

# Annual mortality rates and excess deaths of children under five in Iraq, 1991–98

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*Data from two parallel household surveys conducted in Iraq by UNICEF in 1999 show that under-5 mortality declined steadily from 1974 to 1990, reaching about 63 per 1,000 live births in the period 1986–90. It then rose dramatically to 118 per 1,000 in 1991, the year of the Gulf War. The number of 'excess' under-5 deaths (i.e., the number in excess of the number predicted from past trends) in Iraq between 1991 and 1998 was calculated assuming that, instead of the rates measured by the 1999 survey for this period, either (a) average mortality rates for the period 1986–90 had been maintained, or (b) mortality had continued to decline at the rate observed between 1974 and 1990. According to these calculations, the estimated number of excess deaths resulting from the Gulf War and its aftermath up to 1998 was between 400,000 (assumption a) and 500,000 (assumption b).*

**Keywords:** childhood mortality; excess deaths; Iraq; UN sanctions

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## Introduction

In this paper we present detailed estimates of child mortality in Iraq during the 1990s, using data from two parallel household surveys in the South/Centre and North regions of Iraq—the Iraq Child and Maternal Mortality Survey (ICMMS)—conducted by UNICEF in 1999 (UNICEF 1999a). During this period there were major upheavals in the country: the Gulf War of 1991, the imposition of comprehensive trade sanctions by the United Nations (UN), the placing of the Northern region (inhabited mainly by the Kurds) under UN administration, and the UN's decision in 1995 to institute an Oil-for-Food programme directed at mitigating the effects of conditions in Iraq on nutritional levels and health.

Broad estimates of infant and under-5 mortality rates using data from the 1999 survey were presented in an earlier paper (Ali and Shah 2000), but these rates were for 5-year periods before the survey. In this new paper, we present, as well as infant and under-5 mortality rates, neonatal, post-neonatal, and child (ages 1–4) mortality rates by single calendar year. In addition, we present estimates of the number of excess deaths in the period 1991–98: estimates of the absolute number of under-5 deaths in Iraq implied by these single-year rates, less estimates of

the number that would have occurred had the mortality rates that prevailed immediately before the Gulf War been maintained in the 1990s. The number of excess deaths in the period has been a matter of controversy. A commonly mentioned figure, derived from the preliminary report of the 1999 survey (UNICEF 1999b) is 500,000 under-5 deaths, but the methods used to obtain this figure and some very different figures announced by other sources have not been available for scrutiny. For our estimates, we use what we believe are the most robust of the procedures available and these are fully described below. The earlier paper (Ali and Shah 2000) summarized literature on the explanation of the trends and differentials, but here we are concerned exclusively with the estimation of excess mortality.

The first part of the paper comprises a brief summary of the data sources, a description of the methods used to calculate the mortality rates, details of their design-based standard errors, and estimates of the number of excess under-5 deaths. In the second part, we present the annual childhood mortality rates for the South/Centre region and, separately, for the North region, the weighted average for infant and under-5 rates for the whole country for the period 1974–98, and the estimated number of under-5 deaths for the whole country in the period 1991–98 under

different assumptions. We conclude with a brief discussion.

## Data and methods

### Data

The mortality estimates we present use data collected with the birth history section of the ICMMS questionnaire (UNICEF 1999a). This section of the questionnaire seeks a complete retrospective birth history. The respondent is asked to list each of her births, beginning with the first, and to indicate for each live birth the child's sex, month and year of birth, survivorship status, and current age or age at death. Mortality rates are estimated directly from data on a child's birth date, survivorship status, and age at death reported for children who died.

For the calculation of excess under-5 deaths, the estimated numbers of births in Iraq from 1975 to 2000 were provided by the Population Division of the United Nations from their medium projections (1998 Revision). These were then adjusted to correspond with the fertility rates given by the 1999 survey.

### Methods

**Mortality rates.** A life-table approach was used to estimate probabilities of dying between two exact ages. The rates in this report are based on synthetic cohorts, with children born in different years (i.e., representing different birth cohorts) contributing to the exposure and mortality experience used for the estimation of calendar-specific, age-specific probability estimates (Bicego and Ahmed 1996). Five indices of childhood mortality were calculated: *neonatal mortality* ( $NN$ ), *post-neonatal mortality* ( $PNN$ ), *infant mortality*  ${}_1q_0$ , *child mortality*  ${}_4q_1$ , and *under-5 mortality*  ${}_5q_0$ . The Demographic and Health Surveys calculate post-neonatal mortality by subtracting the neonatal mortality rate from the infant mortality rate. We use the conventional life-table approach instead.

