RESEARCH ARTICLE

Top ten causes of mortality among children under five in Nineveh 2018-2023: a time series analysis

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ABSTRACT

Introduction: The Mortality rate is a good indicator of the level of health and health care in different countries and helps assess a country's overall socio-economic development.

Objective: To study the top ten causes and trends of under-five mortality in Nineveh and put a strategy to prevent it.

Methods: A Biometry study used to study 4348 registered cases of deceased child aged less than 5 years regard less cause of death for last six years duration from 2018 to end of 2023 using death certificate adapted by Ministry of Health and proved by Ministry of Interior consist from 5 section (information related to deceased child, information related the person reporting the death, causes of death, setting of death and forensic medicine report). The X2 test was used to assess the association between two variables, with a P-value ≤ 0.05. Death indices include [under-5 mortality rate, crude death rate, proportion of mortality deaths and trend of death].

Results: The total number of deceased children (4348). Sex ratio (1.9:1). Urbanisation ratio (3.2:1). Commonest cause of death according to Tenth International Classification of Disease occurring in, 2023 was certain conditions originating in the perinatal period, it constitutes 25.5%, congenital malformation, deformation and chromosomal abnormalities represent the first top ten causes of death from (2019-2022), it was (16.1 %, 23.9%, 19.9%, and 22.4%) respectively. While in 2018, the disease of the respiratory system formed (7.1%). In general, the trend in the top ten causes increased toward 2023. U5MR/1000 birth was 17.32 and PM/100 was 85.1 during 2018.

Conclusion: Although there is an increasing trend of deaths of the top ten causes of death among children under five years old, the death indicator decreased toward 2023 in Ninevah governorate; at the same time, it is still considered high to achieve the Millennium Development Goal 4 of the WHO.

Key words: Child mortality, under-five death, trend of childhood death.

INTRODUCTION

Under-five mortality rates (U5MR) are defined by the World Health Organisation (WHO) as the number of deaths from birth to 5 years of age in a specific year, multiplied by 1,000, divided by live births (LB) in the same year. [1]

Children under five years of age are divided into two age groups: infancy and the 1-4 age group. Infancy includes the neonatal period, which extends from birth to 28 days and is subdivided into the early neonatal period, which spans the first 7 days of life. The late neonatal period extends from 7 to 28 days.

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And post-neonate extends from 28 days to one year.[2] The world has made substantial progress in reducing child mortality over the last four decades.[3] There are two methods for calculating U5MR: first, direct methods use data on children's date of birth, survival status, and the date of death or age at death of deceased children.[4] Indirect methods use information on the survival status of children to specific cohorts of mothers, typically age cohorts or time since first birth cohorts.[5] Mortality information can be obtained from vital registration systems, national sample surveys, special health surveys, notification of infectious diseases, health facility records, government health institutions, voluntary health institutions, reports of national and international organisations, police, and census.[6]

According to the United Nations report, U5MR reduced by 58% from 12.6 million in 1990 to 5.4 million in 2017. This means that childhood death can be prevented.[7] Medical and social development have a role in reducing childhood mortality.[2]

In Iraq, in the last twenty years of the last century, the U5MR was 121/1000 LB, which means that 1 in every 8 LB died before the age of 5 years.[8] This rate falls toward the current century, reaching 48/1000 in 2000, 45/1000 in 2007, and 22.6/1000 in 2024, according to the UNCIFE report.[9] According to the Iraq Multiple Indicator Cluster Survey (MICS) 2018, there has been a remarkable improvement in U5MR compared to the previous MICS (2011). U5MR has reduced from 37 per thousand live births to 26; however, inequity persists between urban and rural areas, educated and less educated mothers, and geographical regions.[10] The United Nations Estimate revealed that, despite global improvement in U5M, rates declined between 1990 and 2017 from 54 to 30 deaths per 1000 live births.[11] But still, U5MR in developing countries was 20-50 times higher than in developed nations.[12]

Several factors, such as the implementation of high-impact child survival interventions, health system strengthening, improvements in maternal education and family income, commitments by policymakers and donors, and the establishment of Millennium Development Goal 4 (Reduce child mortality), have contributed to a reduction in child mortality globally.[13]

In Ethiopia, 2021 using multilevel count regression model found a relationship between child mortality and many factors such as: vaccination of the child, family size, age of mother, antenatal visit, birth interval, birth order, contraceptive use, father and mother education level, father mother occupation, place of delivery, child twin, age of first birth, and religious were contributed for U5M.[14] Similar factors was seen in across -sectional study design 2023, carried out in two governmental hospitals: AL Zahra teaching hospital and the Al Hakeem hospital in Al Najaf AL Ashraf province among 100 families showed that 30% of them had dead child aged under 5 years, the commenst factors were age of mothers, adolescent marriage, lack of antenatal care, poverty, medical disease of mother.[15]

Under-5 mortality causes are the sum of infant and child deaths. Worldwide, there are six major causes responsible for three-quarters of child mortality each year: neonatal sepsis, preterm delivery, birth asphyxia, pneumonia, diarrhoea and malaria.[16]

Time series for forecasting the under-five mortality rate in Iraq from 2021 to the end of 2032 using the Aroam model. The results showed that the first three years of forecasting will show a slight increase in the under-five mortality rate, followed by a decrease in the following years.[17]

The health sector in Mosul faces considerable conflict and complex challenges, such as less access to quality health care, a shortage of essential medicines and lack of equipment, and unavailability of diagnostic tests, affecting child health and increasing morbidity and mortality. Measuring trends in U5MR indicators over the past six years, since 2018, provides a measure of the quality of the health services offered to Nineveh's population during that period. In addition, studying

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the causes of death for specific subgroups provides details on disparities across different population structures and on whether there have been changes in the causes of death. The present study aims to investigate the top ten causes of U5MR and their trend in Nineveh governorate during 2018-2023.

