

$$\text{Var}(p) = \frac{1}{5} \sum_{i=1}^5 \hat{\text{Var}}(p_i) + (1 + \frac{1}{5}) \cdot 4 \cdot \sum_{i=1}^5 (p - p_i)^2$$

The R-square values and the point estimates for Iraq generated by the regression models, using a data base which includes values which were imputed where original values were missing, are very similar to those generated by the exploratory regression above (See table 8). Using the log of mortality still consistently generated lower point estimates for Iraq than regressions using untransformed under five-year-old mortality. As predicted, little power is lost by including the three most important independent variables rather than the entire variable set.

**Table 8: Untransformed and Log Regressions Using Imputed Values for Missing Data**

Dependent Variable	Independent Variables	Missing Data Handling	Number of Data Points	R-Square Value	Under Five-Year-Old Mortality Estimate
Under Five-Year-Old Mortality	Adult Literacy Stunting Pop With Water	Multiple Imputation	191	.77	110
Under Five-Year-Old Mortality	Adult Literacy Stunting Pop with Water Per Capita GNP Breast feeding Sanitation	Multiple Imputation	191	.77	105
Log of Under Five-Year-Old Mortality	Adult Literacy Stunting Pop with Water	Multiple Imputation	191	.72	78
Log of Under Five-Year-Old Mortality	Adult Literacy Stunting Pop with Water Per Capita GNP Breast feeding Sanitation	Multiple Imputation	191	.82	76

Logistic regression including all variables provided a point estimate for under five-year-old mortality in Iraq midway between estimates using untransformed and log transformed values of under five-year-old mortality (See table 9). Beta coefficients for the three main variables were even more important in the logistic model. Eliminating the three other variables used in the full



model hardly changed the R-square value or the point estimate for Iraq. Parameter estimates for the coefficients for the short logistic model were -1.0132 for the intercept, -0.0194 for each unit of adult literacy, 0.0213 for each unit of stunting, and -0.0128 for each unit of population with potable water.

Data on literacy, sanitation, and stunting for each governorate from the MICS survey (35,36) were grouped by region of the country. Estimates for under five-year-old mortality rates in the four regions of the country show Baghdad governorate to have the lowest rate. The southern governorates, where Suni Muslims predominate, where resource allocation has been poorest in the oil for food program, and where the Iran-Iraq war and post-Gulf war uprising were fought, has the highest under five-year-old mortality rate. Mortality in the southern governorates is estimated to be 34% higher than the level in Baghdad. The northern governorates, where UN administration and NGO actions have reduced the impact of the post-Gulf war uprising and displacement of the predominantly Kurdish population, has a rate of mortality higher than Baghdad and lower than the southern governorates (See table 10).

Rural areas likely have higher infant mortality rates than urban areas. Access to potable water is about 50% lower in rural areas. Illiteracy is much higher among women above 15 years in rural areas in the northern governorates (54% compared to 32% in urban areas) and in Baghdad (51% compared to 27% in urban areas). Sanitation is greater than 50% lower and measles immunization 10% to 15% lower in rural areas (35,36). There are, however, some advantages in rural areas. Breast feeding prevalence is higher and the introduction of weaning foods occurs on a more timely basis in rural areas (49). These feeding practices are probably the reason that stunting is only slightly worse in rural than in urban areas. Stunting in 1996 occurred among 32% of urban and 33% of rural children in the central and southern governorates, and among 25% of urban and 30% of rural children in the northern governorates (35,36). Throughout the country, girls are breast fed slightly less than boys and have higher rates of stunting.

