	78.8±	81.3± 13.9		
Median (IQR)	(90 - 80) 82	(90 - 80) 81	84(84-85)	85(86-88)	2.18	<0.0001
Heart rate (BPM)						
Min. – Max.	53–100	55–89	55-95	55-102		
Mean ± SD.	15.2 ± 79.92	13.1 ± 70.54	73.1 ± 13.4	72.3± 16.4		
Median (IQR)	(90 - 80) 76	(80 - 70) 71	78(76-79)	71(70-80)	2.35	<0.0001
white cells 10⁴ (μL)						
Min. – Max.	1.12–1.23	1.01–1.24	0.83-0.88	0.41-0.62		
Mean ± SD.	0.22 ± 1.21	43 .0±1.04	0.81±0.29	0.52±0.09		
	- 1.14) 1.21	-1.0) 1.04	0.82(0.81-	0.48(0.49-		
Median (IQR)	(1.22	(1.05	0.83	0.52)	2.20	<0.0001
red cells 10⁶ (μL)						
Min. – Max.	2.99-3.42	3.07-3.45	4.25-4.55	6.00-6.64		
Mean ± SD.	0.11 ±3.16	3.39± 0.10	4.45± 0.12	6.24± 0.16		

<i>Median (IQR)</i>	- 3.11) 3.13 (3.15	3.32(3.35- 3.44)	4.50(4.45- 4.54)	6.24(6.22- 6.48)	2.18	<0.0001
<i>plates10⁴(μL)</i>						
<i>Min. – Max.</i>	8.94–10.37	9.10-11.21	12.88-13.80	18.18-20.13		
<i>Mean ± SD.</i>	0.34 ± 9.59 - 9.40) 9.43	10.44. ±0.46 10.47(10.35-	13.49±0.36 13.60(13.72-	18.97±0.54 18.94(18.30-		
<i>Median (IQR)</i>	(9.50	10.42)	13.78)	19.25)	2.24	<0.0001
<i>HB(G/DL)</i>						
<i>Min. – Max.</i>	13–15 ± 13.56	14-16	15-16	14-28		
<i>Mean ± SD.</i>	0.571	0.571 ± 14.9	0.4 ± 15.1	17.2± 0.3		
<i>Median (IQR)</i>	(15 - 14) 14	(16 - 15) 15	15(15-16)	16(15-18)	2.31	<0.0001
<i>Respiratory rate(N)</i>						
<i>Min. – Max.</i>	10–12 .0± 10.56	11–13	12–13	12–25		
<i>Mean ± SD.</i>	571	0.571 ± 11.9	0.4 ± 12.1	14.77± 0.32		
<i>Median (IQR)</i>	(12 - 11) 11	(13 - 12) 12	12(12-13)	13(12-15)	2.09	<0.0001

F: F for One-way ANOVA test, p: p value for comparing between the three studied groups

Table No. 2 shows a comparison with the results of laboratory tests for the four groups, such as heart rate, pressure, number of white blood cells, number of red blood cells, platelet count percentage, and respiratory rate percentage. All the P-values for the groups shows that the data was of a very high degree of importance, as the p- value was 0.0001 P-values. The statistically significant f was greater 1, and this indicates that the data is statistically significant, as is evident from the table. There is no correlation between the values of pressure, heart rate, and white blood cells. Red blood cells are clearly associated with leukaemia, as some of the treatments taken for leukaemia cause irregular heartbeats, as well as the number of white blood cells varies greatly depending on the type of disease and treatment used. It is difficult to determine an accurate average for this increase because each case may be different and affected by several factors. We find the average number of white blood cells to be low and may be normal in the first and third groups, and we find it high in the second and fourth groups and it may be in the normal equations, as well as the pressure.

Table3: shows improvement rate, pr, and Quality of life

		AML patients (n=24)	ALL patients (n = 35)	CML patients (n = 5)	CLL patients (n = 16)	f	P- VALUES
Characteristics							
improvement rate	Min. – Max.%	25-35	23-38	21-30	22-32	2.1 4	<0.001
	Mean ± SD.%	30 ± 2.8	32 ± 2.5	22 ± 3.03	25 ± 1.9		
	Median (IQR)%	30(29-31)	33(32-35)	23(22-25)	26(24-28)		
	sig.bet.gr	p1=<0.00 1	p2=<0.00 1	p3 =<0.001	p4=<0.00 1		
pr	Min. – Max.%	2-20	2-15	2-15	2-12		

