ISSN: 2457-0400

Impact Factor: 7.675

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

www.wjahr.com

Volume: 10, Issue: 4

Page N. 79-84

Year: 2026

Original Article

Coden USA: WJAMA3

# EPIDEMIOLOGICAL PROFILE AND TRENDS OF LEUKEMIA AMONG CHILDREN UNDER 15 YEARS DURING (2002-2006) IN MOSUL CITY OF IRAQ

**Abdulrazak Khalaf Abdulrahman[1]*, Abdullah Abdulrazzaq Khalaf Pharmacist[2]**

[1]Doctor, Al-Arabi Health Center for Family Medicine, Mosul, Ministry of Health, Republic of Iraq.
[2]Mosul General Hospital, Mosul, Iraq.

**Article Received:** 23 February 2026 **Article Revised:** 14 March 2026 **Article Published:** 01 April 2026

***Corresponding Author: Abdulrazak Khalaf Abdulrahman**

Doctor, Al-Arabi Health Center for Family Medicine, Mosul, Ministry of Health, Republic of Iraq.

**DOI:** https://doi.org/10.5281/zenodo.19330938

**How to cite this Article:** Abdulrazak Khalaf Abdulrahman[1]*, Abdullah Abdulrazzaq Khalaf Pharmacist[2] (2026). Epidemiological Profile And Trends Of Leukemia Among Children Under 15 Years During (2002-2006) In Mosul City Of Iraq. World Journal of Advance Healthcare Research, 10(4), 79–84.



**ABSTRACT**

Aiming to determine the epidemiological profile and trend of leukemia among children under 15 years during (2002-2006) in Mosul city of Iraq, a retrospective analytical study had been conducted in the Ibn-Alather pediatric hospital in Nineveh governorate from the period of 1st of June to 31st of December 2007. The data collected from patient's files and by interview of relatives of children under 15 years with leukemia diagnosed by blood film and bone marrow study, where details of each information had been recorded in a special questionnaire form. Out of total collected leukemia cases (n=128), 123 cases were proved to have acute leukemia and 5 cases were proved to have chronic leukemia. Acute lymphoblastic leukemia is the commonest type of acute childhood leukemia and among leukemia cases, male to female ratio was 2.2:1. The present study revealed that there is increase in the incidence rate and trend of childhood leukemia during the study period (2002-2006) in Mosul city, associated with increased death rate during these years. It was also showed that the highest incidence of childhood leukemia was among the age group of < 5 years, and showed no significant association of acute childhood leukemia with some of the risk factors which might be due to small sample size. Further wide scale studies in this field are recommended in future for better case detection, registration, evaluation, and management of the problem of childhood leukemia. A better training of laboratory staff, statistical staff and computerized records looks to be necessary too.

**KEYWORDS:** Epidemiological profile, trends, leukemia, children under 15 years, Mosul city of Iraq.

## INTRODUCTION

Leukemia is a group of malignant diseases in which genetic abnormalities in a hematopoitic cell give rise to a clonal proliferation of cells.[1]

Leukemia in Iraq is seventh in order of frequency among the commonest ten cancers in (1986-1988), while in Mosul city leukemia ranks among the commonest ten cancers among children in both sexes.[2]

It is the most common malignant neoplasm in childhood, accounting for about 41 % of all malignancies that occur in children younger than 15 years of age in USA.[1]

Acute leukemia is better described as blast cell leukemia. Various methods of classification of acute leukemia has been used.[3]

In recent years attempts have been made to see whether there are any correlation between the subgroups and clinical and laboratory findings, response to treatment and prognosis, such a problem has been discussed by a group of seven French, American and British haematologists (FABH).[4]

Acute lymphoblastic leukemia (ALL) is the most common malignancy diagnosed in patients under the age of 15 year و accounting for one-fourth of all cancer and

76 % of all leukemia in this age group in the developing countries.[5]

The increase in the average life expectancy of children treated for ALL represents an important advance in cancer therapy. Childhood leukemia is among the success stories in cancer treatment during the past few decades One of the reasons for the good results is the development of central nervous system treatment along with advanced treatment protocol and improved supportive treat-ment, which have changed childhood leukemia from a fatal to a curable disease for over 80 % of the standerd risk and intermediate risk patients.[6]