METHODS

Setting and study design: A biometric study design for six months from 1 January to 1 July 2024. Review of data of deceased children aged less than 5 years registered in the Health and Vital Statistics section/ Planning Department/ Nineveh Health Directory to study the cause of death for the last six years from 2018 to the end of 2023, and categorise them into the top ten causes of death according to the Tenth International Classification of Diseases (ICD-10).[18]

Ethical Consideration: The research protocol of the study, assigned the number 2023221, was approved by the Ethics Committee of the Nineveh Health Directorate, Ministry of Health, Iraq, with approval license number 249 on 1 November 2025. An agreement of the Vital Statistics section/ Planning Department was obtained.

Definition of cases, inclusion and exclusion criteria: We included all registered cases of death for children under five years from 2018 to 2023. The number of records that fulfilled these criteria was 4,348. We excluded 23 records due to incomplete data or incorrect ICD-10 definitions.

Primary and Secondary outcomes: Serial analysis of deceased children according to age groups and certain socio-demographic characteristics, arranging the cause of death according to the top ten causes and identifying their trends over the last 6 years (2018-2023).

Procedure: Registered information data taken from the death certificate, adapted by the Ministry of Health/ Planning Department/ Health and Vital Statistics Section and proved by Ministry of Interior consist from 6 section

(information related to deceased child, information related the person reporting the death, medical death certificate, setting of death, forensic medicine result and information related to Interior Ministry). All death certificates were sent routinely to the Vital and Medical Statistics Division of the Nineveh Health Department. Statisticians enter all previous information, and a code is given to each information using the Excel program, and the causes of death are coded according to (ICD-10) as follows.[18]

A and B, Certain Infectious and Parasitic Disease), C (Malignant Neoplasm), D (In situ Neoplasm and Benign Neoplasm with blood disease), E (Endocrine, Nutritional, Metabolic Disease), G (Disease of Nervous System), I (Disease of circulatory System), J (Disease of Respiratory System), K (Disease of Digestive System), L (Disease of the skin and Subcutaneous Tissue), M (Disease of musculoskeletal and connective tissue), N (Disease of the Genito urinary), P (Certain Conditions originating in the perinatal period), Q (Congenital Malformation, Deformation and Chromosomal Abnormalities), R (Symptom, Signs and Abnormal clinical and Laboratory not elsewhere Classified), S (Injury, Poisoning, and Certain other Consequences of External causes), T (Superficial Injuries involving multiple body region), U (COVID-19), V (External causes of Morbidity and Mortality), W (Others External causes of Injuries), X (Contact with external different harmful factors that causes morbidity or death)]. Each participant's information was entered into a code sheet, and data entry was performed using the Cori5 program. Statistical analysis was performed using Excel version 19.

Statistical analysis: The data were presented in suitable tables. Percentages were calculated for the various group variables. The X2 test for a 2x2 table was used to compare two variables, with P-values ≤ 0.05 considered significant. The following indices were measured.[19] The sex ratio is the proportion of males to females in a population, urbanisation rate, the percentage of a population that resides in urban areas compared to rural areas, U5MR the probability

Table 1 | Distribution of serial analysis of deceased children according to age groups

Age groups	2018	2019	2020	2021	2022	2023	Grand Total	
0 - <1 years	603 (73.8)	522 (67.7)	436 (68.6)	433 (66.9)	493 (75.1)	622 (75.5)	3109	71.5
< 7 days	118 (14.5)	96 (12.4)	30 (4.7)	21 (3.2)	79 (12.1)	104 (12.6)	448	10.3
≥7 - < 28 day	102 (12.5)	104 (13.5)	122 (19.2)	64 (9.9)	85 (12.9)	94 (11.4)	571	13.1
≥ 28 day – <1 year	383 (46.8)	322 (41.8)	284 (44.7)	348 (53.8)	329 (50.1)	424 (51.5)	2100	48.1
1- <4 years	192 (23.5)	229 (29.8)	184 (29.0)	199 (30.8)	147 (22.4)	175 (21.3)	1126	25.9
4- < 5 years	22 (2.7)	19 (2.5)	15 (2.4)	15 (2.3)	16 (2.5)	26 (3.2)	113	2.6
Total	817	770	635	647	656	823	4348	

of a child born in a specific year or period dying before reaching the age of 5 years per 1,000 LB and measure (deaths of children aged less than 5 years divided by LB) multiply by 1000, crud death rate (CDR) is the number of deaths per 1,000 population in a given year and measure (dead children aged less than 5 years divided by total number children aged less than 15 years in that time) multiply by 1000 and proportion mortality death (PM) is the percentage of deaths in a population attributable to specific causes and measured (dead children aged less than 5 years occurring within a reference period divided by total number of deaths among children aged less than 15 years in that time) multiply by 100. Trend measure using a simple

