

## Trends of Maternal Mortality in Nineveh (2004-2013), A Time Series Analysis

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### ABSTRACT

**Context:** Maternal Mortality is a worldwide issue that serves as a visible health indicator of a nation's health care system. As part of the 5<sup>th</sup> Millennium Development Goal, the UN established the target of reducing maternal mortality by three-quarters between 1990 and 2015 for all national and regional populations.

**Aim:** Determine the trend of maternal mortality in Nineveh for 10 year period (2004-2013).

#### Subjects and methods

**Study design:** Descriptive biometric study design.

**Study settings:** Nineveh Governorate/North of Iraq.

**Study sample:** Maternal deaths, women at childbearing age, and live births from 2004 to 2013.

**Data collection tool:** Death certificates, vital registration system.

**Outcome measures:** Maternal mortality rate, ratio, and life time risk of maternal death, stages of maternal mortality, in addition to their mortality causes and trends by using various rates, ratios, proportions, and Chi-squared test for trend.

**Results:** Maternal mortality ratio changed significantly ( $p=0.002$ ) during the study period being worst in 2007 (45.01/100,000 live birth). On average, about 1:666 women at childbearing age died either due to direct causes predominated by hemorrhage or indirect ones mainly CVDs.

**Conclusions and Recommendations:** Maternal mortality still a major problem that should be addressed carefully through facilitating women's accessibility to maternity services to save their lives.

**Keywords:** Maternal mortality, trend, Nineveh.

### نمط وفيات الأمهات في نينوى للفترة (٢٠٠٤-٢٠١٣)، تحليل السلسلة الزمنية

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#### الخلاصة

**مقدمة:** تعتبر وفيات الأمهات واحدة من أهم المؤشرات الصحية لتطور البلدان على مستوى العالم، و كجزء من أهداف MDG5 فقد وضعت الأمم المتحدة الهدف المتمثل بتقليل نسبة وفيات الأمهات في العام ٢٠١٥ بمعدل ثلاثة أرباع مستوياتهم في العام ١٩٩٠. تهدف هذه الدراسة إلى تحديد نمط مؤشرات وفيات الأمهات في محافظة نينوى للفترة من ٢٠٠٤ و لغاية ٢٠١٣.

#### طريقة العمل:

**تصميم الدراسة:** دراسة البايومترية الوصفية.

**موقع الدراسة:** محافظة نينوى / شمال العراق.

**المشاركين في الدراسة:** وفيات الأمهات، النساء في سن الإنجاب، و الولادات الحية للأعوام ٢٠٠٤-٢٠١٣.

**وسيلة جمع المعلومات:** شهادات الوفاة لسكان نينوى، نظام الإحصاء الحيوي.

**المحصلة النهائية:** نسب وفيات الأمهات، خطورة التعرض للوفاة في سن الإنجاب، مراحل وفيات الأمهات، بالإضافة إلى أسباب الوفاة و أنماطهم و ذلك باستخدام مختلف النسب، النسب المئوية، و مربع كاي الخاص بالنمط.

**النتائج:** اختلف نمط وفيات الأمهات بصورة معنوية خلال فترة الدراسة ( $p=0,002$ )، و سجلت أسوأ المعدلات في العام ٢٠٠٧. أما معدل خطورة الوفاة في سن الإنجاب فكان ١:٦٦٦ امرأة في سن الإنجاب إما بسبب العوامل المباشرة للحمل والولادة و المتمثلة بالنزيف الدموي أو بسبب العوامل غير المباشرة و على رأسها أمراض القلب الوعائية.

**الاستنتاج والتوصيات:** ما زالت وفيات الأمهات تمثل إحدى المشاكل الصحية التي تعاني منها المحافظة و التي يجب تقليلها من خلال توفير خدمات الصحة الإنجابية بصورة كافية لإنقاذ حياتهم.

**الكلمات المفتاحية:** وفيات الأمهات، نمط، نينوى.

## INTRODUCTION

**M**aternal mortality is one of the most important indicators that reflects the socioeconomic and health statuses of any country, that is why the United Nations made the reduction in maternal mortality one of its goals and established the target of reducing maternal mortality by three-quarters between 1990 and 2015 as part of the 5<sup>th</sup> Millennium Development Goal (MDG5)<sup>1</sup>.