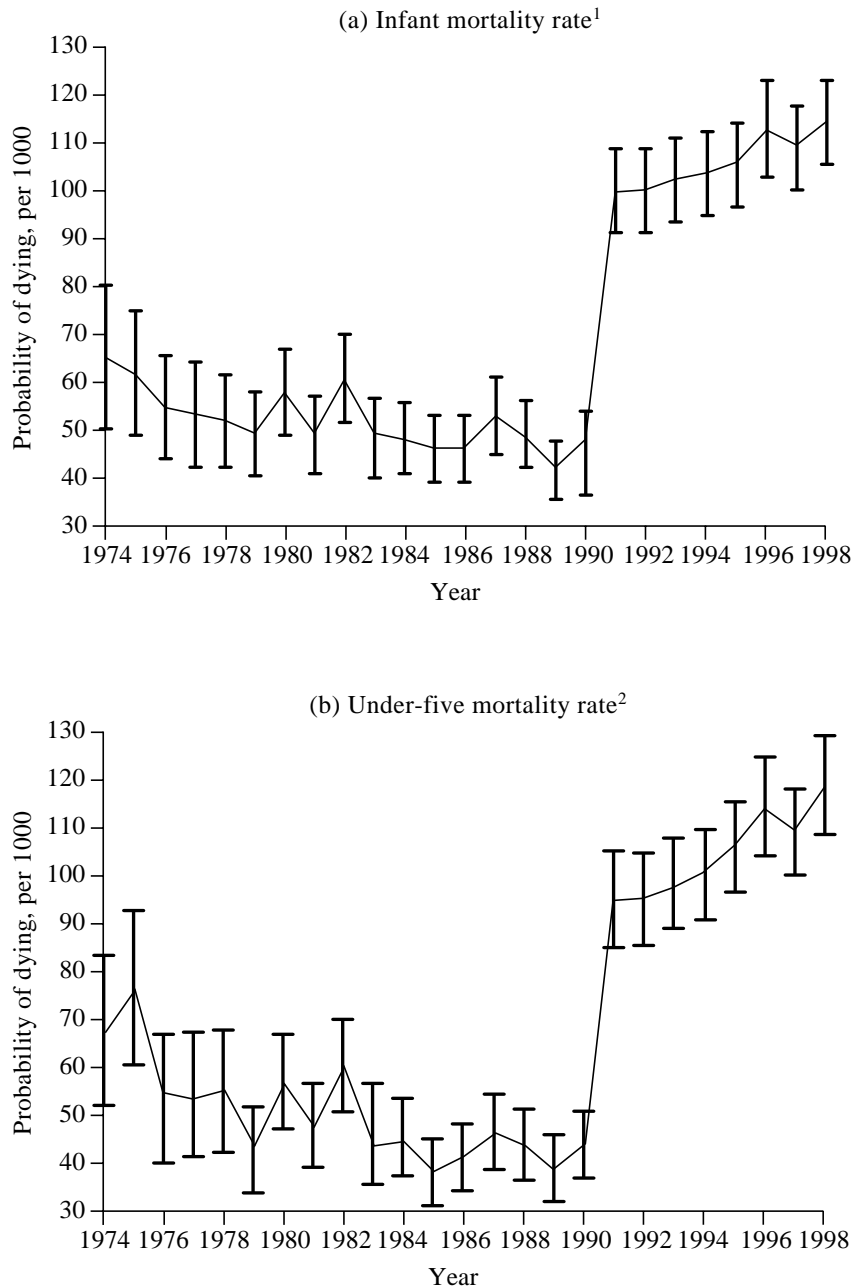
Because the survey design is a multistage sampling design, design-based or 'robust' standard errors for the estimated mortality rates were calculated, using the *jack-knife* repeated replication procedure (JRR) (Wolter 1985; Efron and Tibshirani 1993; Lê and Verma 1997). The standard errors were used to establish confidence intervals, which are shown graphically in Figures 1 and 2. For the calculation of the mortality rates and their standard errors, we used a program

provided by K. H. Hill that calculates mortality rates using the principles described by Rutstein (1984); the probabilities of death are calculated for subintervals of exposure in months (0, 1–3, 4–11, 12–15, 16–23, 24–35, 36–47, 48–59).