Index equation as follows:

2018 Index Number = (2018 Index Number (base period)/ 2018 Index Number) X 100 = 100%

Trend index = (2019 Index Number/2018 Index Number) X100

Result dropped or elevated 100- trend index

RESULTS

Socio-Demographic Characteristics of Study Sample: Serial analysis of deceased children was conducted by age group, Table 1. It revealed that 3109 (71.5%) of deceased children aged

Table 2 | Distribution of serial analysis of deceased children according to certain socio-demographic characteristics

Categories	2018 (%)	2019(%)	2020(%)	2021(%)	2022(%)	2023(%)	Grand Total No.	
Sex*								
Male†	440 (53.8)	436 (56.6)	348 (54.8)	342 (52.9)	365 (55.6)	437 (53.1)	2368	54.4
Females†	377 (46.2)	334 (43.40)	287 (45.2)	305 (47.1)	291 (44.3)	386 (46.9)	1980	45.6
Residence**								
Urban††	684 (83.7)	656 (85.2)	531 (83.6)	457 (70.6)	432 (65.8)	563 (68.4)	3323	**76.4**
Rural††	133 (16.3)	114 (14.8)	104 (16.4)	190 (29.4)	224 (34.2)	260 (31.6)	1025	**23.6**
Place of death**								
Home	59 (7.2)	102 (13.3)	102 (16.1)	97 (15.0)	42 (6.4)	52 (6.3)	454	**10.4**
Hospitals	696 (85.2)	654 (84.9)	482 (75.9)	470 (72.6)	603 (91.9)	768 (93.3)	3673	**84.5**
Others	62 (7.6)	14 (1.8)	51 (8.0)	80 (12.4)	11 (1.7)	3 (0.4)	221	**5.1**
Religion*								
Muslim	808 (98.9)	750 (97.4)	625 (98.4)	641 (99.1)	644 (98.2)	811 (98.5)	4279	**98.4**
Others	9 (1.1)	20 (2.6)	10 (1.6)	6 (0.9)	12 (1.8)	12 (1.5)	69	**1.6**
Nationality**								
Iraqi	816 (99.9)	769 (99.9)	634 (99.9)	647 (100)	655 (99.9)	823 (100)	4344	**99.9**
Others	1 (0.1)	1(0.1)	1(0.1)	0(0.0)	1(0.1)	1(0.0)	4	**0.1**
Total	817	770	635	647	656	823	4348	

*Significant Chi-Square test   **Non-significant Chi-Square test   *** Non- applicable Chi-Square test
†Sex ratio= 1.9:1   †† Urbanization rate = 3.2:1

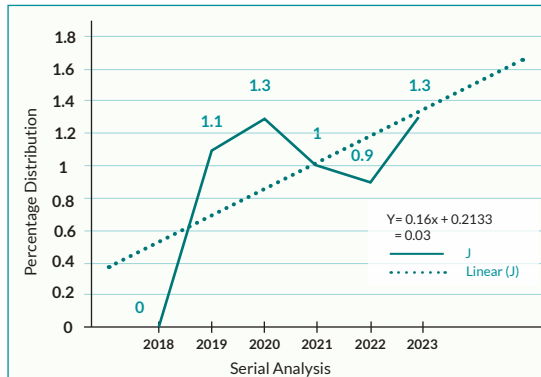| Table 3	Distribution of the Top Ten Direct Causes of Death among children under 5					
Top ten direct causes of death	2018	2019	2020	2021	2022	2023
Disease of the Respiratory System (J)	58(7.1)	124(16.1)	136(21.0)	119(18.3)	112(17.1)	139(16.8)
Certain Conditions originating in the perinatal period (P)	55(6.7)	108(14.0)	53(8.2)	59(9.1)	135(20.5)	210(25.50
Disease of the circulatory System (I)	36(4.4)	19(2.5)	34(5.2)	47(7.2)	20(3.0)	21(2.6)
Congenital Malformation, Deformation and Chromosomal Abnormalities (Q)	23(2.8)	124(16.1)	155(23.9)	129(19.9)	147(22.4)	170(20.6)
Certain infectious and parasitic diseases (A, B)	17(2.1)	83(10.8)	106(16.4)	124(19.7)	115(17.5)	130(15.8)
Endocrine, Nutritional, Metabolic Disease (E)	5(0.6)	12*(1.6)	12(1.8)	13*(2.0)	20(3.0)	24(2.9)
Disease of the Nervous System (G)	3(0.4)	39(5.1)	45(6.9)	41(6.3)	50(7.6)	79(9.6)
Malignant Neoplasm (C)	3(0.4)	9*(1.2)	26(4.0)	10*(1.5)	1*(0.1)	192.3)
Disease of Digestive System (K)	2(0.20	3*(0.30	6*(0.9)	20(3.0)	22(3.3)	1(0.1)
Others*	2(0.2)	21(2.7)	29(4.5)	30(4.6)	4(0.6)	12(1.4)
Total	817	770	635	647	656	823
* Others include: in situ Neoplasm and Benign Neoplasm with blood disease (D), Disease of the skin and Subcutaneous Tissue (L), Disease of musculoskeletal and connective tissue (M), Symptom, Signs and Abnormal clinical and Laboratory not elsewhere Classified (R), COVID-19(U), External causes of Morbidity and Mortality (V), Others External causes of Injuries (W), Contact with external different harmful factors that causes morbidity or death (X).						

less than one year, among them 2100 (48.1%) aged more than 28 days and less than one year. During 2023, deceased children were (75.5% and 3.2%) among (0 - <1 years and 4- < 5) years, respectively. At the same time, 30.8% of dead children were seen during 2021 among 1- <4 years.