Maternal mortality is the death of a woman while pregnant, or within 42 days of termination of pregnancy irrespective of the duration or site of the pregnancy from any cause related to, or aggravated by the pregnancy or its management and not from accidental causes<sup>2,3</sup>. Late maternal death is the death from direct or indirect obstetric causes, more than 42 days, but less than one year after termination of pregnancy<sup>4</sup>.

The WHO defines maternal mortality rate as the number of maternal deaths due to complications of pregnancy, labour and the puerperium in a year  $\times$  1000 divided by total women (15-49 years) in the same year. The same agency describes maternal mortality *ratio* as the number of maternal deaths  $\times$  1000 divided by total number of live birth in the same year<sup>2,3</sup>.

Another indicator used to assess maternal mortality is the life time risk of maternal mortality which takes into account both the probability of becoming pregnant and the probability of dying as a result of pregnancy cumulated across a woman's reproductive years. It can be measured by multiplying maternal mortality rate  $\times$  35 which is the woman's reproductive years<sup>1</sup>.

Globally, maternal mortality ratio in 2005 was ranging between 1 in Ireland to 2100 in Sierra Leone for every 100,000 live births. In Iraq, it was 300/100 000 live births, a ratio considered high if compared with all adjacent countries including

Kuwait, Saudi Arabia, Turkey, Jordan, Syria, and Iran with maternal mortality ratios of 4, 18, 44, 62, 130, and 140/100,000 live births respectively<sup>5</sup>. Thus, too many women still die every day in the process of giving new life, most of these deaths could be prevented by improving access to health services and better trained, qualified, and more numerous staff especially in developing regions<sup>6</sup>. In most developing countries, the major medical causes of maternal mortality are hemorrhage, hypertensive diseases of pregnancy and various types of maternal infections<sup>7</sup>. Whereas in USA, there is a dramatic reduction in these causes but what emerged were underlying or worsening medical conditions such as CVDs<sup>8</sup>. The same figure was explored by WHO and the Institute for Health Metrics and Evaluation<sup>9</sup> when they published a comprehensive analysis of maternal mortality causes and disclose that there is a striking increased importance of indirect causes of maternal death as a result of successful addressing of direct complications of pregnancy and childbirth.

**Aim of the Study:** To determine the trends of maternal mortality in Nineveh Governorate for 10 year period (2004-2013).

## SUBJECT AND METHODS

### Ethical Consideration and Study Setting

Administrative agreements and ethical consideration were obtained from the Ethical and Research Committee in Mosul College of Medicine, followed by formal agreement from Nineveh Health Directorate that in turn provided official permissions directed to all study settings involved in this work.

### Study Setting

This research was done in Nineveh, the 2<sup>nd</sup> most populated governorate in Iraq after Baghdad with a total population approximating three and half million. The registered crude birth rate equal to 43.4/1000 midyear population and crude death rate approaching 3.6/1000 midyear population with 4% growth rate<sup>10</sup>. Mortality data were obtained from vital registration system/ Statistical Department/ Nineveh Health Directorate in addition to the Public Health Center.

### Study Design

Descriptive biometric study design which involves the analysis of routinely available data such as vital registration system to provide valuable information at local or national level<sup>(11)</sup>, then followed by time series analysis.

### Study Sample

The sample of this study included all maternal deaths and all alive women at childbearing age (15-49 years) in addition to the live births for 10 year period.

### Data Collection Tool and Duration of the Study

In the absence of relevant census information, vital registration data were used which depend on death certificate. The duration of performing this research last from 1<sup>st</sup> January 2018 to 1<sup>st</sup> June 2018.