The calculations were made both for the South/Centre and for the North region. Weighted averages for the country as a whole were then established by applying weights of 0.8 to the South/Centre estimates and 0.2 to those for the North—these weights reflecting the relative proportions of the population in the two regions at the time of the survey. The national figures for infant and under-5 mortality rates before 1990 were then compared with the rates derived from other sources. As will be shown below, the estimates derived from the 1999 survey were found to be in reasonably good agreement with those from other sources, with the exception of the 1989 Gulf Child Health Survey (GCHS). Average trends over time for the pre-1990 period were therefore calculated by regressing the logits of the  ${}_1q_0$  and  ${}_5q_0$  values against their relevant dates, omitting the GCHS. The regressions were made using the logits rather than the  ${}_1q_0$  and  ${}_5q_0$  values directly for two reasons. First, it was clear that before 1990 child mortality ( ${}_4q_1$ ) was declining much more quickly than infant mortality. Any linear extrapolation of these trends for the years after 1990 quickly went into negative values, so that the  ${}_5q_0$  values were lower than the  ${}_1q_0$  values. Secondly, it has been shown by Brass (1971) that life tables tend to be linearly related on the logit scale.

The national figures for under-5 mortality were then converted into life-table survivors at ages 1 and 5 and interpolated values for ages 2, 3, and 4 were calculated using a mathematical model devised by Brass (1971) that takes the form  $l(x) = (1 + \alpha x)^{-\beta}$ , where  $x$  is age in years and  $\alpha$  and  $\beta$  are parameters. These were calculated following the procedure described by Brass and Blacker (1999). Thus from life-table survivors for single years of age between birth and age 5, single-year age-specific mortality rates ( $m_x$ ) were calculated.

Hypothetical mortality rates that might have occurred had there not been the upsurge after 1990 were then calculated using two alternative assumptions. First, the averages of the  ${}_1q_0$  and  ${}_5q_0$  values derived from the regression estimates for the years 1986–90 (54.5 and 62.9 per 1,000, respectively) were assumed to remain constant. Second, the downward trends shown by the regression lines were extrapolated to 1998, giving annual mortality rates for the period 1991–98.



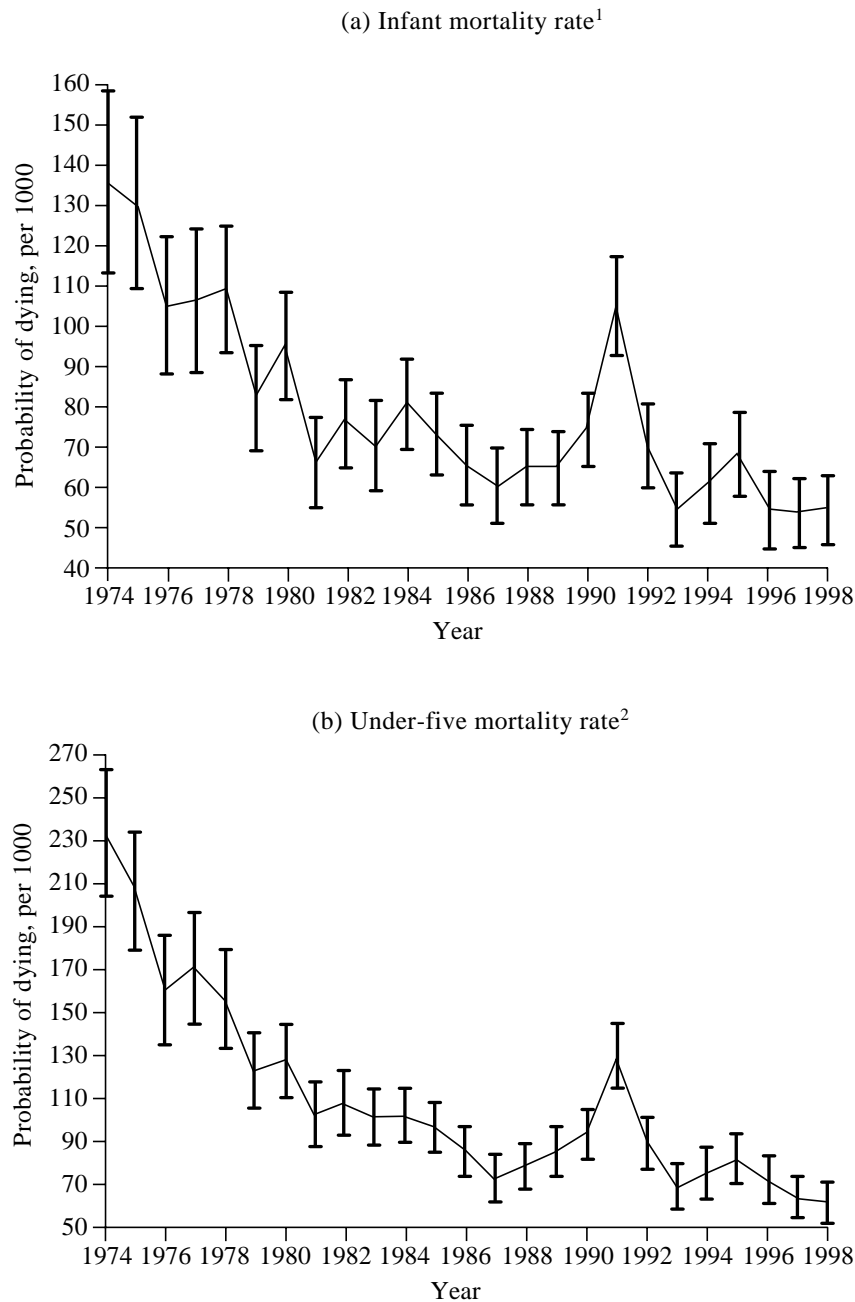
**Figure 1** Infant and under-5 mortality rates, Iraq South/Centre, 1974–98, with 95 per cent confidence intervals  
 Notes: <sup>1</sup>Probability of dying between birth and exact age 1. <sup>2</sup>Probability of dying between birth and exact age 5  
 Source: UNICEF (1999a)