The distribution of dead children according to certain demographic characteristics is seen in Table 2. Nearly half of died children (54.4%) were male, three-fourths (76.4%) were urban, the place of death was in a hospital, which

was commonly seen during 2023, constituting 93.3%.

Table 3 shows the top ten direct causes of death among children under five. During 2023, the commonest causes of death were conditions related to the perinatal period, constituting 25.5% of the total deaths. Congenital malformation, deformation and chromosomal abnormalities represent the first top ten causes of death in the period from 2019-2022; 16.1 %, 23.9%, 19.9%, and 22.4%, respectively. In 2018, the most common cause

Table 4	Time Series Analysis of Direct Cause of Death among Children under 5									
	Trend of Top Ten Direct Causes of U5M									
Series of Years	Disease of Respiratory System (J)	Certain Conditions originating in the perinatal period (P)	Disease of circulatory System (I)	Congenital Malformation, Deformation and Chromosomal Abnormalities (Q)	Certain infectious and parasitic disease (A, B)	Endocrine, Nutritional, Metabolic Disease (E)	Disease of the Nervous System (G)	Malignant Neoplasm (C)	Disease of Digestive System (K)	Others*
2018	0	0	0	0	0	0	0	0	0	0
2019	1.1	0.9	-0.48	4.3	3.8	1.4*	12.0	2.0*	0.5*	9.5
2020	1.3	-3.6	-0.04	5.7	5.2	1.4	14.0	7.6	2.0*	13.5
2021	1.0	0.07	0.3	4.6	6.2	1.6*	12.6	2.3*	9.0	14.0
2022	0.9	1.4	-0.46	5.3	5.7	3.0	16.7	-0.67*	10.0	1.0
2023	1.3	2.8	-0.42	6.3	6.6	3.8	25.3	5.3	-0.67	5.0
*Others includes (In situ Neoplasm and Benign Neoplasm with blood disease (D), Disease of the skin and Subcutaneous Tissue (L), Disease of musculoskeletal and connective tissue (M), Symptom, Signs and Abnormal clinical and Laboratory not elsewhere Classified (R), COVID-19(U), External causes of Morbidity and Mortality (V), Others External causes of Injuries (W), Contact with external different harmful factors that causes morbidity or death (X).										

Figure 1 (a) | Trend of Disease of Respiratory System (J) among children U5.

Figure 1 (d) | Trend Congenital Malformation, Deformation and Chromosomal Abnormalities (Q) among children U5.

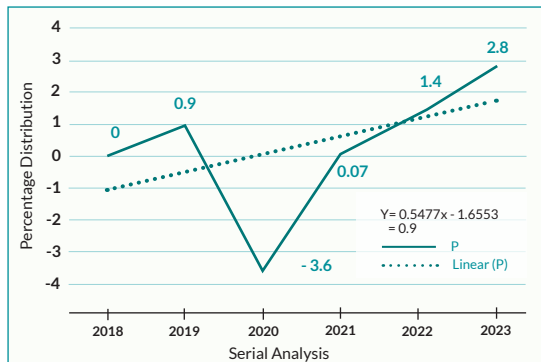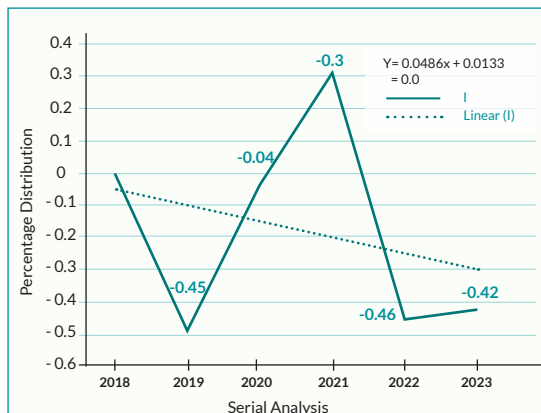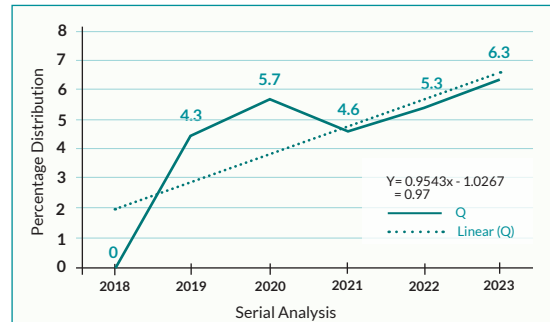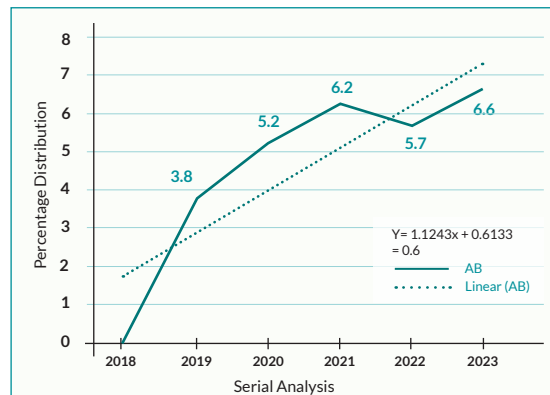**Figure 1 (b) |** Trend Certain Conditions Originating in the Perinatal Period (P) among children under 5 years old.