Acute myeloid leukemia (AML) is the predominant form of leukemia during the neonatal period, but it represents a small proportion of cases during childhood and adolescence. The mortality rate from AML is about 0.5 per 100000 persons under age 10 years and increase progressively until it reaches about 20 per 100000 person in the ninth decade of life. AML accounts for 15 to 20 % of the acute leukemia in children and 80% of the acute leukemia in adult.[5]

Chronic myelogenous leukemia (CML) is a myeloproliferative disorder caused by the clonal expansion of a pluripotent stem cell and associated with the presence of the Philadelphia (ph) chromosome.[7]

Leukemia is the most common malignancy among children aged under 15 years. ALL accounts for 76-85% of all diagnosis of childhood leukemia and representing 30% of all childhood malignancies.[8,9]

There are substantial geographic differences in the incidence of childhood leukemia. In the developed countries, the incidence rates for childhood ALL are two to fourfold compared to the rates in the underdeveloped countries, which could represent differences in environmental factors, genetic factors and diagnostic accuracy.[10]

Each year approximately 150 -200 children are diagnosed with ALL in the Nordic countries, with an overall incidence of 3.6 cases per 100000 children aged under 15 years. The incidence of childhood ALL has been stable in the Nordic (North European) countries during the past years.[9] In contrast, it has been show that the incidence of ALL has been increasing in the united states and England. The increase has been more pronounced amongst young children in the age group of 2-4 years.[11,12]

In the developed countries, there is a significant peak in the incidence of childhood ALL between the age of two and five years, and one subtype, referred to as common acute lymphoblastic leukemia, accounts for the high incidence in this age group.[13] Overall boys have a higher leukemia risk than girls, but leukemia diagnosed in the first year of life is more common in girls than in boys.[13]

Throughout childhood, the incidence of ALL in blacks is consistently about half of that in whites.[8]

However, geographic variation has been reported. Male preponderance has been described especially in the pubertal age. Variable demographic, prenatal, perinatal, genetic and environmental factors have been suggested to contribute to the development of childhood ALL. Included, these are, increased paternal or maternal age, maternal use of oral contraceptives, in utero and in the first year of life viral infections, living in proximity to high voltage power lines or exposure to electromagnetic fields, parental occupational exposures, socioeconomic status, higher birth weight, male sex, in-utero ionizing radiation exposure, having asibling, especially a monozygotic twin with leukemia, and history of maternal fetal loss.[15]

## OBJECTIVE OF STUDY

To determine the epidemiological profile and trends of leukemia among children under 15 years during (2002 - 2006) in Mosul city of Iraq.

## METHOD

Administrative agreement had been undertaken from Nineveh health office; and formal consents from care givers of the included children had been considered too.

The study had been carried out in Ibn-Alather pediatric teaching hospital in Nineveh governorate which is located at the left side of the city. It serves the children within the city and nearby towns and villages. It was established in 1958, and contains 316 beds. The leukemic center (LC) in this hospital contain 21 beds. The data collection period was from 1st of June to 31st of December 2007.

The study sample consists of all cases of leukemia children under 15 years (n=128) diagnosed by blood film or bone marrow examination and registered in LC at Ibn-Alather pediatric teaching hospital as cases of leukemia during (2002-2006) in Mosul Retrospective analytical epidemiological design had been chosen to conduct the present study. Sources of data: records in LC and patient's interview. A questionnaire form had been prepared, and reviewed by several specialists (including consultant pediatrician) later to be used for proper data collection.

The important information were registered from the patient's files in the archive unit of the LC ward. An interview with the patient's parents (or relatives) was undertaken in order to complete the information about exposure to risk factors which did not mentioned in the patient's file and records.

A separate questionnaire form had been filled for each case included by the study sample. The questionnaire form items included: the socio-demographic and personal characteristics (age, sex, residence, age of mother and rank of child in the family), family history, history of mother exposure to diagnostic radiation during pregnancy, history of child exposure to cigarette smoking and history of breast feeding.

All the forms of leukemia cases in children under15 years of study years were collected and they were grouped by years 2002, 2003, 2004, 2005 and 2006.After completing data entering in the data collection form of all cases (n:135), data processing was done to check and sort them. The duplicated cases were identified and excluded, they were 5 cases identified based on their names, ages address and some other information. Each record of the total remaining data (n:128) were addressed to their village, district and sub-districts to simplify data analysis.

In this study, statistical analysis has been done. Chi-square test, Z test, Fisher Exact test and correlation coefficient were used to find association and correlation between variables. P-value < 0.05 were considered significant.