	<i>Mean ± SD.%</i>	<i>15± 4.18</i>	<i>10 ± 2.1</i>	<i>14 ± 2.11</i>	<i>9 ± 3.33</i>	<i>2.3</i>	<i><0.001</i>
	<i>Median (IQR)%</i>	<i>16(14-17)</i>	<i>11(8-12)</i>	<i>14(13-16)</i>	<i>11(10-13)</i>		
	<i>sig.bet.gr</i>	<i>p1=<0.001</i>	<i>p2=<0.001</i>	<i>p3 =<0.001</i>	<i>p4=<0.001</i>		
<i>Quality of life</i>	<i>Min. – Max.%</i>	<i>35-43</i>	<i>34-45</i>	<i>31-39</i>	<i>27-40</i>	<i>2.4</i>	<i><0.001</i>
	<i>Mean ± SD.%</i>	<i>36± 3.12</i>	<i>38 ± 2.88</i>	<i>32 ± 2.11</i>	<i>33 ± 2.8</i>		
	<i>Median (IQR)%</i>	<i>37(36-38)</i>	<i>39(36-40)</i>	<i>33(32-34)</i>	<i>34(32-36)</i>		
	<i>sig.bet.gr</i>	<i>p1=<0.001</i>	<i>p2=<0.001</i>	<i>p3 =<0.001</i>	<i>p4=<0.001</i>		

F: F for One-way ANOVA test,

p: p value for comparing between the four studied groups

p1: p value for comparing between G1 and all patients

p2: p value for comparing between G2 and all patients

p3: p value for comparing between G3 and all patients

p4: p value for comparing between G4 and all patients

Table No. 3 shows the qualitative measures: the average rate of improvement, the average risk rate, the average quality of life in the four groups, and the rate of decrease in cells affected by cancer also in the four groups. The best improvement was in the second group by 32%, followed by the first group by 30%, then the third group by 25%. %, then the fourth group at a rate of 22%. The highest risk rate was in the first group at a rate of 15%, then the third group at a rate of 14%, then the second group at a rate of 10%, and the third group at a rate of 9%. As for the average quality of life rate, the best percentage was in the second group with a rate of. The variance values between the groups also indicate that the data is statistically significant and can be relied upon, as the value was greater than one, all degrees of importance are in proportion, and all values of p-values are less than 0.0001, whether between groups or within groups, which means that the data is of great importance. Whereas, if the value of P-value is less than 5%, it means that the data is of some degree of importance. According to the table, all BEV values were less than 0.0001, which means that the data is very important.

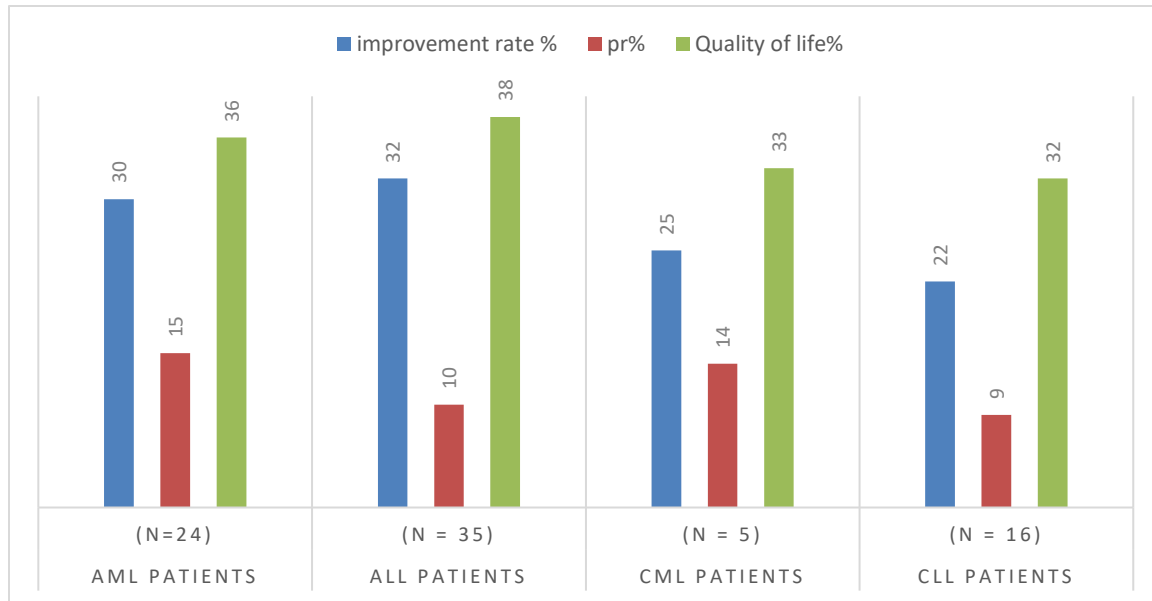


Figure 4: shows Comparison between the four groups according to average of improvement rate, pr. and Quality of life

Figure 5 shows the qualitative measures: the average rate of improvement, the average risk rate, and the average quality of life. The rate of improvement was calculated by combining the rate of increase in healthy blood cells in the four groups and the rate of decrease in cells affected by cancer also in the four groups, where the rate of increase in healthy cells was In the four groups, it ranged between 0.1:1 in 10^9 white cells per litter per day during the recovery period, which ranged from two to four weeks. The best improvement was in the second group by 32%, followed by the first group by 30%, then the third group by 25%. %, then the fourth group at a rate of 22%. The highest risk rate was in the first group at a rate of 15%, then the third group at a rate of 14%, then the second group at a rate of 10%, and the third group at a rate of 9%. As for the average quality of life rate, the best percentage was in the second group with a rate of 38%, third in the first group with a rate of 36%, then the third group with a rate of 33%, and the fourth group with a rate of 32%.

