Comparing the cancer in Ninawa during three periods (1980-1990, 1991-2000, 2001-2010) using Poisson regression

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Background: Iraq fought three wars in three consecutive decades, Iran-Iraq war (1980-1988), Persian Gulf War in 1991, and the Iraq's war in 2003. In the nineties of the last century and up to the present time, there have been anecdotal reports of increase in cancer in Ninawa as in all provinces of Iraq, possibly as a result of exposure to depleted uranium used by American troops in the last two wars. This paper deals with cancer incidence in Ninawa, the most importance province in Iraq, where many of her sons were soldiers in the Iraqi army, and they have participated in the wars. **Materials and Methods:** The data was derived from the Directorate of Health in Ninawa. The data was divided into three sub periods: 1980-1990, 1991-2000, and 2001-2010. The analyses are performed using Poisson regressions. The response variable is the cancer incidence number. Cancer cases, age, sex, and years were considered as the explanatory variables. The logarithm of the population of Ninawa is used as an offset. The aim of this paper is to model the cancer incidence data and estimate the cancer incidence rate ratio (IRR) to illustrate the changes that have occurred of incidence cancer in Ninawa in these three periods. **Results:** There is evidence of a reduction in the cancer IRR in Ninawa in the third period as well as in the second period. Our analyses found that breast cancer remained the first common cancer; while the lung, trachea, and bronchus the second in spite of decreasing as dramatically. Modest increases in incidence of prostate, penis, and other male genitals for the duration of the study period and stability in incidence of colon in the second and third periods. Modest increases in incidence of placenta and metastatic tumors, while the highest increase was in leukemia in the third period relates to the second period but not to the first period. The cancer IRR in men was decreased from more than 33% than those of females in the first period, more than 39% in the second period, and regressed to 9.56% in the third period. **Conclusion:** Our paper confirms the media reports that there are increases in the number of cancer cases, but when it analyzed statistically with population growth in the Ninawa province, there are decreases in incidence rates in most cancer types.

Key words: Cancer, incidence rate ratio, Ninawa, Poisson regression

INTRODUCTION

Ninawa is a second biggest province in Iraq after Baghdad (Capital of Iraq), it is located in the north of Iraq. It has an area of 37,323 square kilometers and an estimated population of 3,270,422 people in 2011 according to the Central Organization for Statistics (the population data were estimated based on the results of the 1997 census).[1] Ninawa bordering Syria and Turkey, the provincial capital is Mosul.

In Ninawa there are three specialized cancer treatment center, which are the Mosul Oncology and Nuclear Medicine Hospital for the treatment of patients with cancer, Specialist Center for Breast Diseases, and Ibn Al-Atheer Hospital for Leukemia. Cancer is one of the serious diseases in Ninawa that leads to the death in many cases. Figure 1 displays the cancer incidence and death by cancer

(the data of cancer deaths is not available between 1980 and 1992). The figure reflects the fact that, in most cases, the patients with cancer in Ninawa are dying, this because most of the cancer cases are detected at an advanced stage, treatment, and care are seriously deficient.[2] Figure 2 displays the incidence rate (the number of incidences divided by the (100,000) population per year) for all cancer sites combined between 1980 and 2010. Incidence rates of all cancers combined have overall increased in Ninawa since 1985. The highest incidence rates were in the 1993, where rates steadily increased from 23.8707 in 1980 to 44.9808 in the 1993, incidence rates have leveled off since then, decreasing to 40.1746 in 1999 and increasing during 2000-2004 to 43.4496 except 2002, oscillatory rate during 2005-2010. The incidence rate in 2010 was 35.5373.

Breast cancer, the most common cancer in Ninawa with 3,563 cases from 1980 to 2010 accounted for 15.3% of

all cancers diagnosed in Ninawa [Figure 3]. Lung, trachea, and bronchus is the second most common cancer (13.6%), non-Hodgkin lymphoma (NHL) cancer is the third (6%), larynx is the fourth (5.9%), and the fifth most common cancer is the leukemia (5.3%). The account of these five cancers is 46.1% of all cancers diagnosed in Ninawa from 1980 to 2010.

Lung, trachea and bronchus accounts for more than one in five (22.6%) cases diagnosed in male [Figure 4]. Other common cancers for males is larynx, NHL, leukemia, urinary bladder, and brain and other nervous system (9.1, 6.7, 5.7, 5.7, and 5.1%); these six cancer site diseases account for 54.9% of cases diagnosed in males from 44 cancer sites. About a third (32.6%) of cases diagnosed in females is breast cancer [Figure 5], NHL, leukemia, skin, and brain and other

nervous system. Metastatic tumors account for 5.1, 4.8, 4.8, 4.5, 4.2% of cases, respectively; these six cancer site diseases account for 56% of cases diagnosed in females.

Cancer is more common among older people, and relatively rare in children, the incidence rates increasing with age for most cancers. Form Figure 6 we observe 15.2% of cancer cases diagnosed in people aged 70 and over; for the people aged 60-64, 50-54, 55-59, 65-69, 45-49, 40-44, 35-39, 30-34, and 0-4 years, the accounts are 13.1, 11.8, 9.3, 9.2, 8.4, 7.0, 5.3, 3.9, and 3.2%, respectively. Which stands out in this figure is the category 0-4 which precede the aged 5-9, 10-14, 15-19, 20-24, and 25-29 which accounts for 3.1, 2.8, 2.6,
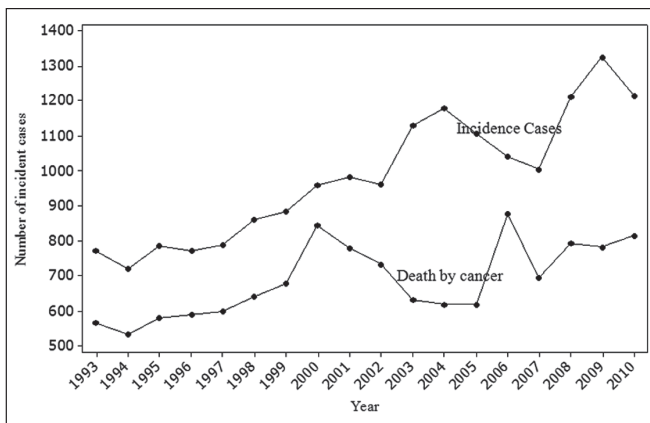

Figure 1: Deaths for all cancers vs incidence cases, Ninawa/Iraq 1993-2010
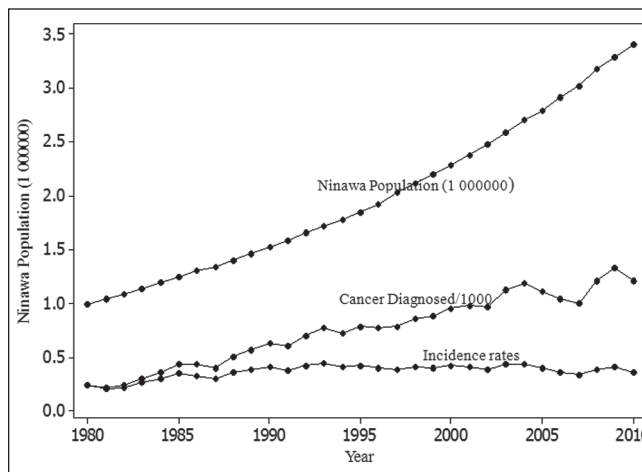