*Fertility and births.* In order to convert the mortality rates into numbers of deaths, it was necessary to multiply the rates by the numbers of births occurring in each year. These annual births were provided, in the first instance, by the UN projections for Iraq (1998 Revision), which were based on the assumption of a rapid fall in fertility: Iraq's total fertility was assumed to have declined from 7.18 before 1970 to 5.25 in the period 1995–2000. The 1999 mortality survey confirmed that such a fall in fertility had in fact taken place, though not quite as fast as had been

assumed by the UN. The estimated total fertility levels were:

1974–79	1979–84	1984–89	1989–94	1994–99
7.14	7.09	6.59	6.43	5.69

Since the 1999 survey was confined to ever-married women, estimates of total fertility were obtained by using data on proportions ever-married from the 1997 census. A logistic curve was fitted to



**Figure 2** Infant and under-5 mortality rates, Iraq North, 1974–98, with 95 per cent confidence intervals  
*Notes:* <sup>1</sup>Probability of dying between birth and exact age 1. <sup>2</sup>Probability of dying between birth and exact age 5  
*Source:* UNICEF (1999a)

the total fertility figures to generate single-year estimates. These were then re-grouped to match the UN's 5-year periods, and the numbers of births provided by the UN were scaled up proportionately. They were split into annual figures using the age-splitting coefficients of Carrier and Hobcraft (1971). This procedure consists essentially of fitting a quadratic to three consecutive 5-year periods. As the 5-year periods were shown as 1975–80, 1980–85, etc., they presumably ran from mid-year to mid-year.

Figures for calendar years were therefore estimated by averaging neighbouring pairs of annual figures.

*Number of deaths.* Annual numbers of deaths were calculated by multiplying the births by the mortality rates, working down the diagonals of the age-calendar-year matrix. This was done both with the observed and the hypothetical mortality rates described above.

## Results

### Childhood mortality rates

Table 1 gives the annual childhood (neonatal, post-neonatal, infant, child, and under-5) mortality rates per 1,000 live births for the period 1974–98, by region. The results show that childhood mortality rates in the South/Centre declined steadily from the mid-1970s to the end of the 1980s and that there was a substantial relative drop in the post-neonatal mortality rate (50 per cent). In 1991 the mortality rates soared to levels higher than those of the mid-1970s except for the child mortality rate  $_{4q1}$ , though this too showed an increase of 45 per cent on the rate for 1990. After the 1991 upsurge in mortality, the rates continued to rise but at a slower pace. None of the post-1991 rates were significantly higher than those of 1991 at the 95 per cent confidence level, except for the under-5 rate in 1998, which was significantly higher than the rates in 1991, 1992, and 1993 (Figure 1).

The mortality rates in the late 1970s and the early 1980s were consistently much higher in the North than in the South/Centre (Figure 2), but by the end of the 1980s the mortality rates converged with those of the South/Centre. Immediately after the Gulf conflict, the mortality rates for the North surged to the levels of the late 1970s (Figure 2). After 1991 there was a sharp fall in mortality, but from 1993 to 1998 any further decline was small and not statistically significant.