### Outcome Measures and Statistical Analysis

To achieve the aim of the study, the following measures are used<sup>1,2,3</sup>:

$$1. \text{ MM Rate} = \frac{\text{No. of maternal deaths (preg., labor and puerp.) in a specific year}}{\text{Total no. of women (15-49y) in the same year}} \times 100000$$

[Note: the proportion of women at childbearing age is 22%]<sup>12</sup>.

$$2. \text{ MM Ratio} = \frac{\text{No. of maternal deaths (preg., labor and puerp.) in a specific year}}{\text{Total no. of LB in the same year}} \times 100000$$

Life time risk of maternal death = maternal mortality rate  $\times$  35

[Note: 35 represents women's reproductive years].

$$3. \text{ Proportion of MM by cause} = \frac{\text{No. of MM due to specific cause in a specific year}}{\text{Total no. of MM in the same year}} \times 100$$

$$4. \text{ Proportion of MM by stage} = \frac{\text{No. of MM at certain stage (preg., labour or puerp.) in a specific year}}{\text{Total no. of MM in the same year}} \times 100$$

The significant changes in the trends of mortality and their causes were examined by Chi-squared

test for Trend using Statdirect software program version 3. P-value<0.05 was considered statistically significant throughout data analysis.

## RESULTS

**Table 1** shows maternal mortality indicators including maternal mortality rates, maternal mortality ratios, and life time risk of maternal death. While maternal mortality rates were not changed significantly during the study period, maternal mortality ratios displayed the reverse state with p=0.002. The situation was worsen in 2007 where highest levels of maternal mortality rates and ratios were recorded (6.74/100,000 women and 45.01/100,000 live births respectively).

Life time risk of maternal death experienced a fluctuation in its trend with worsening during 2007 (235/100,000 women) and relieving in 2011 (83/100,000 women).

In **Table 2** although there was unmistakable variation in the proportions of maternal mortality by stages of pregnancy, labour, and puerperium, however; p-values indicated non-significant changes in their trends throughout the study period.

**Table 3** reveals that direct causes of maternal mortality formed the overwhelming proportion compared with indirect ones and they were responsible for 72.97% - 96.15% of maternal deaths.

Hemorrhage whether antepartum or postpartum blamed to threat maternal lives and it was responsible for about a quarter to just more than half of all maternal deaths followed by hypertensive disorders of pregnancy (HDP), embolism, and obstructed labor. On the other hand, indirect causes formed small proportions among causes and were responsible for 3.85% - 27.03% of maternal mortality predominated by cardiovascular diseases (CVDs). Most causes of maternal mortality showed non-significant changes throughout the study period although gathering direct and indirect causes portrayed significant changes in their trends with p=0.006 each, (**Table 3 and Figure 1**).

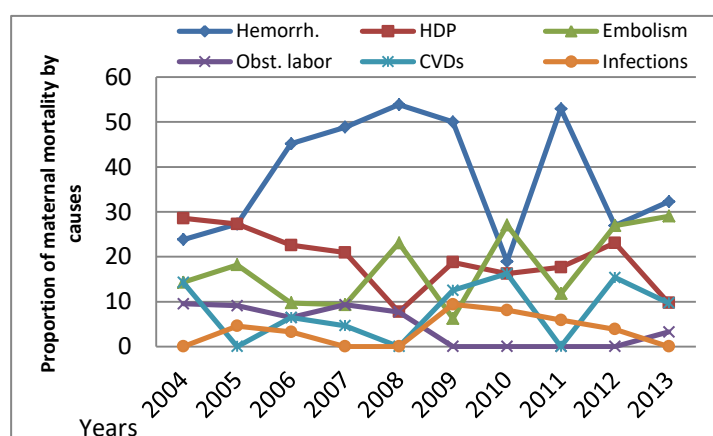
**Table 1.** Trends of maternal mortality rates and ratios in Nineveh (2004-2013).