Figure 2: Ninawa population, cancers diagnosed for all cancers and incidence rates, Ninawa/Iraq, 1980-2010
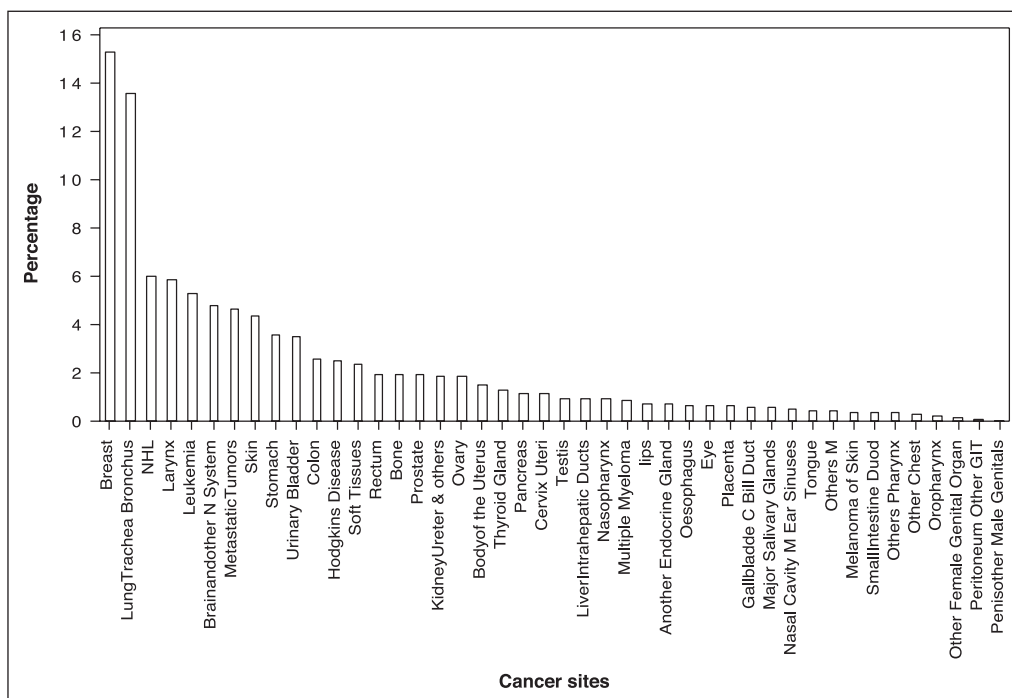

Figure 3: Percentage distribution for all cancer types, males and females combined, Ninawa/Iraq 1980-2010

Figure 4: Percentage distribution for all cancer types, males, Ninawa/Iraq 1980-2010

Figure 5: Percentage distribution for all cancer types, females, Ninawa/Iraq 1980-2010

2,6, and 2.2%. This requires in depth study of the causes of incidence in this age.

There have been media reports of increase in cancer in Ninawa as in all provinces of Iraq and have been blamed for some time on mutagenic and carcinogenic agents (like depleted uranium) employed in the wars of 1991 and 2003.[3] Increase in childhood leukemia in Basrah have recently been investigated and the findings confirm that there has indeed been a significant increase since 1991,[4] in Fallujah also

have recently been investigated and confirm the reported increase in cancer and infant mortality which are alarmingly high.[3] To investigate the media reports of increase in cancer in Ninawa, the most importance provinces in Iraq, where many of her sons were soldiers in the Iraqi army, and they have participated in the three wars, as it were, the last bastions of resistance after the fall of Saddam Hussein. The data was divided into three sub periods: The first between 1980 and 1990 [Figure 7] which includes the period of the Iran-Iraq war (1980-1988), the second between

1991 and 2000 [Figure 8] which include the Persian Gulf War, and followed by economic sanctions on Iraq, the last from 2001-2010 which [Figure 9] include the Iraq war and followed by a 7-year occupation and a complete destruction of the infrastructure. In the last two wars, the depleted uranium munitions have been used in Iraq.[4,5]

For the most common cancer, we observed a substantially decrease in lung, trachea, and bronchus. The rates decreased from 17.5% in 1980-1990 to 15.5% in 1991-2000 and to 10.8% in 2001-2010. Similarly, larynx and skin also decreased from 9.6 and 6.9% in 1980-1990 to 6.6 and 4.7% in 1990-2000 and to 3.9 and 3.1% in 2001-2010, respectively. In contrast, an increase in breast, brain and other nervous system, and metastatic tumors during the same time period from 12.6, 4.0, and 3.1% in 1980-1990 to 13.1, 4.4, and 3.8% in 1991-

2000 and to 17.9, 5.4, and 5.8% in 2001-2010, respectively. Urinary bladder and leukemia incidence rates has leveled off, decreased from 4.3 and 3.9% in 1980-1990 to 2.9 and 3.4% in 1990-2000 and increased to 3.6 and 7.1% in 2001-2010, respectively. In contrast, NHL increased from 4.9% in 1980-1990 to 7.5% in 1991-2000 and decreased to 5.3% in 2010.

MATERIALS AND METHODS

Data were derived from the Directorate of Health in Ninawa-Mosul Continuing Medical Education Center who published the results of Mosul Cancer Registry annually.[6] The data were collected from all hospitals in Ninawa Province and contained all cancer cases by site, age, and sex that registered in Mosul. Population data were derived from the Central Organization for Statistics, Ministry of Planning.[1] The data analyzed for each sub period 1980-1990, 1991-2000, and 2001-2010 using the Poisson regression with a log link function. The mean, μ_i, of the number of incidence cases in Ninawa, which is a count variable and considered as response variable related to the factors year, cancer site, age, and sex (which considered as the explanatory variables) for observation i by:

$$\log(\mu_i) = \log(pop_i) + \alpha + year_i(j)\beta_j + cancersite_i(k)\gamma k + age_i(l)\delta_l + sex_i(n)\theta_n. \qquad (1)$$