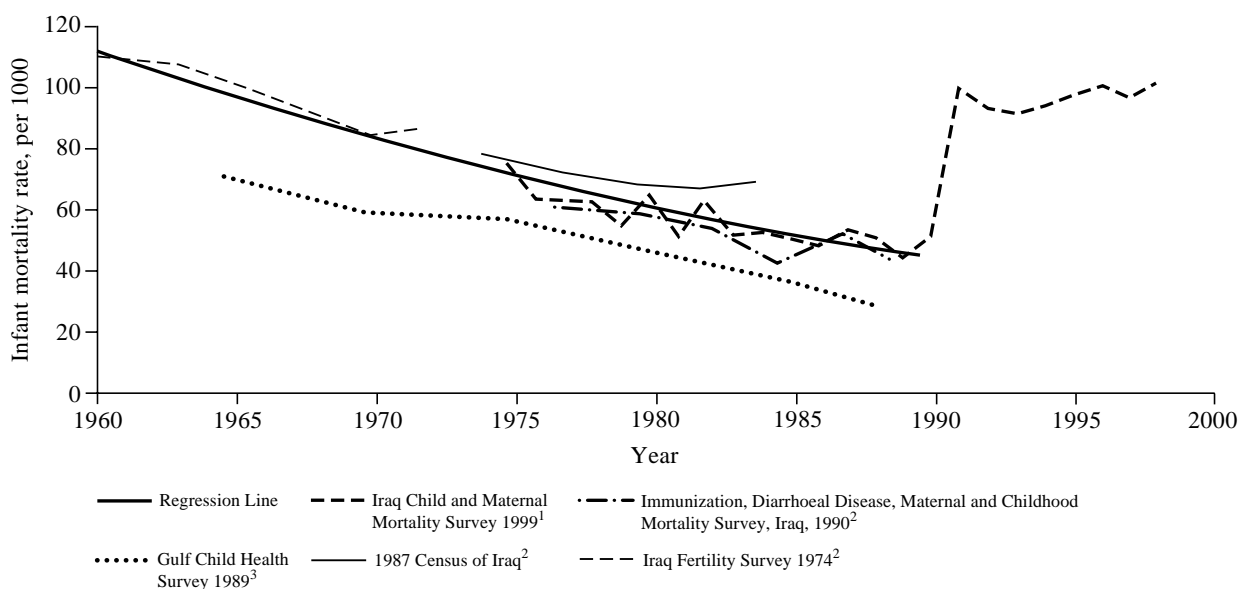
The weighted infant and under-5 mortality rates for the whole country are shown in Table 1. These

rates are plotted in Figures 3 (infant mortality) and 4 (under-5 mortality), together with corresponding estimates derived from various other surveys—the 1974 Fertility Survey, the 1987 Census, the 1989 Gulf Child Health Survey (GCHS), and the 1990 Immunization and Diarrhoea Disease Survey (IDMS). Also shown are the fitted regression lines described above for infant mortality and under-5 mortality.

The dramatic upsurge in mortality in 1991 is clearly apparent. For the period before 1990, the estimates from the 1999 survey appear to be in reasonably good agreement with those from the other sources, with the exception of the 1989 GCHS, which seems to have under-estimated mortality. The infant mortality rates from the 1990 IDMS also appear somewhat low, but this may be because they were indirect estimates obtained by applying the Princeton West model life tables. The direct estimates from the 1999 birth histories suggest that the ‘East’ models, which would have raised the estimates of infant mortality, would have been more appropriate. The IDMS estimates of under-5 mortality (which are more robust to the assumed age pattern) are more consistent with those from the other data sources. The fitted and extrapolated calendar-year infant and under-5 rates from the regressions are presented in Table 2.

### Fertility and births

Table 3 shows the total fertility levels from the UN projections and those derived from the 1999 survey re-grouped to correspond with the UN’s time