**RESULTS**

Overall, childhood leukemia form 2.2% of the total cancer cases during the period of study (2002-2006). There is an increased trend in the fraction of childhood leukemia over time. A significant positive correlation is present between the proportion of leukemia cases out of total cancer cases and progressing of time. It was 1.6 % in 2002 and increased progressively to become almost 3.0% in 2006.

Overall there is an increasing trend of childhood leukemia over time. The highest incidence is shown among the age group of < 5 year (13.8/100000).

Male shows a higher incidence than female during the whole study period. Moreover, the incidence showing an increasing trend over time. Overall male to female ratio is 2.2:1.

Out of 128 total leukemia cases 50.0 % were under 5 years of age, 33.6 % were at the age group 5- < 10 years, and 16.4% were 10-< 15 years old. No significant difference between age group is presented (chi–square test was used).

Out of 123 patients who were diagnosed as acute leukemia, 68.3 % were male and 31.7 % were female, with male to female ratio of 2.1: 1 .While out of 109 patients with ALL, 67.9 % were male and 32.1 % were female with M : F ratio of 2.1:1 .In AML two thirds (71.4 %) were male and 28.6% were female with M : F ratio of 2.5: 1.

Out of the total leukemia cases registered during (2002 - 2006) there were only 5 cases of chronic leukemia. Four cases were male and there is only one female. Also four of them were under the age of five and one was 10 – 15 years old.

Out of 123 patients who were diagnosed as acute leukemia, 48.7% were under 5 years of age, 34.9 % fall at the age group of 5-< 10 years and 16.2 % were patients 10 -< 15years of age. There were 109 patients with ALL, 48.6 % of them were under 5 years, 37.6% their age was 5-<10 years and 13.7 % were patients 10-<15 years of age. Out of 14 patients with AML, 7 were under5 years, 2 were at the age group 5-<10 years and 5 were patients 10-<15 years old. No significant association is found between age of the study cases and type of acute leukemia.

Out of 128 children who were diagnosed as having leukemia 35.9% were diagnosed during spring, 18.8 % during summer, while 25.0% during autumn, and 20.3% were diagnosed during winter.

Case fatality rate (CFR) of different types of leukemia show that ALL is of significantly lower CFR in comparison to AML and CML.

The distribution of case fatality rate of different types of leukemia according to sex show that females has a higher CFR than males (45.0% vs. 37.5%). However, the reported figures did not reach a significant value.

Overall, the highest case fatality rate of childhood leukemia registered during the study period is among the age group < 5 years (53.1%). Taking each type separately, children < 5years and have ALL showed a significantly highest CFR compared to other age group. Other types showed no significant difference.

The association between acute leukemia cases and breast feeding history shows that more than one third of the children (37.4 %) were breast fed for less than 6 months, 43.9 % for 6 months and more, and18.7 % were never breast fed. No significant association is found between the types of acute leukemia and breast feeding history.

The association of acute leukemia types and maternal exposure to diagnostic radiation during pregnancy show that overall 5.7 % of the cases their mother have had a history of exposure to diagnostic radiation during pregnancy. No significant association is found between the types of acute leukemia and history of exposure to diagnostic radiation during pregnancy.

The association between types of acute leukemia and maternal age shows that although almost two third (64.2%) of mothers were equal or older than 40 years of age, there is no significant association between maternal age and types of acute leukemia.

The association of acute leukemia cases and parental smoking shows that out of 123 patients who were diagnosed as acute leukemia 8.9 % were children of smoker mothers, 31.7% were children of smoker fathers, and 4.1% were children of both smoker parents. No significant association is found between parental smoking behavior and types of acute leukemia.

The association of types of acute leukemia and rank of the child in the family shows that more than one third of the cases (39.0%) were children of the first rank, and 20.3% were children from a large family (i.e > 3 children). No significant association is present between the child rank in the family and types of acute leukemia.

The distribution of leukemia according to the family history of leukemia indicates that the majority of leukemia cases (96.1%) have no history among the family.