Figure 1 (e) | Trend Certain Infectious and Parasitic Disease (A, B) among Children U5

was respiratory disease (7.1%).

Trend of the top ten direct causes of death among children under five, as seen in **Table 4**, and **Figure 1a-j**. It revealed that there is an increasing trend of following diseases toward 2023 (diseases of the respiratory system; certain conditions originating in the perinatal period; congenital malformation, deformation and chromosomal abnormalities; certain infectious
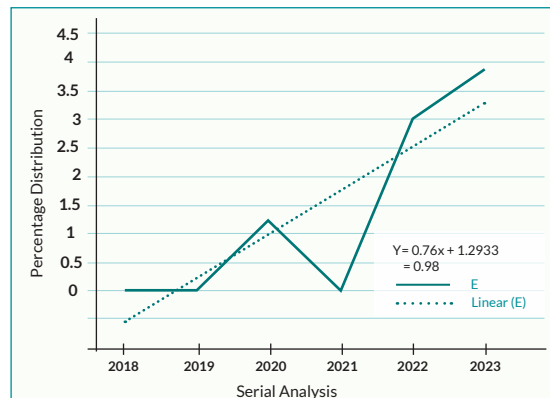

Figure 1 (f) | Trend Endocrine, Nutritional, Metabolic Disease (E) among Children U5

and parasitic diseases; endocrine, nutritional, metabolic disease; disease of the nervous system; disease of malignant neoplasm; disease of the digestive system, it was 0.03, 0.9, 0.9, 0.6, 0.9, 1.9, 0.1, 0.5, respectively).

Death indicators among children under 5 years old: Fluctuation of U5MR was reported, with a higher percentage observed during 2018
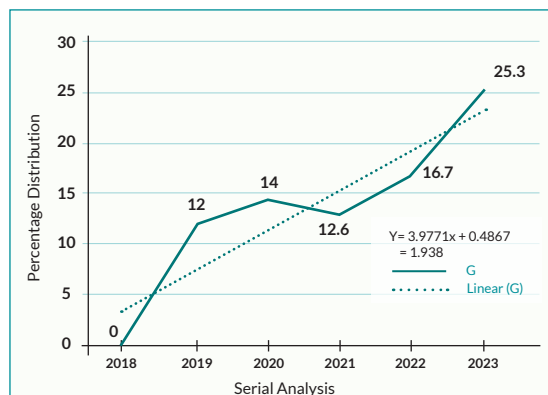

Figure 1 (c) | Trend Disease of Circulatory System (I) among children U5

Figure 1 (g) | Trend Disease of Nervous System (G) among Children U5
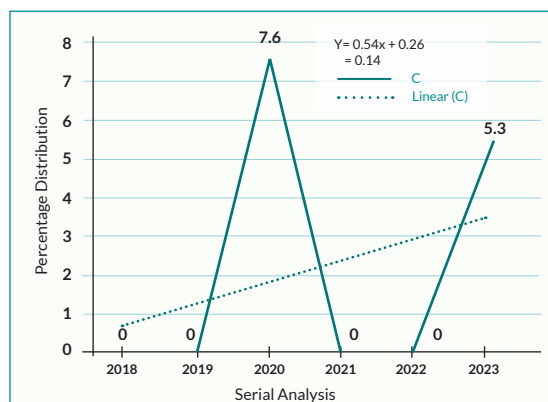

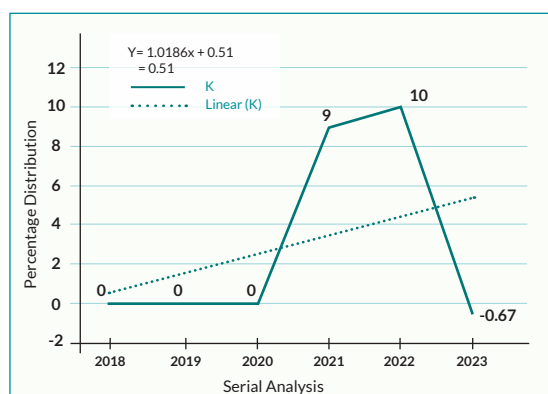**Figure 1(h) |** Trend of Disease of Malignant Neoplasm (C) among U5 Children