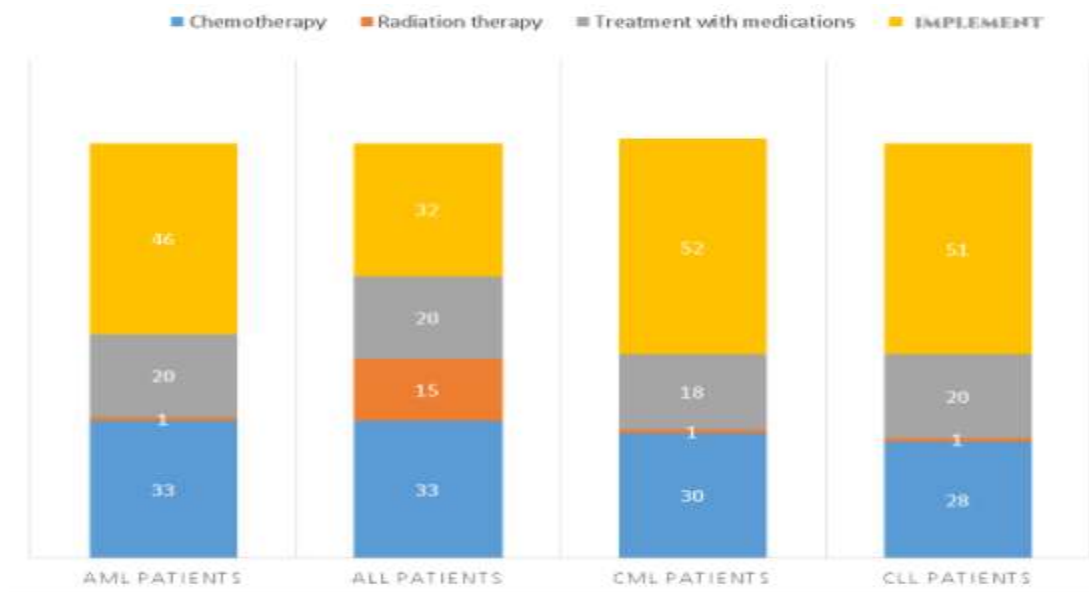


Figure 5: shows Comparison between the four groups according treatment type

Figure No. 5 shows a comparison between the results of chemotherapy, radiation therapy, treatment with drug inhibitors, and transplant therapy between the four groups. It is clear from the figure that transplant therapy has the highest results, as the percentage reached 47% in the case of acute myeloid leukaemia, 32% in the case of acute lymphoblastic leukaemia, while it reached 52% in the case of chronic myeloid cancer, 51% in the case of chronic lymphocytic cancer, while the highest value for chemotherapy was 33% in the case of acute myeloid leukaemia, 33% in the case of acute lymphoblastic leukaemia, while the percentage reached 28% in the case of chronic myeloid cancer. 22% in the case of chronic lymphocytic cancer. While the result of radiation therapy in all cases was rare, it did not exceed 1%, except in the case of acute myeloid leukaemia, where radiation therapy is performed before transplantation, where the percentage reached 15%, while treatment with medications, whether they are inhibitory medications or chemotherapy. The percentage in all groups was 20%, with the exception of the second group, a group of patients with acute lymphocytic leukaemia, which reached 18%.