**Table 1: Frequency of leukemia in children under 15 years out of total cancer cases in Mosul.**

| Year | Total cancer cases | Leukemia in children | %out of total cancer |
|---|---|---|---|
| 2002 | 959 | 16 | 1.6 |
| 2003 | 1125 | 15 | 1.3 |
| 2004 | 1157 | 26 | 2.2 |
| 2005 | 1168 | 36 | 3.0 |
| 2006 | 1188 | 35 | 2.9 |
| Total | 5615 | 128 | 2.2 |

**Table (2): Distribution of acute leukemia cases according to sex and types (2002-2006)**

| Type of leukemia | Male | % | Female | % | Total | % | M:F*Ratio |
|---|---|---|---|---|---|---|---|
| ALL | 74 | 67.9 | 35 | 32.1 | 109 | 88.6 | 2.1:1 |
| AML | 10 | 71.4 | 4 | 28.6 | 14 | 11.4 | 2.5:1 |
| Total | 84 | 68.3 | 39 | 31.7 | 123 | 100 | 2.1:1 |

**Table (3): Case fatality rate of different types of leukemia during the study period (2002-2006)**

| Types of leukemia | Number of cases | Number of death | CFR | P-value |
|---|---|---|---|---|
| ALL | 109 | 39 | 35.8 | 0.024* |
| AML | 14 | 8 | 57.1 | 0.161* |
| CML | 5 | 4 | 80.0 | 0.082** |
| Total | 128 | 51 | 39.8 | 0.053* |

*Chi-square test was used,
**Fisher exact test was used

ALL shows significantly lower CFR (P-value= 0.024) in comparison to AML and CML

## DISCUSSION

Acute leukemia in Iraq is a common neoplastic disease.[2] It is commonest cancer among children in both sexes in Mosul.[2] Leukemia is the first in the order of frequency among top ten cancer death in children in Mosul city during 2003.[31] So, whenever leukemia is suspected a prompt act- ion is necessary to be performed in order not to miss even one critical case.

This study therefore might, help to determine the extent of the problem of leukemia among Mosul population in form of increasing incidence and death rates.

The present study showed that there is an increasing trend of registered cases of childhood leukemia during the study period (2002-2006) which might be explained by change in the pattern of exposure to many risk factors including environmental factors and improvement in the diagnosis and registration of cases of cancer as a whole and of leukemia as a specific disease. American cancer society showed that over the time period of 1992-2004. Overall cancer incidence in the united states declined by about 0.6% per year. Cancer incidence rate were about 8.0% lower in 2004 than they were in the year 1992. No appreciable down turn has been shown in multiple myeloma, non-Hodgkin lymphoma and leukemia (32). In the same setting the incidence of leukemia in girls showed an increasing trend during 1975-2003, while among boys, the incidence was increased during this period for leukemia (which began to stabilize in 2001) but decreased for cancer of other sites (oral cavity, pharynx and for lung).[33]

The same results are shown by the present study regarding childhood leukemia. Acute childhood leukemia in Mosul was found to be more common in male (68.3%) than in female (31.7%) with M:F ratio of 2.2:1, and this is agreed with the results of Awad in Mosul in 1992.[34]

The highest incidence of acute childhood leukemia is shown among children under 5 years of age in the present study and this is agreed with the results of various other workers such as that of Catovsky and Hoffbrand in England; Raouf, in Baghdad in 1990; and

Awad in Mosul.[3,34,35] On the other hand, Ibrahim in Baghdad showed higher incidence of acute leukemia in age group greater than 5 years.[35]

In the present study patients with acute leukemia showed a preponderance of ALL (88.6%) over the AML (11.4%), which is different from the results of AL-Niaimi and Al-Mondhiry, in Baghdad[37], and from that of Ibrahim in the same setting, in 1983[36] such studies showed the preponderance of AML over that of ALL. This might be related to inadequate records and to less frequent admission of children to Medical city in Baghdad. On the other hand the present findings agreed with that of Awad in Mosul and Knox-Macaulay in sultanate of Oman.[38]

In the present study seasonal distribution of childhood leukemia showed a peak incidence in spring (35.9%) and in autumn (25.0%) respectively, which might be explained by increased incidence of infectious diseases as a whole and of viral infections as specific diseases during these two seasons. This results was different from that of other study in Mosul in 1992 which showed that the peak incidence of childhood leukemia was in summer.[34]

Death rates in the form of case fatality rates of childhood cancer including leukemia have declined in developed countries by approximately 47.0% since 1975, and was presented in the study of Matthew in U.S.A in 2006.[33] Matthew study identified changing patterns in the cancer burden across divers United states populations, measures progress against cancer, and examine implication for cancer control in the context of association with risk factors, prevention intervention, and the advances in treatment. This results are different from that of the present study, which showed an increasing case fatality rates during the whole study period, this might be due to inadequate diagnostic and therapeutic facilities, and poor control measures in the form of determination of association of childhood leukemia with risk factors and subsequent preventive measures.