Figure 1(i) | Trend of Diseases of Digestive System (K) among Children U5.
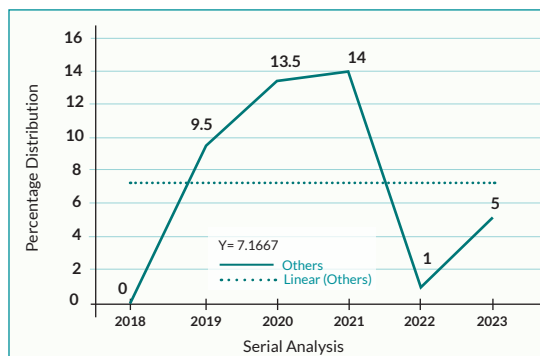

Figure 1(j) | Trend of Others* Disease among Children U5

* Others includes (In situ Neoplasm and Benign Neoplasm with blood disease (D), Disease of the skin and Subcutaneous Tissue (L), Disease of musculoskeletal and connective tissue (M), Symptom, Signe and Abnormal clinical and Laboratory not elsewhere Classified (R), COVID-19(U), External causes of Morbidity and Mortality (V), Others External causes of Injuries (W), Contact with external different harmful factors that causes morbidity or death (X).

Table 5 | Death indicators among under 5 years children

Serial of years	U5MR/ 1000	CDR/ 1000	PMR/ 100
2018	17.32	2.62	85.1
2019	13.80	2.04	81.3
2020	9.28	1.31	76.6
2021	7.03	1.08	53.1
2022	10.35	1.51	69.3
2023	11.94	1.77	70.4

deceased under five children: In recent decades, people have become more conscious about their health, and they exert all possible efforts to relieve their suffering, restore health and preserve a good quality of life.[20]

According to Millennium Development Goal NO. 4 (reduce child mortality). A significant improvement has been made globally in reducing the under-5 children mortality rate from 90 deaths/ 1000 live births in 1990 to 46/1000 in 2013.[21] In Iraq, the neonate mortality rate decreased from 66/1000 live births in 1975 to 22/1000 live births in 2020, according to the UN Inter-agency Group for Child Mortality Estimation (IGME, 2023).[22]

In the present study, serial analysis of deceased children according to age groups revealed that 3109 (71.5%) of deceased children were aged less than one year, among them 2100 (48.1%) were aged more than 28 days and less than one year. Nearly half of the dead children (54.4%) were Male, three-fourths (76.4%) were urban, and the place of death was in a hospital, which was commonly seen during

(17.32/1000), while CDR and PMR showed a decreasing trend toward 2023; they were 1.77/1000 and 70.4/100, respectively. This is clear in **Table 5**.

DISCUSSION

Socio-Demographic Characteristics of

2023, constituting (93.3%).

Child and Maternal Mortality Survey 1999, the Iraqi national sample showed that rates in rural areas exceed those of urban areas, with 138.7 and 115.7 per 1000 live births respectively. The southern region has the highest mortality rate in the country, 144.1/ 1000 live births and under-five deaths occurred among male children if they compare with females, it was (128.8 and 120.0 per 1,000 during 1994–1999. The commonest risk factors were a short birth interval and a low level of the mother's education. The study was conducted during Iraq's economic crisis, with deterioration in the quality and quantity of health care services.8 This is proved by the UN Inter-agency Group for Child Mortality Estimation, 2015, as U5M is mainly seen in low-income countries associated with poverty.[23]

Abid Al-Ahad, 2012 revealed that a high proportional mortality rate was among Male (32.5/1000), three-quarters of them live in urban areas, due to the use of the estimated birth technique rather than the registered mortality, reflecting the problem of under-registration practices, especially in rural areas. [24]

A similar finding was seen in community-based cross-sectional data from Ethiopia's Mini Demographic and Health Survey, 2022, which showed that region, residence, level of education, wealth index, place of delivery and multiple births have all been statistically significant factors of under-five mortality in Ethiopia.[25]

Another study in Ethiopia, 2022, using a multilevel count regression model, concluded that: child vaccination, family size, age of mother, antenatal visit, birth interval, birth order, contraceptive used, parent education level, father occupation, place of delivery, child twin, age at first birth and religion were significantly associated with under-five mortality.[14]

Causes of death and their Trend of under-5 Child deaths: The top ten direct causes of U5M include certain conditions originating in the perinatal period, congenital malformation, deformation and chromosomal abnormalities; at the same time, diseases of the digestive system rank as the 9th leading cause of death from 2018 to 2023.

Trend of top ten direct cause of death among under five children of present study revealed that there is increase trend toward 2023 of following disease (disease of respiratory system; certain conditions originating in the perinatal period; congenital malformation, deformation and chromosomal abnormalities; certain infectious and parasitic disease; endocrine, nutritional, metabolic disease; disease of nervous system; disease of malignant neoplasm; disease of digestive system). U5MR/1000 fluctuates with a decreasing trend from 17.32/1000 in 2018 to 11.94/1000 in 2023. This finding is attributed to the improvement of health care services, availability of supplies and drugs, raising the socio-economic condition of families, rising health awareness level of the population, rehabilitation of most health institutions after Mosul liberation from ISIS and conflict, but the mortality rate among U5MR among Ninevah's children is still considered high to achieve MDG4 of WHO.[26]