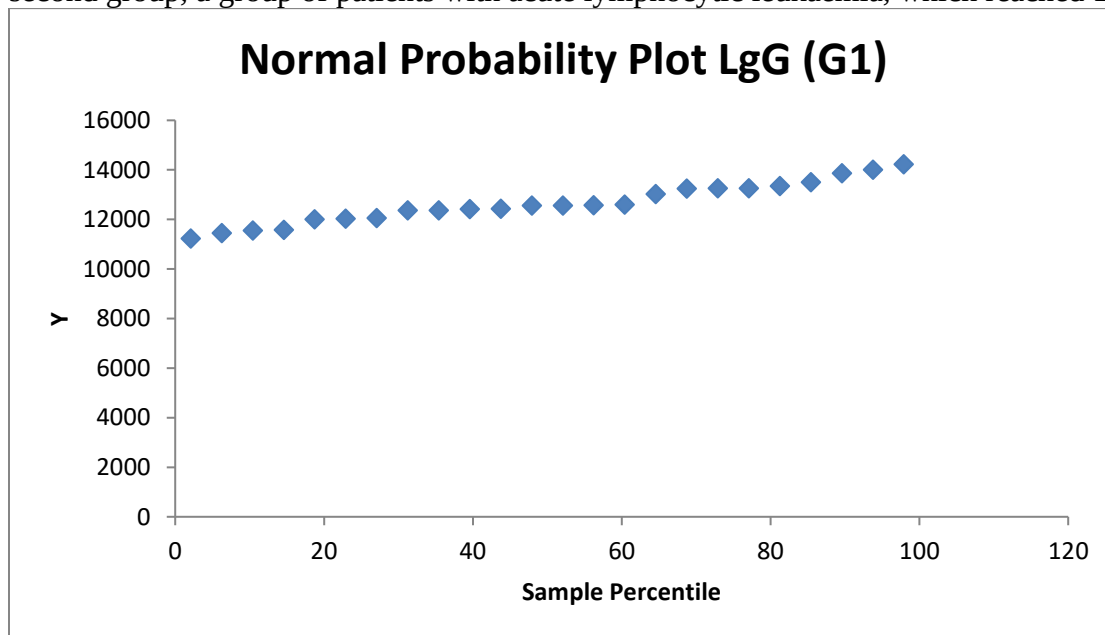


Figure 6: shows IgG normal plot probability for group 1

Figure No. 6 shows the proportional plot of the IgG antibody in the first group, which is the group of patients with acute myeloid leukaemia. The figure shows a straight line, which means that the data is normally distributed and the correlation coefficient is 0.1. This means that the link between IgG antibodies and acute myeloid leukaemia is very weak. This means that the levels of IgG antibodies are normal or low in people with acute myeloid leukaemia.

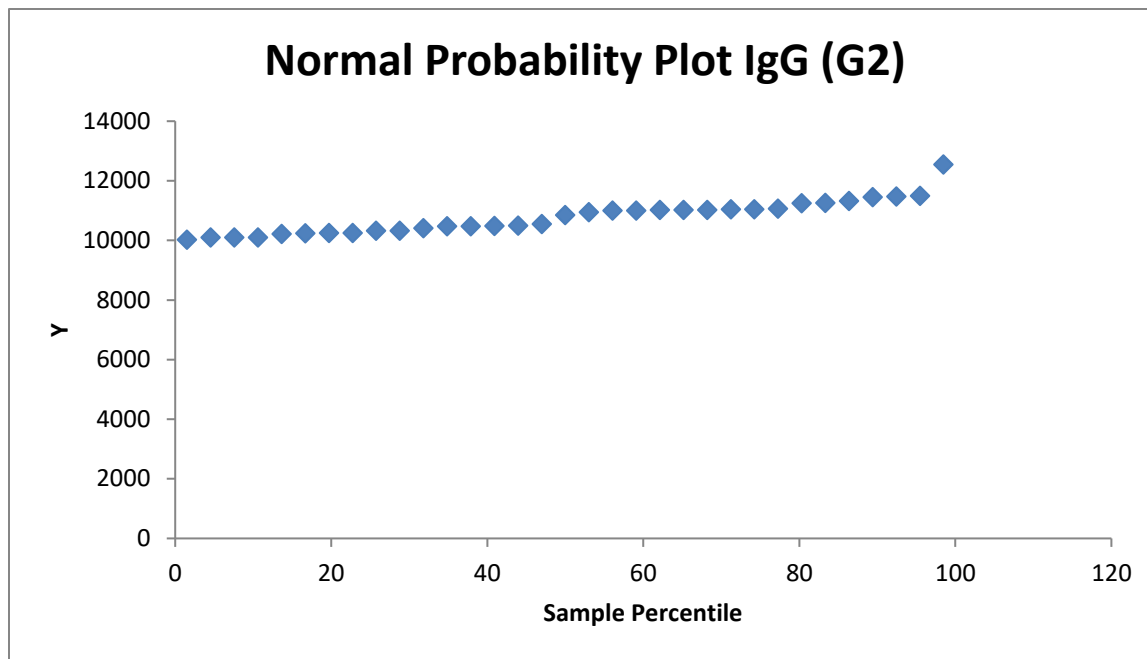


Figure 7: shows normal plot probability for group 2

Figure No. 7 shows the proportional plot of the IgG antibody in the second group, which is the group of patients with acute lymphoblastic leukaemia. The figure shows a straight line, which means that the data is normally distributed and the correlation coefficient is 0.8. This means that the link between IgG antibodies and acute myeloid leukaemia is very weak. This means that the levels of IgG antibodies are normal or low in people with acute myeloid leukaemia.