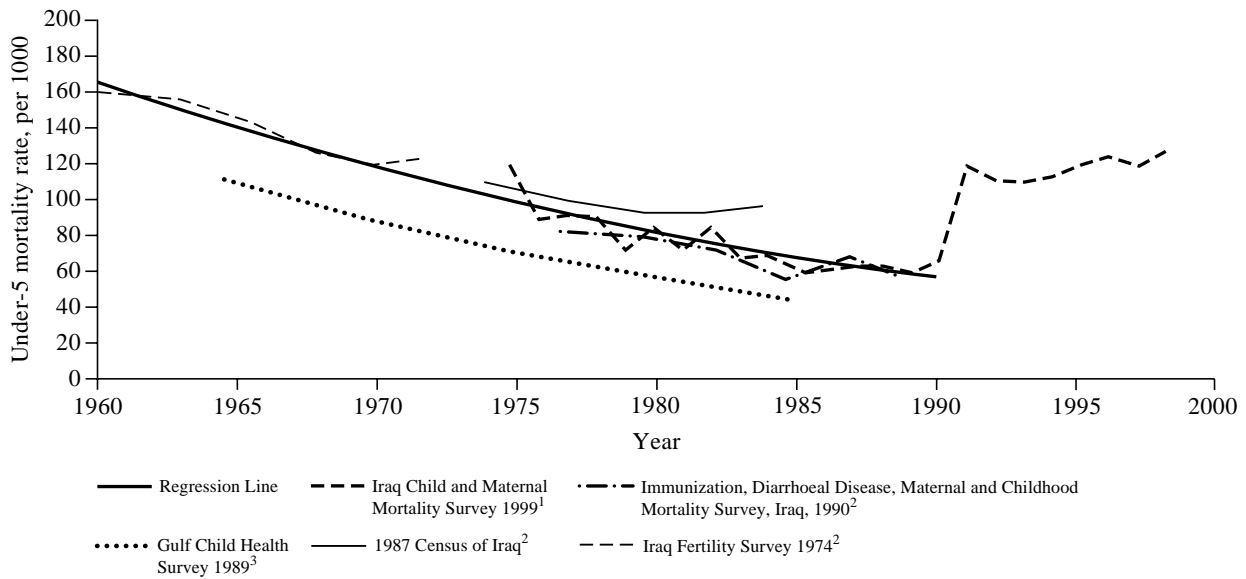
**Figure 3** Infant mortality, Iraq, 1960–98: estimates derived from different sources  
Sources: <sup>1</sup>UNICEF (1999a), <sup>2</sup>United Nations (1992, pp. 167–70), <sup>3</sup>Republic of Iraq (1990)

**Table 1** Annual childhood mortality rates for South/Centre (S/C) and North (N) of Iraq, 1974–98

Year	Neonatal <sup>1</sup>		Post-neonatal <sup>2</sup>		Infant <sup>3</sup>		Child <sup>4</sup>		Under-5 <sup>5</sup>		Weighted total	
	S/C	N	S/C	N	S/C	N	S/C	N	S/C	N	Infant	Under-5
1974	38.0	63.8	27.9	75.6	64.8	134.6	23.1	114.9	86.4	234.0	78.7	115.9
1975	33.9	46.8	28.9	86.4	61.8	129.2	37.0	88.7	96.5	206.5	75.3	118.5
1976	31.4	46.0	23.5	60.3	54.2	103.5	17.5	63.7	70.7	160.6	64.1	88.7
1977	26.5	43.9	27.0	63.6	52.8	104.7	19.4	73.1	71.2	170.2	63.2	91.0
1978	30.2	55.6	21.7	55.1	51.3	107.6	22.3	54.0	72.4	155.8	62.5	89.1
1979	28.2	32.9	20.8	49.1	48.4	80.4	10.5	46.3	58.4	122.9	54.8	71.3
1980	33.2	44.6	24.8	51.3	57.2	93.6	18.5	37.0	74.6	127.1	64.5	85.1
1981	25.2	21.3	23.9	44.0	48.4	64.4	16.4	40.7	64.1	102.4	51.6	71.7
1982	30.2	37.3	30.6	39.2	59.9	75.0	19.4	34.9	78.1	107.3	62.9	83.9
1983	28.5	32.8	20.1	37.0	48.0	68.6	11.5	33.7	59.0	100.0	52.1	67.2
1984	29.0	36.7	19.0	43.8	47.4	78.9	14.2	23.9	60.9	100.9	53.7	68.9
1985	29.9	35.8	15.6	37.1	45.1	71.6	8.1	26.2	52.8	95.9	50.4	61.4
1986	31.5	36.2	13.6	28.4	44.8	63.6	12.1	22.4	56.3	84.5	48.5	62.0
1987	38.2	29.4	14.2	29.9	51.8	58.4	11.0	14.0	62.3	71.6	53.2	64.1
1988	33.4	34.3	14.9	29.8	47.8	63.1	12.0	15.6	59.2	77.7	50.9	62.9
1989	25.9	36.2	14.9	27.9	40.4	63.1	13.9	22.3	53.8	84.0	45.0	59.8
1990	26.2	42.5	21.2	31.3	46.8	72.4	13.2	21.1	59.4	91.9	52.0	65.9
1991	59.1	48.4	42.2	57.5	98.7	103.1	19.2	27.9	116.0	128.2	99.6	118.4
1992	59.5	39.5	42.2	29.7	99.2	68.0	18.8	21.2	116.1	87.7	92.9	110.4
1993	63.4	31.7	40.5	21.5	101.3	52.5	20.3	16.1	119.5	67.8	91.5	109.2
1994	67.2	36.7	38.1	22.7	102.8	58.6	21.3	15.9	121.9	73.5	93.9	112.2
1995	66.9	47.3	40.8	19.7	105.0	66.1	26.5	15.4	128.7	80.4	97.2	119.0
1996	69.2	33.2	46.3	19.5	112.3	52.0	28.3	19.6	137.4	70.6	100.2	124.1
1997	63.1	35.2	48.2	17.0	108.3	51.5	26.5	11.1	131.9	62.1	96.9	117.9
1998	67.6	41.7	48.6	11.0	113.0	52.2	33.3	7.9	142.5	59.6	100.8	125.9