Year	No. of women (15-49) years	No. of live births	No. of maternal deaths	MM rate /100,000 women	MM ratio /100,000 live births	Life time risk of maternal death*
2004	559992	83717	21	3.75	25.08	131
2005	580212	88916	22	3.79	24.74	132
2006	599045	99137	31	5.17	31.27	181
2007	638345	95526	43	6.74	45.01	235
2008	665746	117067	26	3.91	22.21	136
2009	670515	130244	32	4.77	24.57	167
2010	723934	137775	37	5.11	26.86	179
2011	719493	146040	17	2.36	11.64	83
2012	733744	146864	26	3.54	17.70	124
2013	756403	149297	31	4.10	20.76	143
<b>P-value</b>	-----	-----	-----	<b>0.19</b>	<b>0.002</b>	-----

\*Measured for each 100,000 women at childbearing age (15-49 years).

**Table 2.** Trends of stages of maternal deaths in Nineveh (2004-2013).

Year	No. of maternal Deaths	Stages of Maternal Death					
		During pregnancy		During labour		During puerperium	
		No.	%	No.	%	No.	%
2004	21	6	28.57	10	47.62	5	23.81
2005	22	4	18.18	9	40.91	9	40.91
2006	31	6	19.35	9	29.03	16	51.62
2007	43	9	20.93	20	46.51	14	32.56
2008	26	5	19.23	16	61.54	5	19.23
2009	32	11	34.38	12	37.50	9	28.12
2010	37	9	24.32	9	24.32	19	51.36
2011	17	7	41.18	1	5.88	9	52.94
2012	26	6	23.08	15	57.69	5	19.23
2013	31	8	25.81	12	38.71	11	35.48
<b>P-value</b>	-----	-----	<b>0.393</b>	-----	<b>0.489</b>	-----	<b>0.948</b>



**Figure 1.** Trends of causes of maternal mortality in Nineveh (2004-2013).

**Table 3.** Trends of causes of maternal mortality in Nineveh (2004-2013).

Year	Causes of maternal death in %									
	Direct obstetric causes					Indirect causes				
	Hemorrhage	HDP	Embolism	Obstructed labour	Others	Total	CVDs	Infections	Others	Total
2004	23.81	28.57	14.29	9.52	9.52	85.71	14.29	0.00	0.00	14.29
2005	27.27	27.27	18.18	9.09	13.64	95.45	0.00	4.55	0.00	4.55
2006	45.16	22.58	9.68	6.45	3.23	87.10	6.45	3.23	3.23	12.90
2007	48.84	20.93	9.30	9.30	6.98	95.35	4.65	0.00	0.00	4.65
2008	53.85	7.69	23.08	7.69	3.85	96.15	0.00	0.00	3.85	3.85
2009	50.00	18.75	6.25	0.00	3.13	78.13	12.50	9.38	0.00	21.88
2010	18.92	16.22	27.03	0.00	10.81	72.97	16.22	8.11	2.70	27.03
2011	52.94	17.65	11.76	0.00	0.00	82.35	0.00	5.88	11.76	17.65
2012	26.92	23.08	26.92	0.00	0.00	76.92	15.38	3.85	3.85	23.08
2013	32.26	9.68	29.03	3.23	3.23	77.42	9.68	0.00	12.90	22.58
P-value	<b>0.551</b>	<b>0.104</b>	<b>0.026</b>	<b>0.011</b>	<b>0.109</b>	<b>0.006</b>	<b>0.226</b>	<b>0.526</b>	<b>0.004</b>	<b>0.006</b>

## DISCUSSION

Globally, a substantial reduction in maternal deaths had been achieved in the past two decades from 543,000 deaths in 1990 to an estimated 287,000 by 2010 with an annual global reduction of 3.1%, however; it still considered a global crisis in the current century<sup>13</sup>.

In the present study, maternal mortality rate was fluctuating insignificantly from 3.75 in 2004 to 4.1 in 2013 per 100,000 women at childbearing age, and the same, but significantly, was shown for maternal mortality ratio. The worst level of maternal death was during 2007 with maternal mortality rate and ratio of 6.74 and 45.01 respectively and the best was during 2011, this may be due to the variation in security and economic statuses that made pregnant women seek management from different sites whether at home, birth attendants, or medical institutions. On average, each women had a risk of death of 1:666 or in other words, 1.5 for each 1000 women during maternity period approximating the global average life time risk in 2005 which was 1.13, with extremes of 5.42 and 0.01 in Sub-Saharan Africa and Europe respectively<sup>1</sup>.