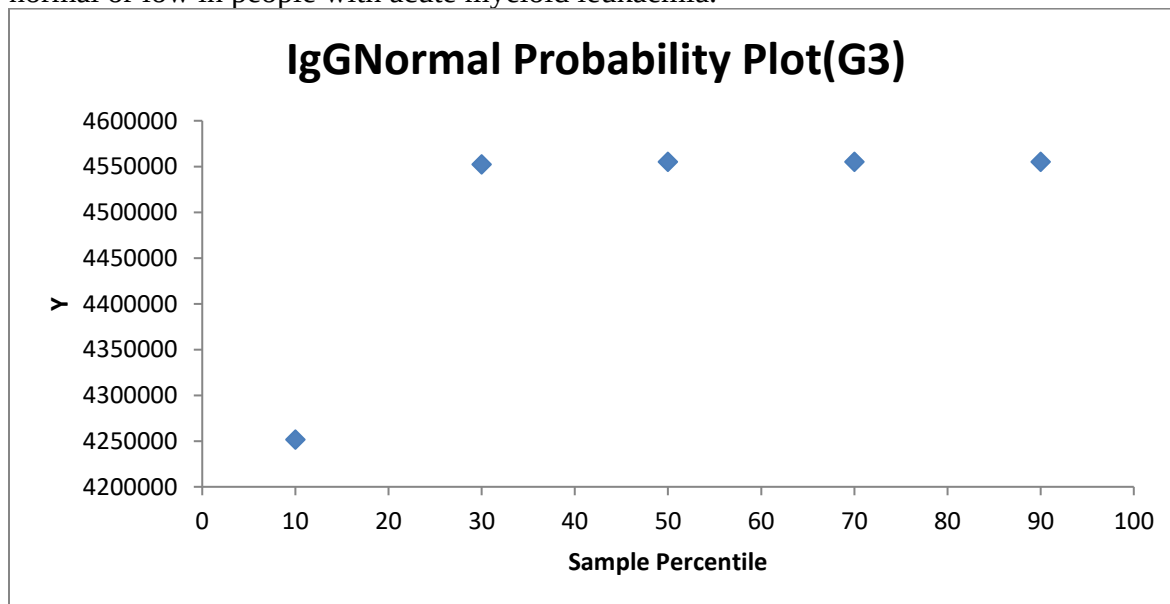


Figure 8: shows IgG normal plot probability for group 3

Figure No. 8 shows the probability plot for the IgG antibody in the second group, which is the group of patients with chronic myeloid leukaemia. The figure shows the presence of a straight line, which means that the data is more than normally distributed, and the correlation coefficient is $R = 0.1$. This means that the correlation is very weak between IgG antibodies and chronic lymphocytic leukaemia, and this means that the levels of IgG antibodies are normal, low, or sometimes high.

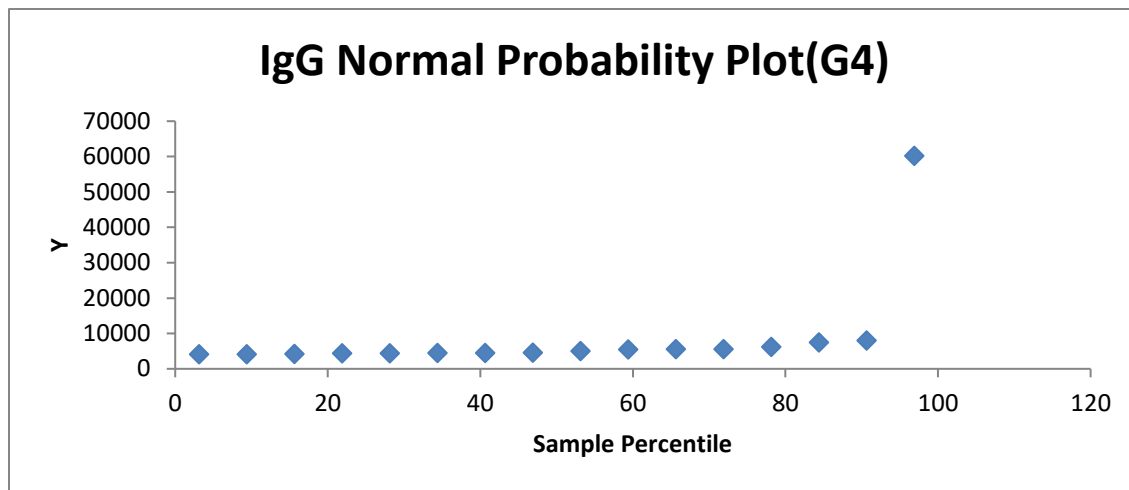


Figure 9: shows IgG normal plot probability for group 4

Figure No. 9 shows the proportional plot of the IgG antibody in the second group, which is the group of patients with acute lymphoblastic leukaemia. The figure shows a straight line, which means that the data is normally distributed and the correlation coefficient is $R=0.5$. This means that the link between IgG antibodies and chronic lymphocytic leukaemia is very weak. This means that the levels of IgG antibodies are normal, low, or sometimes high.