<sup>1</sup> Probability of dying within the first month of life.<sup>2</sup> Probability of dying after the first month of life but before exact age 1 year.<sup>3</sup> Probability of dying between birth and exact age 1 year.<sup>4</sup> Probability of dying between exact age 1 and exact age 5.<sup>5</sup> Probability of dying between birth and exact age 5.

Source: UNICEF (1999a).



**Figure 4** Under-5 mortality, Iraq, 1960–98: estimates derived from different sources  
 Source: As for Figure 3

**Table 2** Fitted and extrapolated values of infant and under-5 mortality rates, Iraq 1976–98

		Rate (per 1,000)	
		Infant	Under-5
	Year		
Fitted	1976	69.8	95.8
	1977	67.6	92.4
	1978	65.6	89.1
	1979	63.6	85.9
	1980	61.6	82.7
	1981	59.7	79.7
	1982	57.9	76.8
	1983	56.1	74.0
	1984	54.4	71.3
	1985	52.7	68.7
Extrapolated	1986	51.0	66.1
	1987	49.5	63.7
	1988	47.9	61.3
	1989	46.4	59.0
	1990	45.0	56.8
	1991	43.6	54.7
	1992	42.2	52.7
	1993	40.9	50.7
	1994	39.6	48.8
	1995	38.4	47.0
	1996	37.1	45.2
	1997	36.0	43.5
	1998	34.8	41.8

Sources: UNICEF (1999a); United Nations (1992).

**Table 3** Estimated births, Iraq 1975–2000

	Total fertility		Births (thousands)	
	UN <sup>1</sup>	Survey <sup>2</sup>	UN <sup>1</sup>	Survey <sup>2</sup>
1975–80	6.56	6.95	2,517	2,667
1980–85	6.35	6.78	2,903	3,100
1985–90	6.15	6.50	3,364	3,556
1990–95	5.70	6.08	3,662	3,906
1995–2000	5.25	5.52	3,937	4,139

Sources: <sup>1</sup>Estimates provided by the Population Division of the United Nations. <sup>2</sup>UNICEF (1999a).

periods. The survey-based rates are higher throughout. The right-hand section of the table shows the original numbers of births from the UN projections and adjusted numbers, scaled up in proportion to the total fertility levels. Table 4 shows the interpolated numbers of births for single calendar years, obtained as described in the section on methods.

### Excess deaths

Table 5 shows the estimated annual number of childhood deaths by single years of age. It can be seen that, in the period 1991–98 as a whole, the estimated total number of deaths was 794,216, whereas if the mortality rates of 1986–90 had remained constant, the implied number of deaths for the period 1991–98 would have been 412,270. The difference between the

**Table 4** Interpolated annual births (thousands), Iraq 1976–99

Year	UN	Survey
1976	483	508
1977	496	525
1978	510	542
1979	524	559
1980	540	557
1981	555	593
1982	572	611
1983	589	629
1984	606	647
1985	628	667
1986	650	687
1987	666	704
1988	681	720
1989	695	735
1990	706	750
1991	715	763
1992	727	776
1993	738	788
1994	750	798
1995	761	808
1996	771	817
1997	782	825
1998	793	832
1999	803	838

Sources: As for Table 3.

totals yields an estimated excess mortality of 381,947 under-5 deaths. Alternatively, if instead of remaining constant, mortality had continued to decline at the pre-1990 rate, deaths in the period 1991–98 would have been reduced to a total of 312,323, and the estimated number of excess deaths would be 481,893. These two figures—382,000 and 482,000—could reasonably be regarded as the upper and lower limits of the estimated number of excess deaths.