The indicator variables $year_i$ (j), cancer $site_i$ (k), age_i (l), and sex_i (n) are associated with the (j,k,l,n) levels of the variables year, cancer site, age, and sex for observation i. The α, βs, γs, δs, and θs are regression coefficients that represent the expected change in the log of the mean per unit change in the
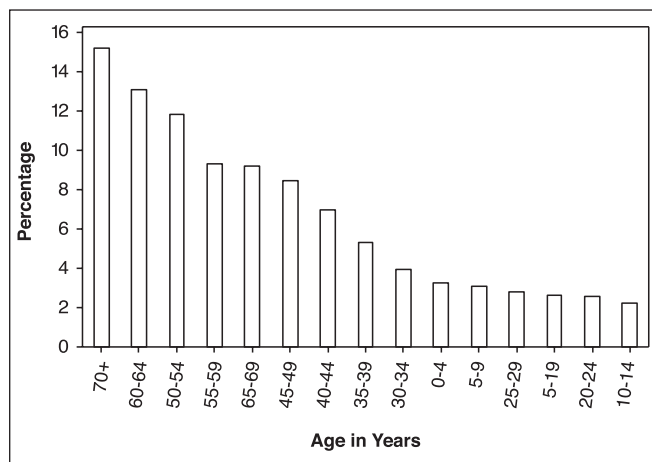
Figure 6: Cancers diagnosed by age, Ninawa/Iraq, 1980-2010
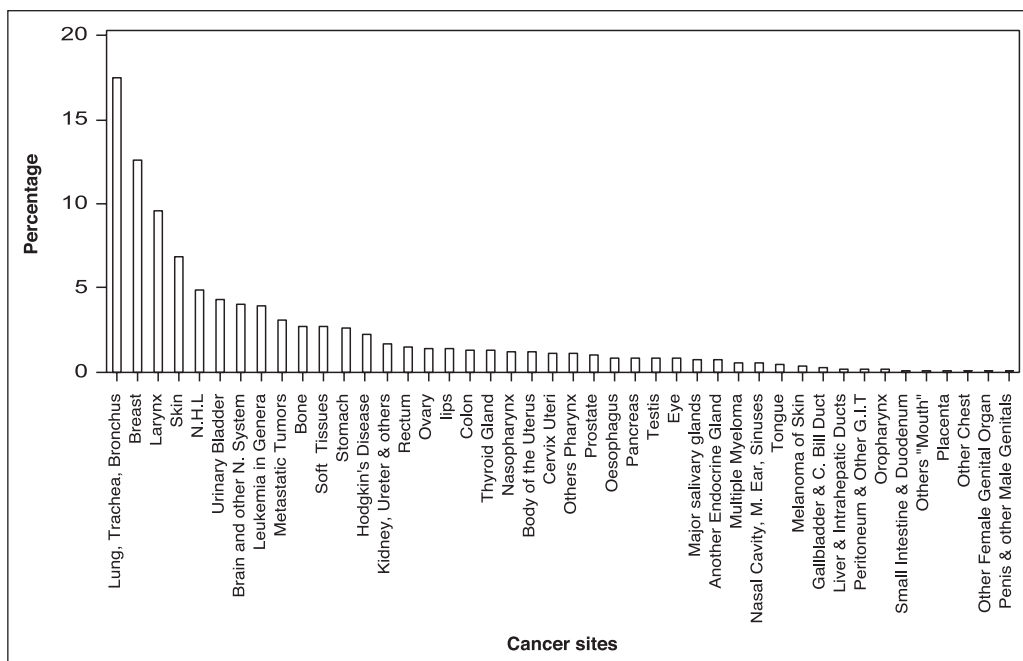
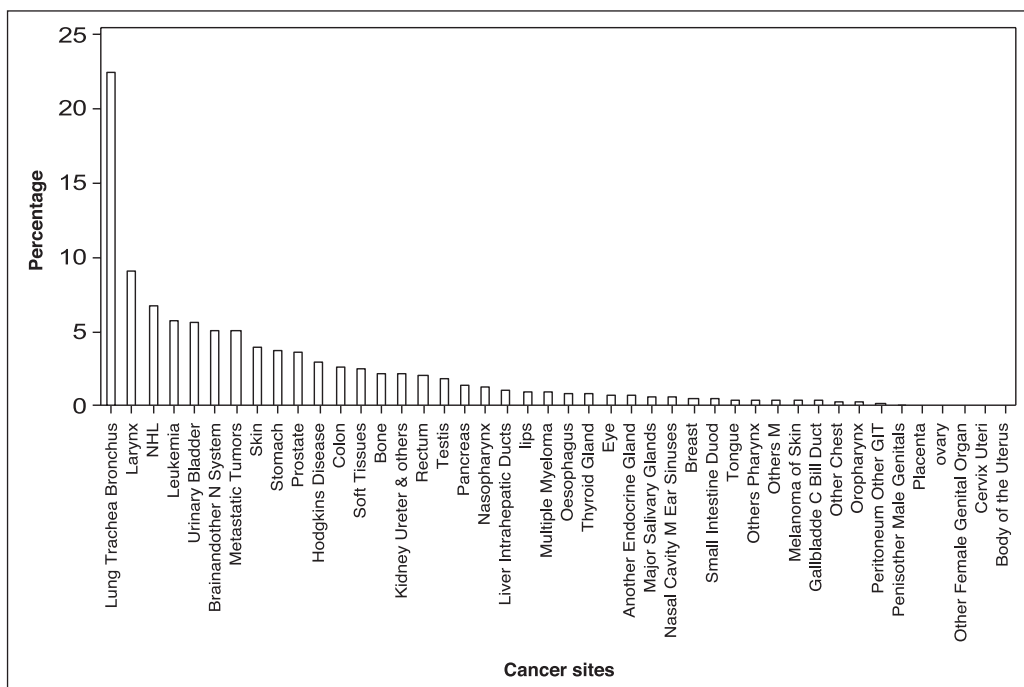**Figure 7:** Percentage distribution for all cancer sites, males and females combined, Ninawa/Iraq 1980-1990

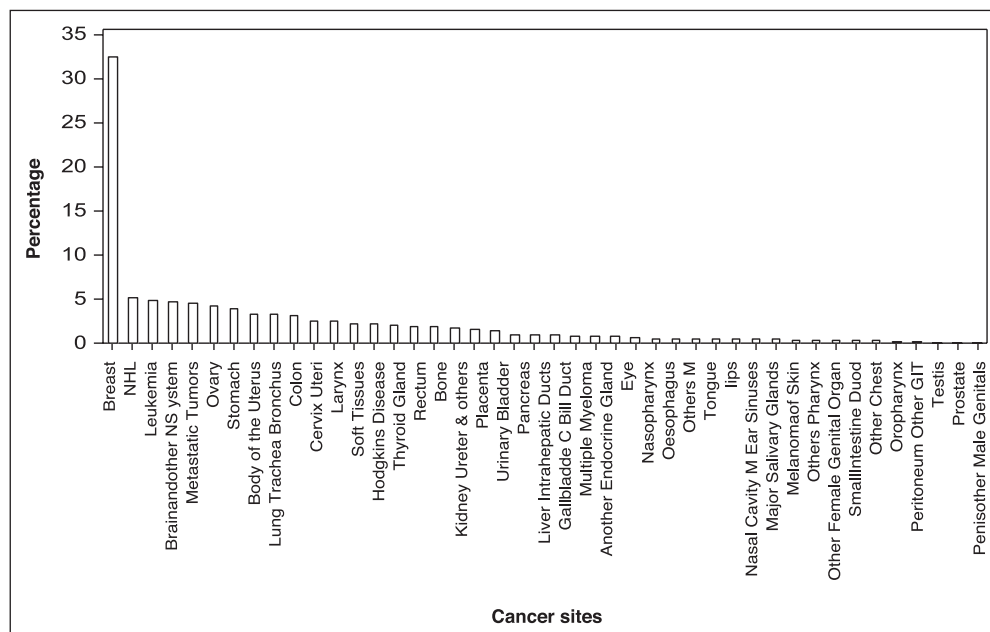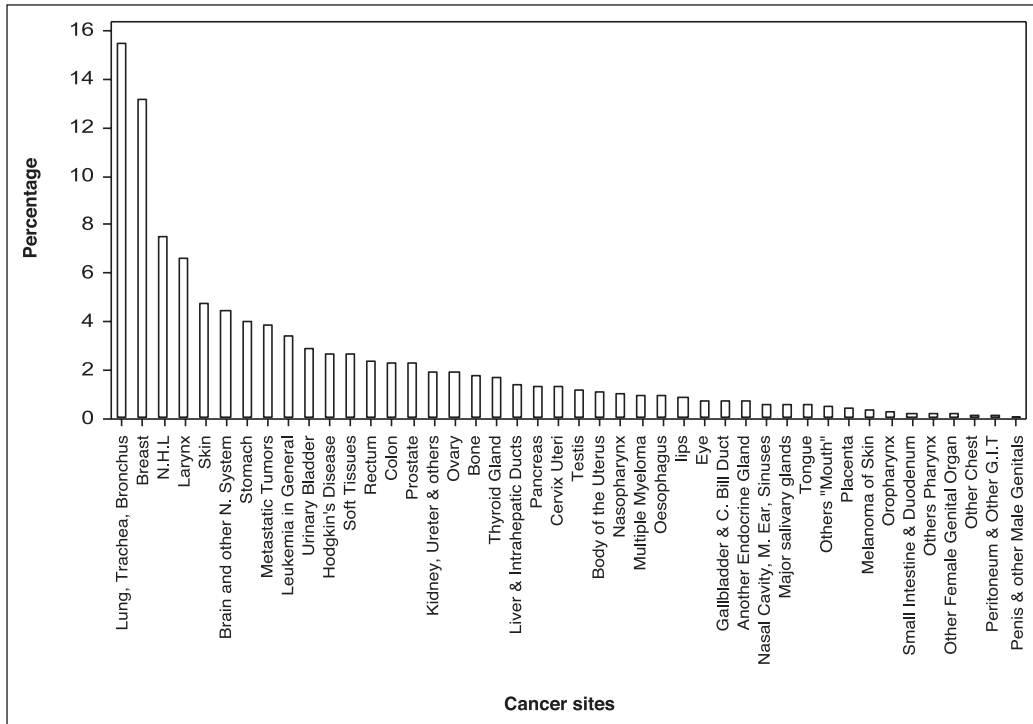**Figure 8:** Percentage distribution for all cancer sites, males and females combined, Ninawa/Iraq 1991-2000
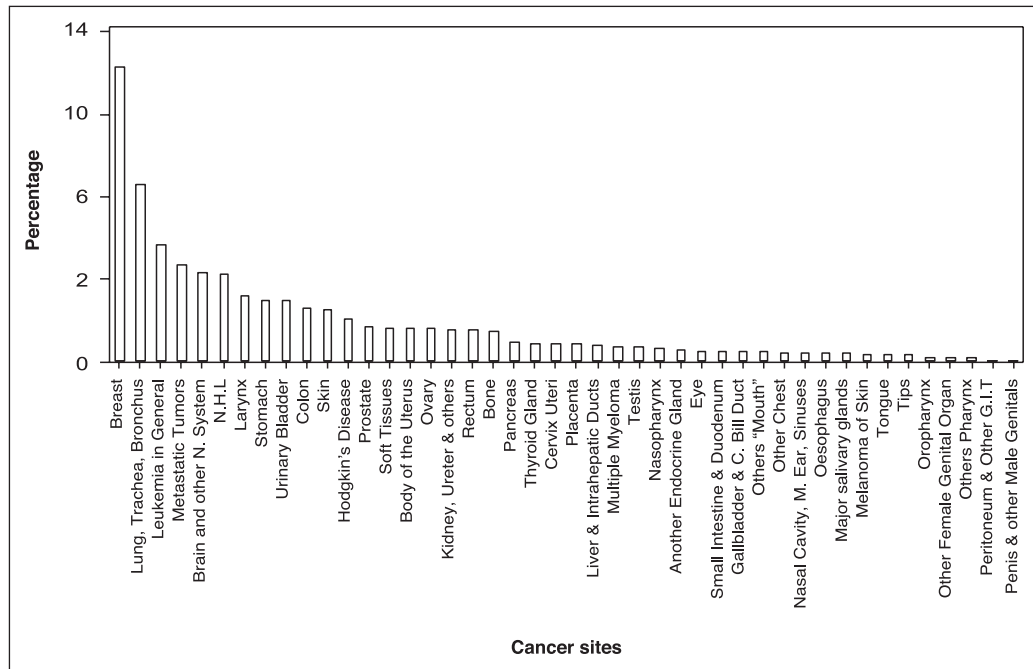
Figure 9: Percentage distribution for all cancer sites, males and females combined, Ninawa/Iraq 2001-2010