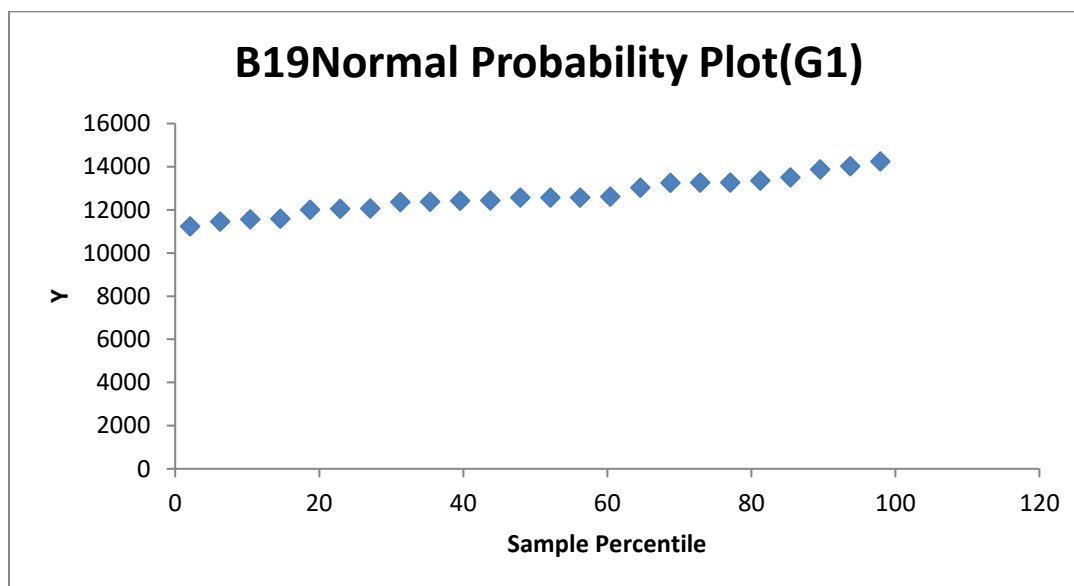


Figure 10: shows B19 normal plot probability for group 1

Figure 10 shows the probabilistic plot for the B19 virus, which is only present in Group One and Group Three, as no one in Group 2 or Group 4 was infected with this virus. For the B19 virus, it becomes clear that the relationship takes the form of an almost straight line, and this means that the data is normally distributed. Also known as parvovirus B19 or human parvovirus B19, it is a member of the parvovirus family that infects humans. This virus is considered the main cause of “fifth rash” syndrome or “scarlet fever” in children. The correlation coefficient R of B19 virus with chronic myeloid leukaemia is 4. This means that the correlation is moderate between the presence of B19 and AML, as it is 1:4. The situation is weak, from 4:6, and if the correlation is moderate, from 6:9, the correlation is strong. A negative sign means that the correlation is inverse, and a positive sign means that the correlation is direct.

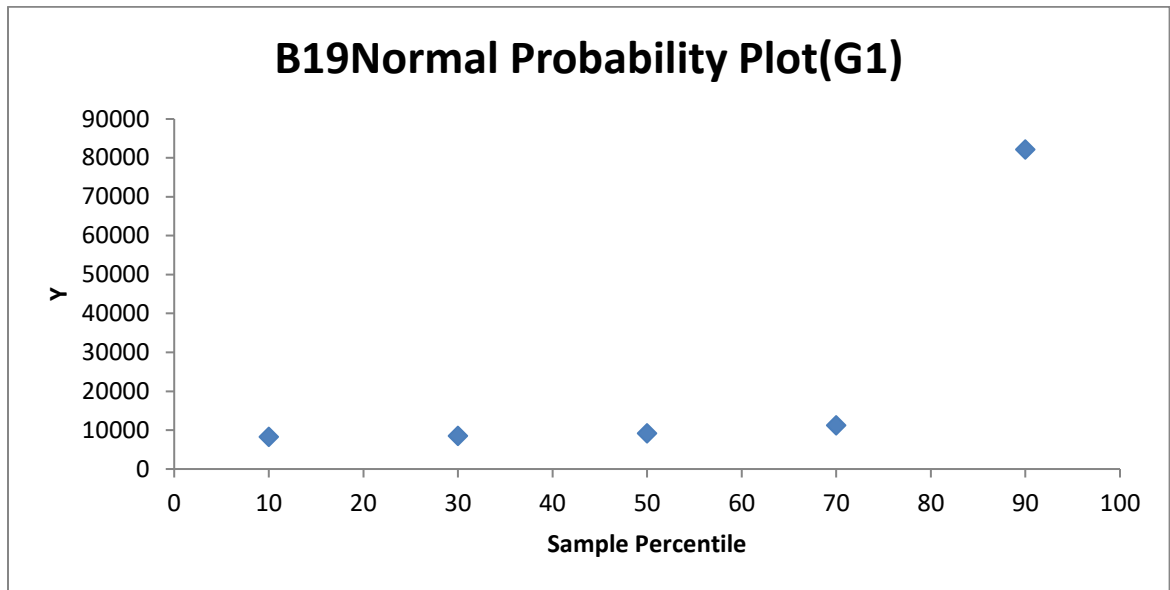


Figure 11: shows B19 normal plot probability for group 3

Figure 11 shows the probabilistic plot for the B19 virus, which is only in Group 3. It becomes clear that the relationship takes the form of an almost straight line, which means that the data is normally distributed. The coefficient is equal to 2.3, and this means that the correlation between the presence of B19 and CML disease is weak, as from 1:4 the situation is weak, from 4:6 if the correlation is moderate, from 6:9 the correlation is strong. A negative sign means that the correlation is inverse, and a positive sign means that the correlation is direct.