**Table 9: Logistic Regression Model**

Dependent Variable	Independent Variables	Missing Data Handling	Number of Data Points	R-Square Value	Under Five-Year-Old Mortality Estimate	95% Confidence Interval
Binomial Under Five-Year-Old Mortality	Adult Literacy Stunting Pop with Water Per Capita GNP Breast feeding Sanitation	Multiple Imputation	191	.76	88	80-99
Binomial Under Five-Year-Old Mortality	Adult Literacy Stunting Pop with Water	Multiple Imputation	191	.75	87	80-95



**Table 10: Estimated Under Five-Year-Old Mortality for Iraq in Short Logistic Regression Model with Imputation**

Region	Estimated Under Five-Year-Old Mortality (per Thousand)	95% Confidence Interval
National	87	80-95
Northern Governorates	81	75-87
Central Governorates	83	76-89
Baghdad Governorate	76	73-80
Southern Governorates	102	89-117

#### *Validity Check on Mortality Estimates*

The estimate of 87 deaths per thousand children under five years of age in Iraq cannot be validated as no other good sources currently exist on mortality for the period after 1991. Indeed, this entire exercise would not have been carried out if such a source did exist. But good quality mortality estimates have already been provided for the end of the period of stability prior to sanctions and the Gulf war (mid-year 1990) and for the first eight months of 1991, including the period of the Gulf war, sanctions, and the postwar uprisings. Estimates for literacy, potable water, and stunting in these two periods of time were applied to the logistic regression model described above. Values generated by these models are shown to provide good estimates for the known under five-year-old mortality rates (See table 11).

**Table 11: Comparison of Binomial Model and Known Rates of Under Five-Year-Old Mortality**

Time Period	Known Rate (per thousand)	Model Estimate (per thousand)
1990	38	36; 33-40
1991	128	103; 90-119

The model successfully estimated the 1990 mortality rate within a 95% confidence interval. It provided a slight underestimation for the 1991 rate. This underestimation was expected, as 1991 was a period of rapid mortality increase due to war-related factors. It is assumed that the



regression model estimates mortality rates when the dependent variables are stable; it should provide an underestimate when those dependent variables are undergoing rapid change. Indeed, given this assumption, it is surprising how well the model approximated the known value for under five-year-old mortality.

## Implications of Mortality Estimates

It will not be possible to verify these under five-year-old mortality estimates until the 1997 national Iraqi census is analyzed in detail or other high quality mortality studies are done. Meanwhile it is important to identify the likely magnitude and mechanisms by which sanctions policies impact death rates in Iraq.

### Attributable Risk of Political, Economic, and Social Disruption in the 1990s

Attributable risk of under five-year-old deaths is derived by calculating the rate of excess mortality, and multiplying this by the population exposed to that risk and the period of time of the exposure, divided by five (for an annual, rather than cumulative five year estimate). The population of children under five years of age in Iraq is reliably calculated by the Gulf Child Health Survey in 1989 as about 2.639 million. Lacking current information about fertility in recent years prevents us from accurately determining the under five population in subsequent years. It is predicted, roughly, by a six percent increase per year since 1989. These projections are presented below.

\*First quarter only

The projections in table 12 are based on the following assumptions:

1. That under five-year-old mortality in Iraq in 1990 was 40 per thousand.
2. That under five-year-old mortality would have remained stable at the 1990 rate. It is more likely that the mortality rate would have fallen by at least another 20% more in the 1990s if sanctions and the Gulf war had not occurred, accounting for an additional 16,000 deaths.
3. That the mortality increase during sanctions prior to the Gulf war was negligible. If the increase in the rate of mortality during four months of sanctions prior to the Gulf war is included, an additional 900 deaths are estimated.
4. That by 1996 under five-year-old mortality had risen to at least 55 per thousand, the lower bound of the 95% confidence interval. If the point estimate of 57 (from table 9) deaths per