Depending on the sources of mortality data, maternal mortality ratios in the present study were lower than the national levels reported by WHO<sup>(13)</sup>

in 2013 where their trend was reduced from 89 to 78 then to 63 /100,000 live births between 1990, 2000, and 2010 respectively which may result from the improvement in maternity services produced. These national ratios were in turn lower than the global average levels which were 110, 90, and 66/100,000 live births in the same time period respectively with annual reduction rate of 2.6% as stated by Lawn et al.<sup>14</sup>.

During 2013, maternal mortality ratio was highest (250) in developing countries and lowest (16) in developed for each 100,000 live births<sup>4</sup>. The average life time risk of maternal death was 1:190 being worst (1:160) in developing and best (1:3700) in developed countries. The same document reported that, Iraq's maternal mortality ratio during 2013 was 67/100,000 live births a little bit higher than its level in 2010 with a life time risk of 1:340<sup>4</sup>.

Many countries made a good progress between 1990 and 2010 toward achieving their MDG5 through improving their maternity services like Bangladesh from 800 to 240, China from 120 to <40, Egypt from 240 to 60, Ethiopia from 960 to 350, Nepal from 790 to 190, Peru from 200 to 65, and Rwanda from 900 to 300 for each 100,000 live births<sup>15</sup>. However, the present study demonstrated maternal mortality levels approximating that of



developed countries which may reflect the improved maternity health care services or could be an artifact as a result of under registration practices.

Exploring the causes of maternal mortality in the present work revealed that, 8-9 out of each 10 maternal deaths were attributed to direct causes among which hemorrhage was dominating and responsible for about a quarter to half of these deaths. On the other hand, HDP was the cause of another quarter of maternal mortality followed by embolism and obstructed labor. Of the indirect causes, CVDs were blamable for about 10% of maternal mortality followed by infections. Apart from embolism, the other major causes of maternal mortality were not changed significantly throughout the study period. Similarly, between 2003 and 2009, among the main causes of maternal mortality hemorrhage was the 1<sup>st</sup> leading cause of death globally (27%) followed by indirect causes including anemia, malaria, CVDs, tuberculosis, HIV/AIDS, and accidents (27%), then HDP (14%), sepsis (11%), obstructed labor (9%) abortion (8%), and embolism (3%)<sup>16,17</sup>. Toward 2013, these causes changed greatly through which hemorrhage, HDP, and sepsis reduced, and unsafe abortion complications increased<sup>18</sup>. On the other hand, the indirect causes were also increased and became responsible for 40% of maternal mortality according to the 2011 statistics<sup>19</sup>.

Hemorrhage is one of the leading causes of maternal mortality in the present study and worldwide with a global prevalence rate of approximately 6%. In Africa and Asia, where most maternal deaths occur, hemorrhage, especially postpartum, accounts for more than 30% of all maternal mortality<sup>20</sup>. Sepsis, on the other hand, accounted for 10.7% of maternal deaths from 2003 to 2012 according to the WHO systematic analysis on the global causes of maternal death<sup>21</sup>.

The higher contribution of hemorrhage and very little share of the indirect causes on maternal death in the present study may be related to the shortage in the maternity services that incapacitating the increased levels of fertility, adding to that, the uncommon prevalence of infectious diseases like AIDS, malaria, and tuberculosis in the present study locality make these indirect causes to have

no any impact on maternal mortality compared with other developing countries.

Despite the global progress on reducing maternal mortality, most countries were unable to meet their MDG5 target and Iraq is one of them<sup>(12)</sup>. There is still a lot to be done to improve the national health care systems including maternity services in particular in order to end maternal preventable deaths.

## CONCLUSIONS AND RECOMMENDATIONS

Low levels of maternal mortality rates and ratios are documented in the present study, however; increasing medical institutions and designing programs for home-based deliveries by skilled birth attendants who are educated and trained to proficiency in the skills of managing normal and complicated pregnancies with adequate referral are recommended in a try to overcome the high fertility levels and reduce maternal deaths.

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