explanatory variables, the logarithm of the variable (pop) which is a known quantity, used as an offset. A log linear relationship between the mean and the factors year, cancer site, age, and sex were specified by the log link function.

The factors as follows:
Year (j) group is a categorical predictor with 11 levels for the period 1980-1990, 10 levels for the period 1991-2000, and 10 levels for the period 2001-2010.

cancersite (k) group is a categorical predictor with 44 levels: The diagnostic groups were coded based on the International Classification of Diseases (ICD 9th revision) [Table 1].

Table 1: The ninth revision of the International Classification of Diseases which coded the cancer site (ICD 9th). Analysis of maximum likelihood parameter estimates, incidence rate ratio, and 95% confidence intervals (CIs) for the period (1980-1990)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-square	Probability> Chi-square	Incidence rate ratio	95% CI
	Intercept		1	−1.0233	0.0863	140.67	<0.0001	0.3594	0.3035-0.4256
140	Cancer	Lips	1	−1.6670	0.1399	141.94	<0.0001	0.1888	0.1435-0.2484
141	Cancer	Tongue	1	−1.7233	0.2237	59.32	<0.0001	0.1785	0.1151-0.2767
142	Cancer	Major salivary glands	1	−1.7547	0.1784	96.79	<0.0001	0.1730	0.1219-0.2453
143-5	Cancer	Others "mouth"	1	−1.9686	0.4125	22.77	<0.0001	0.1396	0.0622-0.3135
146	Cancer	Oropharynx	1	−1.8255	0.3827	22.76	<0.0001	0.1611	0.0761-0.3411
147	Cancer	Nasopharynx	1	−1.7062	0.1467	135.23	<0.0001	0.1816	0.1362-0.2420
148-9	Cancer	Others "pharynx"	1	−1.8067	0.1514	142.49	<0.0001	0.1642	0.1220-0.2209
150	Cancer	Esophagus	1	−1.7959	0.1704	111.02	<0.0001	0.1660	0.1188-0.2318
151	Cancer	Stomach	1	−1.4460	0.1060	185.92	<0.0001	0.2355	0.1913-0.2899
152	Cancer	Small intestine and duodenum	1	−1.9960	0.4124	23.43	<0.0001	0.1359	0.0605-0.3049
153	Cancer	Colon	1	−1.6835	0.1443	136.04	<0.0001	0.1857	0.1400-0.2464
154	Cancer	Rectum to anus	1	−1.7015	0.1338	161.73	<0.0001	0.1824	0.1403-0.2371
155	Cancer	Liver and intrahepatic ducts	1	−2.0155	0.3214	39.31	<0.0001	0.1333	0.0710-0.2502
156	Cancer	Gallbladder and common bile duct	1	−1.7640	0.2717	42.15	<0.0001	0.1714	0.1006-0.2919
157	Cancer	Pancreas	1	−1.6800	0.1703	97.30	<0.0001	0.1864	0.1335-0.2602
158-9	Cancer	Peritoneum and other GIT	1	−1.7258	0.3585	23.18	<0.0001	0.1780	0.0882-0.3595
160	Cancer	Nasal cavity, middle ear, sinuses	1	−1.7346	0.2029	73.06	<0.0001	0.1765	0.1186-0.2627
161	Cancer	Larynx	1	−0.6436	0.0695	85.84	<0.0001	0.5254	0.4585-0.6020
162	Cancer	Lung, trachea, bronchus	1	−0.0579	0.0619	0.87	0.3497	0.9438	0.8359-1.0655
163-5	Cancer	Other chest	1	−1.6943	0.7108	5.68	0.0171	0.1837	0.0456-0.7400
170	Cancer	Bone	1	−1.5069	0.1082	193.79	<0.0001	0.2216	0.1792-0.2740
171	Cancer	Connective tissues	1	−1.6265	0.1052	238.91	<0.0001	0.1966	0.1600-0.2417
172	Cancer	Melanoma of skin	1	−1.8895	0.2634	51.47	<0.0001	0.1511	0.0902-0.2533
173	Cancer	Skin	1	−0.9238	0.0747	153.01	<0.0001	0.3970	0.2132-0.2456
174-5	Cancer	Breast					Reference		
180	Cancer	Cervix uteri	1	−1.3186	0.1499	77.43	<0.0001	0.2675	0.1994-0.3588
181	Cancer	Placenta	1	−1.3222	0.5849	5.11	0.0238	0.2665	0.0847-0.8388
182	Cancer	Body of the uterus	1	−1.3305	0.1456	83.48	<0.0001	0.2644	0.1987-0.3517
183	Cancer	Ovary	1	−1.3302	0.1369	94.39	<0.0001	0.2644	0.2022-0.3458
184	Cancer	Other female genital organ	1	−1.8054	0.7102	6.46	0.0110	0.1644	0.0409-0.6614
185	Cancer	Prostate	1	−1.4693	0.1582	86.25	<0.0001	0.2301	0.1687-0.3137
186	Cancer	Testis	1	−1.6933	0.1747	93.95	<0.0001	0.1839	0.1306-0.2590
187	Cancer	Penis and other male genitals	1				No incidence cases		
188	Cancer	Urinary bladder	1	−1.1515	0.0893	166.14	<0.0001	0.3162	0.2654-0.3767
189	Cancer	Kidney, ureter, and others	1	−1.6219	0.1281	160.20	<0.0001	0.1975	0.1537-0.2539
190	Cancer	Eye	1	−1.8354	0.1761	108.63	<0.0001	0.1596	0.1130-0.2253
191-2	Cancer	Brain and other nervous system	1	−1.4363	0.0940	233.48	<0.0001	0.2378	0.1978–0.2859
193	Cancer	Thyroid gland	1	−1.5620	0.1428	119.63	<0.0001	0.2097	0.1585-0.2775
194	Cancer	Another endocrine gland	1	−1.7563	0.1875	87.77	<0.0001	0.1727	0.1196-0.2494
195-8	Cancer	Metastatic tumors	1	−1.3951	0.0989	199.07	<0.0001	0.2478	0.2041-0.3008
200	Cancer	NHL	1	−1.3694	0.0865	250.86	<0.0001	0.2543	0.2146-0.3012
201	Cancer	Hodgkin's disease	1	−1.5599	0.1147	184.95	<0.0001	0.2102	0.1679-0.2631
202	Cancer	Other lymph neoplasm					No incidence cases		
203	Cancer	Multiple myeloma	1	−1.8229	0.2023	81.18	<0.0001	0.1616	0.1087-0.2402