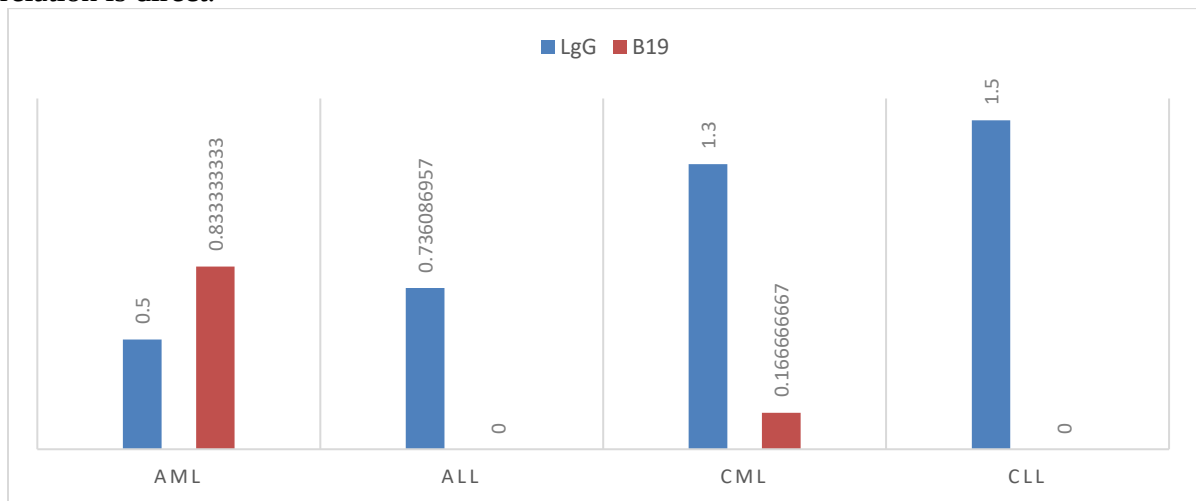


Figure 12: shows Comparison between the four groups according to average of B19 and IgG

The figure shows the relationship between the B19 virus and the IgG antibodies in the four groups. It is clear from the figure that the second and fourth groups are free of the B19 virus, while different percentages of IgG are present in the four groups. The highest group was the group of chronic lymphocytic leukaemia patients, followed by Chronic myeloid leukaemia group Acute myeloid leukaemia

Discussion

The study uncovers a notable disparity in the distribution of leukemia cases based on gender, with females accounting for 66% of the overall patient population. The cancer forms are AML, ALL, CML, and CLL.

The distribution of gender differs among various kinds, suggesting possible risk factors or outcomes. Leukemia is influenced by age, with AML predominantly affecting older individuals, while CLL primarily affects younger patients. Age-related studies observed in chronic myeloid leukemia and chronic lymphocytic leukemia indicate more precise age-related risk factor. The research indicates that both gender and age play significant roles in the study of various forms of leukemia.

In his review Tebbi, C. K. (2021) explained the etiology of cancer and revealed that the fascinating variation in incidence and prognosis based on age, sex, race, disease type, geographic area of residency, and other factors remains unexplained.

The narrower age ranges observed in CML and CLL indicate the presence of more precise age-related risk factors. The extensive research conducted in this field indicates that both gender and age play significant roles in the study of various forms of leukemia. Understanding the specific age groups affected by these types of leukemia can help in developing targeted treatment strategies that consider the unique characteristics and vulnerabilities of different age groups. Additionally, this research brings attention to the importance of identifying and addressing gender-specific risk factors, further enhancing our understanding of leukemia and improving patient outcomes. (Aijaz et al., 2020; Minciacchi et al., 2021).

The study identified notable disparities in laboratory and clinical measurements for blood pressure, white blood cells, platelet count, and respiratory rate among four distinct leukemia cohorts. The correlation matrix revealed inverse relationships among heart rate, pressure, white blood cells, and respiratory rate, but positive correlations were observed between red blood cells and respiratory rate. These connections indicate that certain tests may be affected by common causes, such as a greater heart rate being linked to lower blood pressure and white blood cell count (Gupta et al., 2023; Prasad et al., 2020)

Additionally, the study proposed that leukemia can impact the synthesis of red blood cells, resulting in the development of anemia. Leukemia can also have an impact on platelet count, comparable to its effect on red blood cells. In addition, many leukemia therapies may induce arrhythmias or respiratory complications, hence impacting the observed disparities. Additional research is required to ascertain the fundamental factors responsible for these connections (Abdel-Qadir et al., 2021; Herrmann, 2020)

According to the study, the second group had the most significant improvement rate (32%), with the first (AML), third (CML), and fourth groups (CLL) following in that order. The initial group exhibited the most elevated risk rate (15%), followed by progressively diminishing rates in the subsequent groups. The second group (ALL) reported the highest level of well-being. The statistical analysis revealed that the observed differences between the groups were statistically significant, indicating that these discrepancies were likely indicative of genuine disparities. The results indicate that the effects on patient outcomes differ depending on the treatment methods used or the characteristics of the patients. The best results in terms of improvement and quality of life with a low risk rate were shown by Group 2 (ALL) (Andre et al., 2021; Garassino et al., 2020).