**Table 12: Calculations of Excess (Attributable) Mortality Among Under Five-Year-Olds (Conservative Model)**

Year	Baseline Death Rate/1000 Under Five-Year-Olds	Period Death Rate/1000 Under Five-Year-Olds	Excess Deaths/1000 Under Five-Year-Olds	Percent Rate Increase	Under Five-Year-Olds (in Thousands)	Est. Excess Deaths
1990	40	40	0	0	2,756	0
1991	40	47.5	7.5	19	2,756	4,134
1992	40	54	14	35	2,756	7,717
1993	40	60.5	20.5	51	2,756	11,300
1994	40	67	27	68	2,756	14,882
1995	40	73.5	33.5	84	2,756	18,465
1996	40	80	40	100	2,756	22,048
1997	40	80	40	100	2,756	22,048
1998*	40	80	40	100	2,756	5,512
<b>TOTAL</b>						<b>106,106</b>

\*First quarter only

The projections in table 12 are based on the following assumptions:

1. That under five-year-old mortality in Iraq in 1990 was 40 per thousand.
2. That under five-year-old mortality would have remained stable at the 1990 rate. It is more likely that the mortality rate would have fallen by at least another 20% more in the 1990s if sanctions and the Gulf war had not occurred, accounting for an additional 16,000 deaths.
3. That the mortality increase during sanctions prior to the Gulf war was negligible. If the increase in the rate of mortality during four months of sanctions prior to the Gulf war is included, an additional 900 deaths are estimated.
4. That by 1996 under five-year-old mortality had risen to at least 80 per thousand, the lower bound of the 95% confidence interval. If the point-estimate of 87 (from table 9) deaths per



thousand rather than the lower estimate of the 95% confidence interval had been used, about 10,000 additional deaths would have been calculated.

5. That the mortality increase occurred in a straight-line trend from 1991 through 1996. Indeed, evidence was presented to suggest that excess mortality likely rose faster, at least by 1995, through an embargo-related rise and the effect of postwar fighting and destruction. Lacking data to plot a trend other than a straight-line increase, however, we will use this assumption, which will tend to minimize the total estimated number of excess deaths. Weighting the increase in deaths higher in the earlier years would account for 10,000 to 15,000 additional deaths.

6. That mortality, having risen to 80 in 1996, remained at that level through March 1998. Nutritional survey data through March 1998 suggest that a decline had not yet begun. It is probable that improved access to food, medicines, and other humanitarian inputs resulted in a reduction in the level of excess mortality later in the year, especially and earliest in the northern governorates. Lacking quantitative indicators of improvements since March 1998, we are unable to estimate the magnitude of subsequent mortality decline.

7. That a decline in family formation, divorce, and the birth rate has occurred. While no conclusive evidence of such a decline or its magnitude exists, it is likely that this is true. If the birth rate had risen as it did during the 1980s, there would have been 50% more under five-year-olds in Iraq in 1997 than there were in 1990. Calculations using this rising birth rate would account for an additional 33,000 deaths.

Following these assumptions, an estimate of more than 100,000 excess deaths occurred among under five-year-old Iraqis from August 1990 to March 1998. During January 1996 through March 1998, this represented an average of about 1800 excess deaths among under five-year-olds per month, or about 60 per day. This conservative estimate is 40% of the number of 4500 excess deaths claimed by the Iraqi Ministry of Health in 1996. If these conservative assumptions are replaced by the main estimates for values of the variables included above, the total number of estimated excess deaths thru March 1998 more than doubles to 227,000 (See table 13).

#### Comparisons with Iraqi Reports of Excess Deaths

Many of the claims of million-plus deaths due to sanctions are based on the Ministry of Health information provided since 1995 on the number of deaths in hospitals due to selected causes. Among the causes cited are pneumonia, diarrhoea, infectious diseases, cholera, gastroenteritis, and malaria, and are claimed to be caused by sanctions. Among those over five years of age, all deaths due to cardiac diseases, hypertension, diabetes mellitus, renal diseases, liver diseases, and cancers are claimed to be caused by sanctions. These data are presented in table 14.

There are serious methodologic problems with these data. First, not all the deaths from these causes are related to sanctions. Indeed, cancer, heart diseases were the most common causes