Table 1: (Continued)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-square	Probability> Chi-square	Incidence rate ratio	95% CI
204-8	Cancer	Leukemia in general	1	−1.2160	0.1007	145.70	<0.0001	0.2964	0.2433-0.3611
	Sex	0					Reference		
	Sex	1	1	0.2897	0.0361	64.40	<0.0001	1.3360	1.2447-1.4339
	Age	0	1	−2.1052	0.1009	435.67	<0.0001	0.1218	0.1000-0.1485
	Age	5	1	−1.9644	0.1031	362.84	<0.0001	0.1402	0.1146-0.1716
	Age	10	1	−2.0058	0.1148	305.44	<0.0001	0.1346	0.1074-0.1685
	Age	15	1	−1.9770	0.1105	320.07	<0.0001	0.1385	0.1115-0.1720
	Age	20	1	−1.7705	0.1080	268.80	<0.0001	0.1702	0.1378-0.2104
	Age	25	1	−2.0167	0.1145	310.23	<0.0001	0.1331	0.1063-0.1666
	Age	30	1	−1.3553	0.0942	207.04	<0.0001	0.2579	0.2144-0.3101
	Age	35	1	−1.1537	0.0801	207.62	<0.0001	0.3155	0.2697-0.3691
	Age	40	1	−0.8406	0.0714	138.73	<0.0001	0.4315	0.3751-0.4962
	Age	45	1	−0.6630	0.0672	97.41	<0.0001	0.5153	0.4517-0.5878
	Age	50	1	−0.2385	0.0596	16.04	<0.0001	0.7878	0.7010-0.8853
	Age	55	1	−0.1829	0.0619	8.74	0.0031	0.8328	0.7377-0.9402
	Age	60	1	0.0047	0.0588	0.01	0.9359	1.0047	0.8953-1.1276
	Age	65	1	−0.0385	0.0687	0.31	0.5754	0.9622	0.8410-1.1010
	Age	70 and over					Reference		

DF = Degrees of freedom, S = Standard error, GIT = Gastrointestinal tract, NHL = Non-Hodgkin lymphoma

age (*l*) group is a categorical predictor with 15 levels: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39,40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and 70 and over were coded as 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, and 70, respectively.

sex (n) is a categorical predictor group with two levels: 0 = female and 1 = male.

The incidence rate ratio (IRR) with its 95% confidence intervals was calculated. The IRR corresponds to the exponential of the coefficients that estimated, IRR = exp (estimate of the parameters).

The data were analyzed with Statistical Analysis Software (SAS) 9.2 by Genmod procedure[7] to fit the Poisson regression analysis and the IRR. The references values are female breast cancer, the age 70 years and over, and year is 1980.

RESULTS

Tables 1, 2, and 3 displays the analysis of parameter estimates and the IRR for the periods 1980-1990, 1991-2000, and 2001-2010, respectively, excluding the year variable which is not significant. The tables contains the Ninth Revision of the International Classification of Diseases which coded the cancer sites (ICD 9th), the parameter and the levels for each parameter, the analysis of maximum

likelihood parameter estimates, which summarizes the results of the iterative parameter estimation process, contains the degrees of freedom (DF), the estimated parameter value, the standard error (SE) of the parameter estimate and the Wald chi-square statistic and associated *P*-value for testing the significance of the parameter to the model as well as the IRR with its 95% confidence intervals (95% CIs).

The ICD 9th, analysis of maximum likelihood parameter estimates, IRR, and 95% CIs for the period 1980-1990 are shown in Table 1. There have been statistically significant with a significance level of 0.01 in rate ratio for all cancer sites (except lung, trachea, and bronchus), males as a level of the factor sex and for all ages (except ages 60 and 65 years) in comparison with the reference values.

From Table 1 and Figure 10, the estimated coefficient of the levels for the cancer sites parameter is comparing to breast cancer, given the other variables are held constant. The difference in the logs of expected counts of the response variable is expected to be less for the all levels of the cancer sites compared to breast cancer, while holding the other variables constant. Breast on top of the list, lung cancer is the second most frequently diagnosed cancer, and larynx is the third; skin, urinary bladder, leukemia, cervix uteri, placenta, and body of the uterus and ovary are the 10 most commonly diagnosed cancers during the period from 1980 to 1990. For the age parameter, the estimated coefficient