Verbal autopsy interviews with all mothers/caretakers of dead children in Iraq, 2009, reported that (81.2%) of U5 deaths were due to illness, with the highest percentage (90.3%) among infants aged 1–11 months. Diarrhoea, cough and/or difficult breathing, vomiting and fever were the commonest causes of death among them.[8]

A time series analysis among children in Nineveh government for a period extended for 10 years (2004-2013) revealed that U5M represent the summation of infant and child causes of death, with predominance of infant causes, as they exhibit a higher rate of mortality compared with 1-4 child deaths. That is RDS, sepsis and congenital anomalies were dominating mortality causes and responsible for two-thirds of U5M or even more each year. In contrast, infections, pneumonia and accidents recorded lower figures and constituted roughly

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20.0% of U5M causes. U5MR trend fluctuated from 17.83/1000 in 2004 to 20.28/1000 LB in 2013, with the worst recorded in 2007 (26.28/1000 LB).[27]

Multiple Indicators Cluster Survey (MICS) comparative result between MICS 5-2011 and MICS 6-2018, and one of its components, studying U5MR per 1000 live births, reported that there is a decline from 37 in 2011 to 26 in 2018 per 1000 live births.[10]

Mortality rates in low and middle-income countries (LMICs), 2022, revealed that the most common causes of death under 5 years old are acute respiratory infections, diarrhoea, malaria, and birth complications, although neonatal disorders and birth complications have recently come to the fore.[28] While cause-specific mortality among Iraqi Kurdistanain, 2021 showed that cardiovascular diseases and neoplasms are the predominate causes of death followed by infectious and genitourinary diseases, were the most common causes of death among 4-5-year-old children. The study concluded that there is an increasing burden of non-communicable diseases among Iraqi Kurdistanain children.[29]

Different sets of U5M causes demonstrated worldwide. In Istanbul, 2005-2009, CVDs were (31.2%), perinatal (22.7%) and respiratory problems (12.1%).[30]

While in Zimbabwe, in 2010 neonatal causes comprised only 29% of U5M, the commonest cause of death was HIV/AIDS (22%), then pneumonia, diarrhoea and measles.[31] Furthermore, in Sub-Saharan Africa infectious problems alone accounted for nearly 70.0% of child deaths.[32]

More recently during 2013, 6.5 million child dead before 5 years globally half of them due to infectious disease mainly (pneumonia, diarrhoea and malaria) while 44% of death occur in neonatal period due to (prematurity (15.4%), birth asphyxia (10.5%), sepsis (6.7%), accidents (5.2%) and congenital anomalies (4.4%). Between 2000 and 2013, half of the U5M reduction was attributed to a reduction in mortality from infectious diseases.[33]

Al-Sammak's study, 2019, revealed that their finding were consistent with the global pattern, especially regarding neonatal causes, but may differ from the results of developing countries, in which infectious diseases were dominating. This is expected as infections like HIV and malaria are uncommon in our locality.[27]

CONCLUSION

The study concludes the top ten causes of death among U5 children were (Disease of Respiratory System, Certain Conditions originating in the perinatal period, Disease of circulatory System, Congenital Malformation, Deformation and Chromosomal Abnormalities, Certain infectious and parasitic disease, Endocrine, Nutritional, Metabolic Disease, Disease of Nervous System, Malignant Neoplasm and Disease of Digestive System) with death indicators (U5MR, CDR and PM) showed decreasing trend toward 2023.

REFERENCES

1. WHO. Catalogue of health indicators: A selection of important health indicators recommended by WHO programs. Unite of strengthening country health information, division of health institution and trend assessment. Geneva, 1996.

2. Park K. Park's textbook of preventive and social medicine: health planning and management. 23rd ed. India: Jabalpur; 2015. P. 568, 570-580.

3. Wang H, Liddell CA, Coates MM, Mooney MD, Levitz CE, Schumacher AE, Apfel H, Iannarone M, Phillips B, Lofgren KT, et al. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;384(9947):957–79.

4. Croft TN, Allen CK, Zachary BW, et al., Guide to DHS Statistics. Rockville, Maryland, USA: ICF. 2023

5. Ayele DG, Zewotir T, Mwambi H. Indirect child mortality estimation technique to identify trends of under-five mortality in Ethiopia. *Afr Health Sci*. 2016 Mar;16(1):18-26.

6. Lwang SK, Cho-YT, Ayeni O. Teaching health statistics: lessons and seminars outline. WHO, Geneva, 1999.

7. United Nations Inter-agency Group for Child Mortality Estimation. Level and Trends in Child Mortality: Report 2018. New York, USA: UNICF, 2018

8. Awqati NA, Ali MM, Al-Ward NJ, Majeed FA, Salman K, Al-Allak M, Al-Gasseer N. Causes and differentials of childhood mortality in Iraq. *BMC Pediatr* 2009;9(40):1431-71.

9. UNCIF 2024. Trends in under-five mortality rate in Iraq. Available from UN Inter-agency Group for Child Mortality Estimation URL: https://childmortality.org/all-cause-mortality/da-

ta?refArea=IRQ&sex=M

10. UNICEF. Multiple Indicators Cluster Survey (MICS6) Briefing. Central Organisation for Statistics: Baghdad, Iraq. 2018:25-6. Available from: URL. https://www.unicef.org/iraq/media/481/file/MICS6.pdf.