## Discussion

In this paper we have estimated the annual childhood mortality rates in the South/Centre and North of Iraq for up to 25 years before the 1999 survey. The annual mortality estimates give more insight into the trend of child mortality before and after the Gulf conflict than the 5-year rates reported previously (UNICEF 1999b; Ali and Shah 2000). The reliability of the estimated infant and under-5 mortality rates can be judged from the width of the 95 per cent confidence intervals. For the period before 1990, the validity of the results is supported by the good agreement observed between the estimates derived from the

1999 survey and those derived from other sources (Figures 3 and 4).

The calculation of excess mortality, based on the survey mortality rates and the UN 1998 birth projections, yields an estimate of between 400,000 and 500,000 excess under-5 deaths during the period 1991–98.

As indicated at the outset, the purpose of this paper was simply to make the best possible estimate of trends in infant and child mortality, not to investigate or comment on how conditions in Iraq produced the mortality trends observed or why these differed by region. These issues have been discussed in various reports from UN organizations (for example, United Nations 1999; FAO 2000) and other bodies. A number of references to this literature are given by Ali and Shah (2000).

## Note

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**Table 5** Estimated number of childhood deaths by single years of age, Iraq 1981–98

	Age (single years)					Total
	0	1	2	3	4	
<b>1. Estimated deaths from 1999 Survey</b>						
1981	31,763	4,951	2,829	1,926	1,438	42,906
1982	40,207	5,479	3,043	2,109	1,570	52,408
1983	34,007	3,939	2,247	1,518	1,151	42,862
1984	36,080	4,146	2,313	1,604	1,186	45,328
1985	34,840	3,069	1,736	1,177	894	41,716
1986	34,519	3,855	2,169	1,492	1,107	43,142
1987	38,822	3,296	1,856	1,269	955	46,200
1988	37,962	3,657	2,087	1,430	1,070	46,205
1989	34,112	4,610	2,621	1,821	1,365	44,530
1990	40,398	4,484	2,535	1,750	1,329	50,496
1991	81,727	6,472	3,714	2,553	1,928	96,394
1992	77,172	5,710	3,441	2,407	1,811	90,541
1993	77,051	5,900	3,336	2,449	1,875	90,610
1994	80,318	6,233	3,553	2,447	1,967	94,518
1995	84,328	7,570	4,341	3,015	2,273	101,528
1996	88,093	8,364	4,799	3,356	2,552	107,164
1997	85,795	7,396	4,243	2,970	2,274	102,678
1998	90,269	9,013	5,144	3,599	2,759	110,784
<b>Total 1991–98</b>	<b>664,751</b>	<b>56,658</b>	<b>32,572</b>	<b>22,795</b>	<b>17,440</b>	<b>794,216</b>
<b>2. Hypothetical deaths with mortality constant at 1986–90 level</b>						
1991	39,478	4,152	2,364	1,635	1,235	48,863
1992	40,130	4,312	2,415	1,672	1,265	49,794
1993	40,733	4,383	2,508	1,708	1,294	50,626
1994	41,288	4,449	2,549	1,774	1,322	51,381
1995	41,794	4,509	2,588	1,803	1,373	52,066
1996	42,251	4,565	2,623	1,830	1,395	52,664
1997	42,660	4,615	2,655	1,855	1,416	53,200
1998	43,020	4,659	2,684	1,878	1,436	53,676
<b>Total 1991–98</b>	<b>331,352</b>	<b>35,644</b>	<b>20,385</b>	<b>14,154</b>	<b>10,735</b>	<b>412,270</b>
<b>Excess deaths</b>	<b>333,399</b>	<b>21,014</b>	<b>12,187</b>	<b>8,641</b>	<b>6,705</b>	<b>381,947</b>
<b>3. Hypothetical deaths with mortality declining at pre-1990 rate</b>						
1991	34,310	3,611	2,057	1,422	1,074	42,474
1992	33,755	3,450	1,969	1,363	1,031	41,568
1993	33,154	3,288	1,880	1,304	988	40,615
1994	32,523	3,125	1,790	1,244	944	39,625
1995	31,857	2,962	1,700	1,183	900	38,603
1996	31,163	2,802	1,611	1,123	855	37,554
1997	30,449	2,642	1,521	1,062	810	36,485
1998	29,711	2,486	1,433	1,003	766	35,399
<b>Total 1991–98</b>	<b>256,922</b>	<b>24,367</b>	<b>13,961</b>	<b>9,705</b>	<b>7,368</b>	<b>312,323</b>
<b>Excess deaths</b>	<b>407,829</b>	<b>32,291</b>	<b>18,611</b>	<b>13,090</b>	<b>10,072</b>	<b>481,893</b>

Source: Tables 2 and 4.

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