Table 2: The ninth revision of the International Classification of Diseases which coded the cancer site (ICD 9th). Analysis of maximum likelihood parameter estimates, incidence rate ratio, and 95% confidence intervals (ICs) for the period (1991-2000)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-Square	Probability > chi-square	Incidence rate ratio	95% CI
	Intercept		1	−0.7926	0.0761	108.61	<0.0001	0.4527	0.39-0.5254
140	Cancer	Lips	1	−2.0791	0.1252	275.88	<0.0001	0.1250	0.0978-0.1598
141	Cancer	Tongue	1	−2.2499	0.1636	189.11	<0.0001	0.1054	0.0765-0.1453
142	Cancer	Major salivary glands	1	−2.2183	0.1601	191.93	<0.0001	0.1088	0.0795-0.1489
143-5	Cancer	Others "mouth"	1	−2.2018	0.1773	154.26	<0.0001	0.1106	0.0781-0.1566
146	Cancer	Oropharynx	1	−2.1887	0.2265	93.34	<0.0001	0.1121	0.0719-0.1747
147	Cancer	Nasopharynx	1	−2.1919	0.1171	350.22	<0.0001	0.1117	0.0888-0.1405
148-9	Cancer	Others "pharynx"	1	−1.9887	0.2529	61.84	<0.0001	0.1369	0.0834-0.2247
150	Cancer	Esophagus	1	−2.1754	0.1236	309.90	<0.0001	0.1136	0.0891-0.1447
151	Cancer	Stomach	1	−1.5547	0.0657	559.83	<0.0001	0.2112	0.1857-0.2403
152	Cancer	Small intestine and duodenum	1	−2.2713	0.2607	75.93	<0.0001	0.1032	0.0619-0.1720
153	Cancer	colon	1	−1.8773	0.0816	529.05	<0.0001	0.1530	0.1304-0.1795
154	Cancer	Rectum to anus	1	−1.8760	0.0815	529.99	<0.0001	0.1532	0.1306-0.1797
155	Cancer	Liver and intrahepatic ducts	1	−2.0801	0.1026	411.22	<0.0001	0.1249	0.1022-0.1527
156	Cancer	Gallbladder and common bile duct	1	−2.1012	0.1412	221.56	<0.0001	0.1223	0.0927-0.1613
157	Cancer	Pancreas	1	−2.0475	0.1057	375.06	<0.0001	0.1291	0.1049-0.1588
158-9	Cancer	Peritoneum and other GIT	1	−2.1077	0.4101	26.42	<0.0001	0.1215	0.0544-0.2715
160	Cancer	Nasal cavity, middle ear, sinuses	1	−2.1120	0.1529	190.88	<0.0001	0.1210	0.0897-0.1633
161	Cancer	Larynx	1	−0.9026	0.0547	272.63	<0.0001	0.4055	0.3643-0.4514
162	Cancer	Lung, trachea, bronchus	1	−0.2430	0.0436	31.09	<0.0001	0.7843	0.7201-0.8542
163-5	Cancer	Other chest	1	−2.1489	0.4105	27.41	<0.0001	0.1166	0.0522-0.2607
170	Cancer	Bone	1	−1.9639	0.0918	458.03	<0.0001	0.1403	0.1172-0.1680
171	Cancer	Connective tissues	1	−1.9180	0.0777	608.62	<0.0001	0.1469	0.1261-0.1711
172	Cancer	Melanoma of skin	1	−2.3702	0.2116	125.45	<0.0001	0.0935	0.0617-0.1415
173	Cancer	Skin	1	−1.2788	0.0596	460.55	<0.0001	0.2784	0.2477-0.3129
174-5	Cancer	Breast				reference			
180	Cancer	Cervix uteri	1	−1.5417	0.1054	213.83	<0.0001	0.2140	0.1741-0.2631
181	Cancer	Placenta	1	−1.6816	0.1862	81.60	<0.0001	0.1861	0.1292-0.2680
182	Cancer	Body of the uterus	1	−1.6453	0.1143	207.25	<0.0001	0.1930	0.1542-0.2414
183	Cancer	Ovary	1	−1.4176	0.0875	262.58	<0.0001	0.2423	0.2041-0.2876
184	Cancer	Other female genital organ	1	−1.9765	0.3181	38.61	<0.0001	0.1386	0.0743-0.2584
185	Cancer	Prostate	1	−1.2489	0.0845	218.68	<0.0001	0.2868	0.2431-0.3385
186	Cancer	Testis	1	−1.8336	0.1139	258.99	<0.0001	0.1598	0.1279-0.1998
187	Cancer	Penis and other male genitals	1	−2.6841	0.7087	14.34	0.0002	0.0683	0.0170-0.2739
188	Cancer	Urinary bladder	1	−1.3881	0.0737	355.03	<0.0001	0.2495	0.2160-0.2883
189	Cancer	Kidney, ureter, and others	1	−1.9330	0.0889	472.31	<0.0001	0.1447	0.1216-0.1723
190	Cancer	Eye	1	−2.1081	0.1407	224.36	<0.0001	0.1215	0.0922-0.1600
191-2	Cancer	Brain and other nervous system	1	−1.6477	0.0647	648.16	<0.0001	0.1925	0.1696-0.2185
193	Cancer	Thyroid gland	1	−1.8916	0.0929	414.69	<0.0001	0.1508	0.1257-0.1810
194	Cancer	Another endocrine gland	1	−2.0887	0.1405	220.91	<0.0001	0.1238	0.0940-0.1631
195-8	Cancer	Metastatic tumors	1	−1.4469	0.0659	481.95	<0.0001	0.2353	0.2068-0.2677
200	Cancer	NHL	1	−1.4049	0.0541	675.18	<0.0001	0.2454	0.2207-0.2728
201	Cancer	Hodgkin's disease	1	−1.8830	0.0782	579.25	<0.0001	0.1521	0.1305-0.1773
202	Cancer	Other lymph neoplasm				No incidence cases			
203	Cancer	Multiple myeloma	1	−2.1680	0.1261	295.72	<0.0001	0.1144	0.0894-0.1465
204-8	Cancer	Leukemia in general	1	−1.7541	0.0712	607.46	<0.0001	0.1731	0.1505-0.1990

Table 2: (Continued)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-Square	Probability > chi-square	Incidence rate ratio	95% CI
	Sex	0					Reference		
	Sex	1	1	0.3324	0.0253	172.99	<0.0001	1.3943	1.3269-1.4651
	Age	0	1	−2.1907	0.0766	817.48	<0.0001	0.1118	0.0962-0.1300
	Age	5	1	−1.9974	0.0772	668.87	<0.0001	0.1357	0.1166-0.1579
	Age	10	1	−2.2177	0.0830	714.76	<0.0001	0.1089	0.0925-0.1281
	Age	15	1	−2.0171	0.0810	620.00	<0.0001	0.1330	0.1135-0.1559
	Age	20	1	−1.9822	0.0787	634.69	<0.0001	0.1378	0.1181-0.1607
	Age	25	1	−1.9184	0.0695	762.66	<0.0001	0.1468	0.1282-0.1683
	Age	30	1	−1.3723	0.0657	436.00	<0.0001	0.2535	0.2229-0.2884
	Age	35	1	−1.1788	0.0587	403.93	<0.0001	0.3076	0.2742-0.3451
	Age	40	1	−0.9600	0.0521	339.37	<0.0001	0.3829	0.3457-0.4241
	Age	45	1	−0.6710	0.0472	201.81	<0.0001	0.5112	0.4660-0.5608
	Age	50	1	−0.3540	0.0439	65.06	<0.0001	0.7019	0.6441-0.7650
	Age	55	1	−0.3437	0.0475	52.30	<0.0001	0.7091	0.6460-0.7784
	Age	60	1	0.0261	0.0413	0.40	0.5275	1.0264	0.9467-1.1129
	Age	65	1	−0.0516	0.0463	1.24	0.2651	0.9497	0.8674-1.0399
	Age	70 and over					Reference		