11. WHO EMRO 2018. Framework for a Health Information System and Core Indicators for Monitoring Health Situation and Health System Performance, 2018.

12. Sharrow D, Hug L, You D, Alkema L, Black R, Cousens S, et al. Global, regional, and national trends in under-5 mortality between 1990 and 2019 with scenario-based projections until 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *The Lancet Global Health*. 2022 Feb 1;10(2):e195-206.

13. WHO. Levels and trends of child mortality. WHO, 2015. http://www.who.int/maternal_child_adolescent/documents/levels_trends_child_mortality_2015/en/ (Accessed on 17 March 2016).

14. Muche Fenta S, Mekonnen Fenta H. Level and Determinant of Child Mortality Rate in Ethiopia [Internet]. Mortality Rates in Middle and Low-Income Countries. IntechOpen; 2022. Available from: http://dx.doi.org/10.5772/intechopen.100482.

15. Ibadi AK. Child mortality and associated factors under 5 years old. *Mathews J Case Rep*. 2023;8(1):84

16. Bryee J, Boschi-Pinto C, Shibuya K, Black RE. WHO estimates of the causes of death in children. *Lancet* 2005;356:1147-1152.

17. Meshal Harbi Odah (). Time series for forecasting the under-five mortality rate in Iraq. Int. *J Agricult Stat Sci* 2021;17 (Suppl 1):1873-1877. DocID: https://connectjournals.com/03899.2021.17.1873

18. World Health Organization. (2004). ICD-10: International Statistical Classification of Diseases and related health problems: tenth revision, 2nd ed. World Health Organisation. https://iris.who.int/handle/10665/42980

19. Haupt A, Kane TT. Population Handbook: mortality. 5th Edition. Washington: Population Reference Bureau. 2004. P. 25-30.

20. Das S Trends of mortality indicators in Nagaland: A time series analysis. *Anthropologist* 2012;14(2):149-53.

21. World Health Organisation. Neonatal and perinatal mortality: country, regional and global estimates. World Health Organisation; 2006.

22. Abdulrasol ZA, Obaid AF, Kadim MA, Shlash AM. Mortality rate among Iraqi neonates in neonatal intensive care units: Retrospective study. *Journal of Neonatal Nursing*. 2024 Apr 1;30(2):148-51.

23. You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, Gerland P, New JR, Alkema L. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. The *Lancet*. 2015 Dec 5;386(10010):2275-86.

24. Abid Al-Ahad AK. Assessment of Nutritional Indicators among Under-5 Children in Al-Hamdaniya District, North of Iraq. Thesis in Community Medicine/College of Medicine/University of Mosul, 2012.

25. Yemane GD. The factors associated with under-five mortality in Ethiopia. *Annals of Medicine and Surgery*. 2022 Jul 1;79:104063.

26. Millennium Development Goals (MDGs) 19 February 2018. URL: https://www.who.int/news-room/fact-sheets/detail/millennium-developmentgoals(mdgs)#:~:text=Millennium%20Development%20Goal%204%3A%20reduce%20child%20mortality&text=Between%201990%20and%202013%2C%20under,4.0%25%20during%202005%E2%80%932013

27. Al-SammaK NIM. Trends of mortality in Nineveh (2004-2013): A time series analysis. Ph.D., dissertation. Mosul, Iraq. University of Mosul, College of Medicine. 2018. P. 95-99, 145-150.

28. Tekin M. Under-Five Mortality Causes and Prevention [Internet]. Mortality Rates in Middle and Low-Income Countries. IntechOpen; 2022. Available from: http://dx.doi.org/10.5772/intechopen.100526.

29. Salih SO, Moramarco S, Di Giovanni D, Qadir SA, Alsilefanee HH, Basa FB, Gialloreti LE. Ten-year mortality trends and natural causes of death in Iraqi Kurdistan. *The Open Public Health Journal*. 2021;14(1):264-71.

30. Babaoğlu ÜT, İşse ver H, Hapçioğlu B. Assessment of under-5 mortality rate in Istanbul using the Geographical Information System. *Erciyes Med J* 2016;38(1):6-11.

31. UNICEF, WHO, Ministry of Health and Child Welfare/ Zimbabwe. National Child Survival Strategy for Zimbabwe, 2010-2015. WHO, 2015.

32. UNICEF, UNICEF, Global database: child mortality estimates. United Nations Children's Fund, 2014.

33. Liu L, Oza S, Hogan D, Perin J, Rudan I, Lawn JE, et al., Global, regional and national causes of under-5 mortality in 2000-15: an updated systematic analysis with implications for the Sustainable Development Goal. *Lancet* 2017;389(10082):1884-92.

Abbreviations list: Acquired immunodeficiency syndrome (**AIDS**), Cardiovascular diseases (**CVDs**), Crud death rate (**CDR**), Human immunodeficiency viruses (**HIV**), Inter-agency Group for Child Mortality Estimation (**IGME**), Live births (**LB**), Millennium Development Goal (**MDG**), Multiple Indicator Cluster Survey (**MICS**), Proportion mortality death (**PM**), Tenth International Classification of Diseases (**ICD-10**), Under 5 Mortality Rate (**U5MR**), World Health Organisation (**WHO**).