Childhood cancer death were reported in the United states, Hispanic, and non-Hispanic population during 1990-2004, a total of 2223 cancer deaths occurred in 2004; among these, leukemia were the most common diagnosis, followed by brain and other nervous system neoplasm. From 1990-2004, death rates for leukemia declined significantly by 3.0% per year. For all cancer combined and for childhood leukemia during 1990-2004,boys had significantly higher death rates than girls, young children under 5years had significantly higher death rate, and children with ALL had higher death rate than AML.[32] The overall trend of declining childhood cancer and childhood leukemia mortality during 1990-2004 likely reflects better treatment of childhood leukemia.[32] The results of the present study showed that female had higher case fatality rate than male, and children with ALL had significantly lower case fatality rate in comparison to those with AML and CML; this is agreed with the afore mentioned work in that the case fatality rate higher among children under 5 years compared to other age groups.

## CONCLUSION

Having discussed the data obtained by this study, the following observation were concluded.

1. Childhood leukemia form 2.2 % of the total cancer cases during the study period.
2. There is an increased trend of childhood leukemia over time during this period.
3. The highest incidence of childhood leukemia was among the age group of < 5years.
4. The highest incidence of childhood leukemia was among male than that in female.
5. The commonest type of childhood leukemia was acute leukemia in both sexes.
6. The commonest type of acute leukemia was ALL among both sexes.
7. The case fatality rate was higher among children who had CML than that of children With acute leukemia.
8. The higher case fatality rate of all types of leukemia was among female than that of Male and among children under 5 years of age.

## REFERENCES

1. Behrman RE, Kliegman RM, Jenson BJ. Nelson Textbook of pediatric. 17th edition. Philadelphia: WB Sanders, 2003: 1694.
2. Iraqi cancer registry center. Result of Iraqi cancer registry (1986-1988). Ministry of Health: Baghdad, 1990; 19.
3. Catovsky D, Hoffbrand AV. Postgraduate Hematology. 3rd edition. London: William Hei-Nemann Medical Books(Ltd), 1989; 369-451.
4. Bennett JM, Catovsky D, Danil MT, Flandrin G, GaltonDAG, Gralnick HR Sultan. Proposal For the classification of acute leukemia. Br j haematol, 1976; 33: 451-458.
5. Wiliams, Beutlery E, Lichtman MA, Coller BS, Thomas J, Kipps, Seligsohn URI. Acute Myelogenous Leukemia Hematology. 6th edition. London: Graw Hill MC, 2001; 1047.
6. Lehtinen S. Neurotoxicity in children after treatment for Acute Lymphoblastic leukemia And Methotrixate Neurotoxicity in a Controlled Animal Model. Filand: Department of ped- Iatrics, University of Oulu; P. O. Box5000, FIN-90014 University of Oulu. Filand, 2003; 17-26.
7. Saven A, Lawrence D, Robert HL, Michael L, Kosty M, Dougles T, Ellison Bentles E. Com- Plete Haematological Remission in Chronic phase, Philadelphia -Chromosome Positive, Chronic Myelogenous Leukemia after 2-COA. JIA Cane Soci, 1994; 73(12): 2953.
8. Gurney JG, Severson RK, Davis, Robison LL. Incidence of Cancer in Children in the United State.