DF = Degrees of freedom, SE = standard error, GIT = gastrointestinal tract, NHL = non-Hodgkin lymphoma
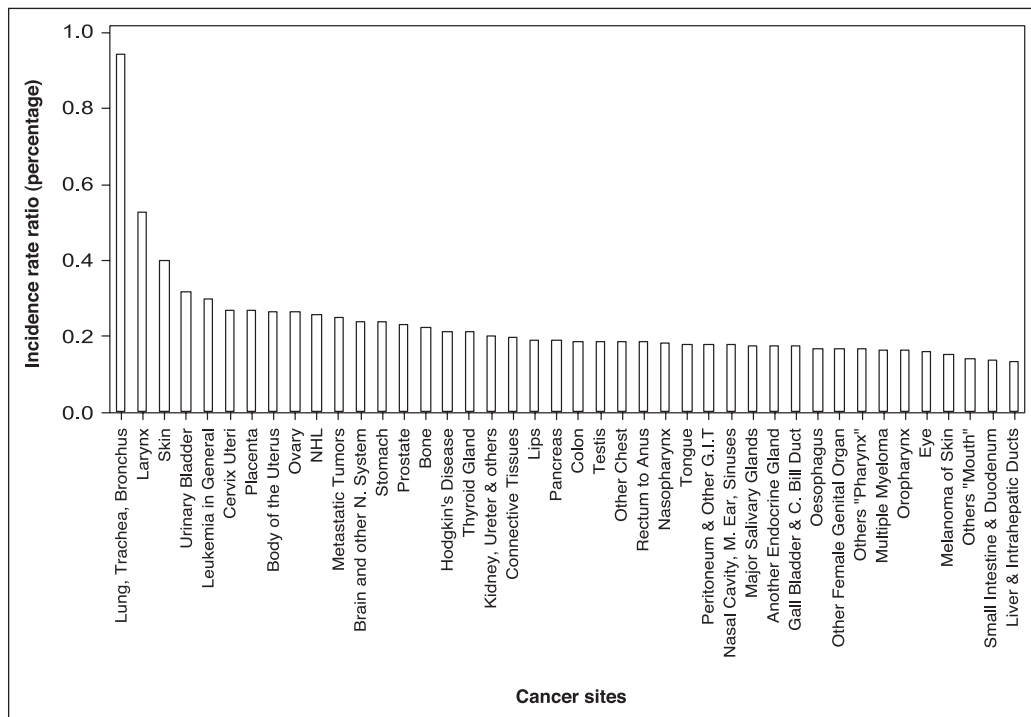

Figure 10: Distribution for all cancer sites (reference cancer site=Female breast), males and females combined according to incidence rate ratio, Ninawa/Iraq 1980-1990

of levels for the age parameter is comparing to age 70 and over, given the other variables is held constant. The difference in the logs of expected counts of the response variable is expected to be 0.0047 unit higher for the age 60 compared to age 70 and over, while the ages 65, 55, 50, 45, 40, 35, 30, 20, 5, 15, 10, 25, and 0 (sorted by decreasing) less than 70 and over, holding the other variables constant. For the males, the estimated coefficient comparing males to

females, given the other variables are held constant. The difference in the logs of expected counts of the response variable is expected to be 0.2897 units higher for males compared to females, while holding the other variables constant.

From Table 2 and Figure 11, the estimated coefficient of the levels for the cancer sites parameter is comparing to breast

Table 3: The ninth revision of the International Classification of Diseases which coded the cancer site (ICD 9th). Analysis of maximum likelihood parameter estimates, incidence rate ratio and 95% confidence intervals (CIs) for the period (2001-2010)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-square	Probability > chi-square	Incidence rate ratio	95% CI
	Intercept		1	−0.2992	0.0715	17.51	<0.0001	0.7414	0.6444-0.8529
140	Cancer	Lips	1	−2.5528	0.1546	272.52	<0.0001	0.0779	0.0575-0.1054
141	Cancer	Tongue	1	−2.7495	0.1601	295.04	<0.0001	0.0640	0.0467-0.0875
142	Cancer	Major salivary glands	1	−2.4568	0.1408	304.33	<0.0001	0.0857	0.0650-0.1130
143-5	Cancer	Others "mouth"	1	−2.6268	0.1326	392.20	<0.0001	0.0723	0.0558-0.0938
146	Cancer	Oropharynx	1	−2.7259	0.2103	168.05	<0.0001	0.0655	0.0434-0.0989
147	Cancer	Nasopharynx	1	−2.5053	0.1125	495.60	<0.0001	0.0816	0.0655-0.1018
148-9	Cancer	Others "pharynx"	1	−2.5172	0.2252	124.99	<0.0001	0.0807	0.0519-0.1254
150	Cancer	Esophagus	1	−2.6797	0.1382	375.72	<0.0001	0.0686	0.0523-0.0899
151	Cancer	Stomach	1	−1.7929	0.0546	1076.50	<0.0001	0.1665	0.1496-0.1853
152	Cancer	Small intestine and duodenum	1	−2.5103	0.1299	373.45	<0.0001	0.0812	0.0630-0.1048
153	Cancer	Colon	1	−1.8774	0.0573	1074.21	<0.0001	0.1530	0.1367-0.1712
154	Cancer	Rectum to anus	1	−2.2485	0.0733	940.73	<0.0001	0.1056	0.0914-0.1219
155	Cancer	Liver and intrahepatic ducts	1	−2.3920	0.1015	554.84	<0.0001	0.0914	0.0749-0.1116
156	Cancer	Gallbladder and common bile duct	1	−2.5038	0.1302	370.02	<0.0001	0.0818	0.0634-0.1055
157	Cancer	Pancreas	1	−2.3684	0.0905	684.81	<0.0001	0.0936	0.0784-0.1118
158-9	Cancer	Peritoneum and other GIT	1	−2.8297	0.5010	31.90	<0.0001	0.0590	0.0221-0.1576
160	Cancer	Nasal cavity, middle ear, sinuses	1	−2.6888	0.1398	369.98	<0.0001	0.0680	0.0517-0.0894
161	Cancer	Larynx	1	−1.5856	0.0521	924.60	<0.0001	0.2048	0.1849-0.2269
162	Cancer	Lung, trachea, bronchus	1	−0.6602	0.0369	320.17	<0.0001	0.5168	0.4807-0.5555
163-5	Cancer	Other chest	1	−2.5923	0.1396	344.77	<0.0001	0.0748	0.0569-0.0984
170	Cancer	Bone	1	−2.3074	0.0751	944.29	<0.0001	0.0995	0.0859-0.1153
171	Cancer	Connective tissues	1	−2.2966	0.0704	1064.29	<0.0001	0.1006	0.0876-0.1155
172	Cancer	Melanoma of skin	1	−2.6412	0.1478	319.55	<0.0001	0.0713	0.0534-0.0952
173	Cancer	Skin	1	−1.8335	0.0569	1039.73	<0.0001	0.1598	0.1430-0.1787
174-5	Cancer	Breast					Reference		
180	Cancer	Cervix uteri	1	−2.0374	0.0942	467.70	<0.0001	0.1304	0.1084-0.1568
181	Cancer	Placenta	1	−1.6379	0.0985	276.47	<0.0001	0.1944	0.1603-0.2358
182	Cancer	Body of the uterus	1	−1.6791	0.0706	565.87	<0.0001	0.1865	0.1624-0.2142
183	Cancer	Ovary	1	−1.7726	0.0708	625.99	<0.0001	0.1699	0.1479-0.1952
184	Cancer	Other female genital organ	1	−2.3533	0.2514	87.61	<0.0001	0.0951	0.0581-0.1556
185	Cancer	Prostate	1	−1.2221	0.0719	289.19	<0.0001	0.2946	0.2559-0.3392
186	Cancer	Testis	1	−2.0951	0.1058	392.23	<0.0001	0.1231	0.1000-0.1514
187	Cancer	Penis and other male genitals	1	−2.5160	1.0013	6.31	0.0120	0.0808	0.0113-0.5750
188	Cancer	Urinary bladder	1	−1.5206	0.0545	778.59	<0.0001	0.2186	0.1964-0.2432
189	Cancer	Kidney, ureter, and others	1	−2.3074	0.0732	994.55	<0.0001	0.0995	0.0862-0.1149
190	Cancer	Eye	1	−2.5585	0.1236	428.54	<0.0001	0.0774	0.0608-0.0986
191-2	Cancer	Brain and other nervous system	1	−1.7717	0.0480	1363.25	<0.0001	0.1700	0.1548-0.1868
193	Cancer	Thyroid gland	1	−2.4464	0.0927	696.78	<0.0001	0.0866	0.0722-0.1039
194	Cancer	Another endocrine gland	1	−2.4068	0.1139	446.55	<0.0001	0.0901	0.0721-0.1126
195-8	Cancer	Metastatic tumors	1	−1.4057	0.0453	963.16	<0.0001	0.2452	0.2244-0.2679