The results of the present study revealed the typical distribution of the level of IgG antibody with a weak correlation coefficient of 0.1 in patients with AML. The results demonstrate that IgG antibodies are not a good biomarker for the diagnosis or progression prediction of AML. The distribution of IgG antibody levels in AML patients is not significantly different from the general population (Flevaris & Kontoravdi, 2022; Mehta et al., 2022). Thus, IgG antibodies are unlikely to be a useful diagnostic or prognostic marker in this type of malignancy (de Jonge et al., 2021).

Transplant therapy is the best treatment for all four types of leukemia and has always had the highest success rates. Chemotherapy, though effective, had lower success rates compared to transplant therapy,

with slightly higher success rates in cases of acute myeloid and lymphoblastic leukaemia. When used as a preliminary measure for transplantation, radiation therapy was not very effective in treating all types of leukemia except acute myeloid leukemia. Drug inhibitors worked equally well in all types of leukemia at a rate of around 20% success. However, this may be influenced by factors such as patient selection criteria and therapy protocols. Chemotherapy is a valid option, especially for acute myeloid and lymphoblastic leukemia. The poor effectiveness of radiation therapy indicates that its use as a solo treatment may be restricted.

Transplant therapy, also known as hematopoietic stem cell transplantation (HSCT), is a complex procedure that aims to treat various hematological malignancies, including leukemia (Bittencourt & Ciurea, 2020). Several techniques have been developed over the years, ranging from complicated surgical procedures to altered chemotherapy protocols. In recent years, technical improvements and the development of supportive care for post-grafting have helped reduce morbidity and mortality, thereby improving the outcome. (McDonald et al., 2020)

Transplant therapy has demonstrated varying outcomes in different types of leukemia, as evidenced by case studies. For instance, a study on leukemia patients' concomitant with active tuberculosis infection found that all 7 patients who underwent HSCT showed response to tuberculosis treatment, with improved symptoms and gradual absorption of tuberculosis. However, complete response was not achieved, and patients exhibited active hyperplasia in bone marrow 30 days after transplantation, indicating the complexity of managing both conditions simultaneously (Liu et al., 2014).

The study demonstrates a moderate positive link between the B19 virus and AML, indicated by a correlation coefficient of 4. This suggests that there is a weak correlation between B19 virus and AML, but not a significant one. There is a weak positive correlation between B19 virus and CML with a correlation coefficient of 2.3, there is a small connection. The results indicate that the B19 virus may be associated with AML, although the association is weak. The correlation between B19 and CML is rather weak. The distributions of both B19 virus datasets are normal. However, the correlation does not imply causation and more research is needed to prove a causal relationship. To make a better interpretation of it, it is important to clarify which units or scale is used for the correlation coefficient.

Several important studies have provided empirical support to the relationship between B19 virus and AML/CML. E. Gama et al. (2017) investigated the potential transmission of B19 virus through allogeneic stem cell infusion in hematopoietic stem cell transplantation (HSCT) recipients. The study did not provide accurate quantitative data due to sample unavailability, but suggested that B19V transmission through hematopoietic allografts is not a frequent event. They also investigated the indirect effects of a B19V-infected graft from a B19V-infected donor on early transplantation parameters, providing insight into the complexities of B19 virus transmission in the HSCT setting. Moreover, Kishore et al. Researchers conducted a pilot study on B19 infection in patients with hematological malignancies. This study revealed a 17.1% infection rate among children, leading to unexplained anemia, an increased need for blood transfusions, and delays in starting chemotherapy. (Kishore et al., 2011).

These studies add to the empirical basis for association of B19 virus with AML/CML and provide insight into the possible impact of B19 infection on pediatric hematologic malignancies and the transmission dynamics of the virus in the setting of HSCT.

The consequences of the weak links found in the B19 virus-AML/CML correlation are numerous and significant for clinical practice and research. The association may not be strong but has practical significance in diagnosis, treatment and further investigations. Understanding the specific relationship between virus B19 and acute/chronic myeloid leukemia may influence health practices and encourage clinicians to seriously consider virus B19 infection when diagnosing unexplained anemia or when a prolonged treatment protocol is required. Furthermore, this relationship underscores the need for continued research to elucidate the precise mechanisms underlying it, which could lead to advancements in patient care and treatment strategies (Kishor et al., 2011).

The implications of these links extend to other hematological malignancies and infectious diseases. Some studies conducted on other viral infections and blood disorders, such as the relationship between COVID-19 and multiple myeloma, have shown that even seemingly minor associations can have serious consequences for patient outcomes and disease management (Wang et al., 2024). Therefore, the significance of these associations in the link between B19 virus and acute/chronic myeloid leukemia warrants continued attention and research to fully understand their clinical and scientific implications.

Conclusion

Initially, the relationship between patients with acute myeloid leukemia (AML) and virus B19 is moderate, but the association of hepatitis B19 with this disease is stronger than its association with other diseases such as chronic lymphocytic leukemia (CLL), acute lymphoblastic leukemia (ALL), and chronic myeloid leukemia (CML). Similarly, the relationship between patients with ALL and antibodies is relatively weak, but antibodies are more strongly associated with this disease than with other diseases such as chronic myeloid leukemia (CML), chronic lymphocytic leukemia (CLL), and acute myeloid leukemia (AML).

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