Sex, race, and 1 year age specific rates by histologic type. JAA Cancer, 1995; 75: 2186-2195.
9. Nordic Society for Pediatric and Hematology and Oncology(NOPHO). Childhood Cancer in The Nordic countries. Report on Epidemiologic and Theraputic results from registries and work- ing groups. Aalbrg. Nordic Society of Pediatric Hematology Oncology, 2000; 512-536.
10. Greaves MF, Alexander FE. An Infectious aetiolog y for common Acute Lymphoblastic Leukemia in childhood. JAA Leuk, 1993; 349-360.
11. McNeil DE, Cote TR, Cleggel Manner A. SEEP update of incidence and Trends in Pediatric Malignancies: Acute Lymphoblastic Leukemia. Med Pediatr Oncol, 2002; 39: 554-557.
12. Mc Nally RJ, Cairns DP, Eden OB, Kelsey AM, Taylor G, Mand Birch JM. Examination of Temporal Trends in the incidence of Childhood Leukemia and Lymphoma provide aetiological Clues. JAA Leuk, 2001; 15: 1612-1618.
13. Greaves M. Molecular Genetics, Natural History and demise of Childhood Leukemia. Eur J. Canc, 1999; 35: 1941-1953.
14. Poplack DG. Acute Lymphoblastic Leukemia. In: Pizzo PH, Poplack GD(eds). Principle and Practice of Pediatric Oncology. 2nd edition. Philadelphia: JB Lippincot company, 1993; 4: 31-81.
15. Daling JR, Strazyk P, Olshan AF. Birth weight and the incidence of Childhood Cancer. J Natl Canc Inst, 1984; 72(0): 39-41.
16. Ridgway RL, Tinny JC, Mac Gregor JT, Starler NJ. Pesticide use in Agriculture. JAA Environm Health perspec, 1978; 27: 103.
17. Passarge E. Blood syndrome : The german experience. JAA Canc, 1991; 34(3-4): 1 79-97.
18. Wertheimer N, Leeper E. Adult Cancer related to electrical wires home. JAA Epidemiol, 1982; 11: 345-355.
19. Gary M, Kupfer MD. Childhood Cancer. Epidemiol, 2006.
20. Greaves MF. Aetiology of Acute Leukemia. Lancet, 1997; 349: 344-349.
21. Mac Mahon B. Is Acute Lymphocytic Leukemia in children virus related. JAA Epidemiol, 1992; 32: 136-416.
22. Greaves M. Childhood Leukemia. BMJ, 2002; 324: 283-287.
23. Kinlen LJ. Epidemiological evidence for an infective basis in Childhood Leukemia. Br J Cane, 1995; 71: 1-5.
24. Gordon W, Dewald P. 154 Chromosome Anomalies in Haematologic malignancies. Leuk Res, 2000; 24: 487-489.
25. Raimondi SC, Chang MN, Ravidranath Y, Behm FG, Gresik MV, Weinstin HJ, Ander J. Chro- mosomal Abnormalities in 475 children with Acute Myeloid Leukemia: clinical characteristics And treatment outcome in a cooperative pediatric oncology group study POG 8821. JAA blood, 1999; 94: 3707-3716.
26. Farwell J, Flannery JT. Cancer in relatives of children with central nervous system neoplasm. NEJM, 1984; 311: 749-753.
27. Sandler DP, Ross JA. Epidemiology of Acute Leukemia in Children and Adults. Semin Oncol, 1997; 24: 3-16.
28. Ford AM, Ridge SA, Cabrera MF, Mahmoud H, Steel CM, Chan LC, Greaves M. In Utero rearra- Ngement in the trithorax-related Oncogenes in infant leukemia. JAA Nature, 1993; 363: 358-360.
29. Labnda J. Parental Genotype in the risk of complex disease. Am J Human genet, 2002; 71(1): 193-197.
30. Doll R, Wakeford R. Risk of Childhood Cancer from Fetal irradiation. Br J Radiol, 1997; 70: 130- 139.
31. Ismail AM, AL-Ramadhani AH. Cancer in Mosul. Incidence and mortality. Results of Mosul Cancer registry(2003). Directory of Health in Nineveh: Mosul, 2004; 63.
32. American Cancer Society. Cancer facts and figures 2007. Atlanta: GA. American cancer society, 2007.
33. Matthew J, Hayat, Nadia Howlader, Marsha E. eichmain, Bernda K. Edwards. Cancer statistics, Trend, and multiple primary cancer analysis from surveillance, epidemiology and end result program Oncologist, 2007; 12(1): 20-37.
34. Awad MH. Acute leukemia in Mosul. M. SC. thesis. Mosul College of Medicine, 1991; 89-100.
35. Raouf MY. Childhood acute leukemia in Babhdad. Msc thesis. Baghdad: Mustansyria Medical College, 1990; 55-67.
36. Ibrahim FA. Clinical, cytomorphological and cytochemical studies of acute leukemia. Msc thesis. Baghdad: College of medicine, 1983; 60-76.
37. Al-Niaimi M, Al-Mondhiry H. The morphologic subtypes of acute leukemia: Application of the new international system of classification on (209)cases. J Fac Med Baghdad, 1980; 22: 5-9.
38. Knox –Macauly HH, Brown LC. Descriptive Epidemiology of denovo acute leukemia in the Sultanate of Oman. Leuk Res, 2000; 24(7): 5 89-94.