Table 3: (continued)

ICD 9th	Parameter	Level	Analysis of maximum likelihood parameter estimates					Estimated rate ratios and 95% CIs	
			DF	Estimate	SE	Wald chi-square	Probability > chi-square	Incidence rate ratio	95% CI
200	Cancer	NHL	1	−1.8111	0.0478	1432.88	<0.0001	0.1635	0.1488-0.1795
201	Cancer	Hodgkin's disease	1	−2.0911	0.0651	1031.89	<0.0001	0.1236	0.1088-0.1404
202	Cancer	Other lymph neoplasm				no incidence cases			
203	Cancer	Multiple myeloma	1	−2.4024	0.1033	540.57	<0.0001	0.0905	0.0739-0.1108
204-8	Cancer	Leukemia in general	1	−1.5357	0.0438	1230.97	<0.0001	0.2153	0.1976-0.2346
	Sex	0				reference			
	Sex	1	1	0.0913	0.0205	19.92	<0.0001	1.0956	1.0525-1.1404
	Age	0	1	−2.2787	0.0588	1503.19	<0.0001	0.1024	0.0913-0.1149
	Age	5	1	−2.1384	0.0605	1248.73	<0.0001	0.1178	0.1047-0.1327
	Age	10	1	−2.2077	0.0703	986.40	<0.0001	0.1099	0.0958-0.1262
	Age	15	1	−2.0882	0.0609	1177.33	<0.0001	0.1239	0.1100-0.1396
	Age	20	1	−2.0941	0.0624	1126.25	<0.0001	0.1232	0.1090-0.1392
	Age	25	1	−2.1578	0.0623	1199.08	<0.0001	0.1156	0.1023-0.1306
	Age	30	1	−1.4429	0.0515	785.16	<0.0001	0.2362	0.2136-0.2613
	Age	35	1	−1.2605	0.0460	751.38	<0.0001	0.2835	0.2591-0.3102
	Age	40	1	−1.0091	0.0424	565.45	<0.0001	0.3645	0.3354-0.3962
	Age	45	1	−0.7962	0.0406	384.07	<0.0001	0.4510	0.4165-0.4884
	Age	50	1	−0.4241	0.0363	136.55	<0.0001	0.6544	0.6094-0.7026
	Age	55	1	−0.4617	0.0393	138.02	<0.0001	0.6302	0.5835-0.6807
	Age	60	1	−0.2291	0.0362	40.14	<0.0001	0.7953	0.7408-0.8537
	Age	65	1	−0.1127	0.0384	8.63	0.0033	0.8934	0.8287-0.9632
	Age	70 and over				Reference			

DF = Degrees of freedom, SE = standard error, GIT = gastrointestinal tract, NHL = non-Hodgkin lymphoma
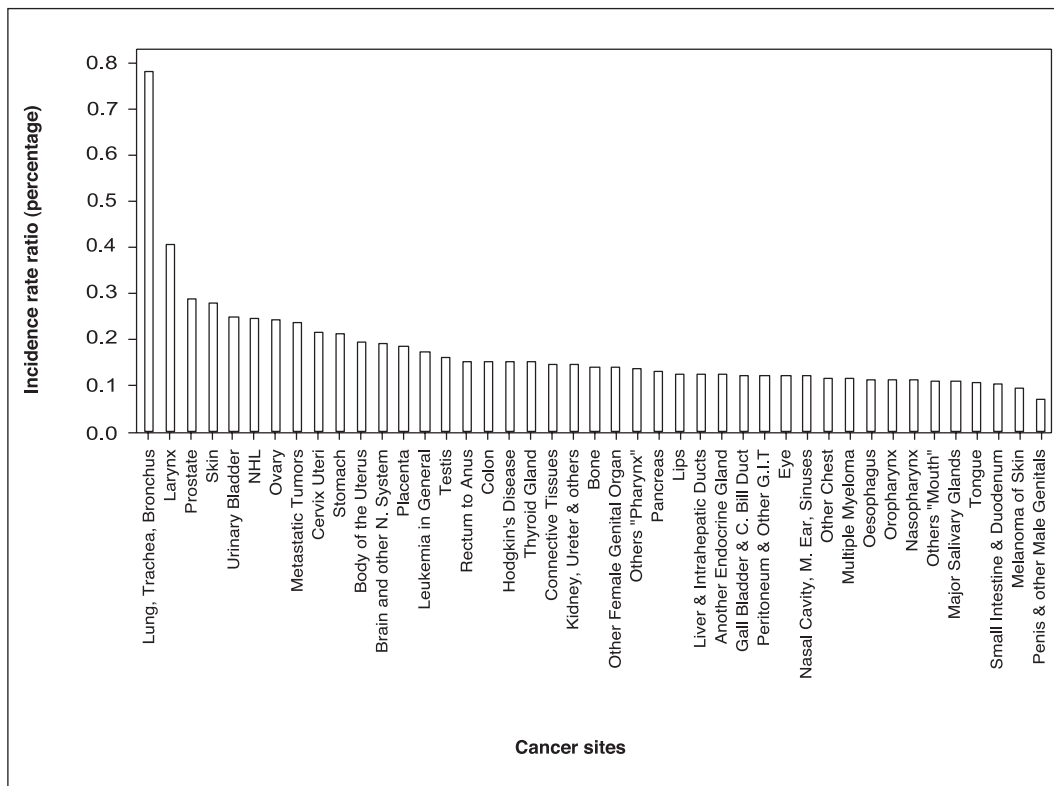

Figure 11: Distribution for all cancer sites (reference cancer site=Female breast), males and females combined according to incidence rate ratio, Ninawa/Iraq 1991-2000

cancer, given the other variables are held constant. The difference in the logs of expected counts of the response variable is expected to be less for the all levels of the cancer sites compared to breast cancer, while holding the other variables constant. Breast on top of the list, lung cancer is the second most frequently diagnosed cancer, and larynx is the third; prostate, skin, urinary bladder, NHL, ovary, metastatic tumors, and cervix uteri, these the 10 most commonly diagnosed cancers during the period from 1991 to 2000. For the age parameter, the estimated coefficient of levels for the age parameter is comparing to age 70 and over, given the other variables is held constant. The difference in the logs of expected counts of the response variable is expected to be 0264 unit higher for the age 60 compared to age 70 and over, while the ages 65, 55, 50, 45, 40, 35, 30, 25, 20, 5, 15, 0, and 10 (sorted by decreasing) less than 70 and over, holding the other variables constant. For the males, the estimated coefficient comparing males to females, given the other variables are held constant. The difference in the logs of expected counts of the response variable is expected to be 0.3324 units higher for males compared to females, while holding the other variables constant.

From Table 3 and Figure 12, the estimated coefficient of the levels for the cancer sites parameter is comparing to breast cancer, given the other variables are held constant. The difference in the logs of expected counts

of the response variable is expected to be less for the all levels of the cancer sites compared to breast cancer, while holding the other variables constant. Breast on top of the list, lung cancer is the second most frequently diagnosed cancer, and prostate is the third; metastatic tumors, urinary bladder, leukemia, larynx, placenta, body of uterus, and brain and other nervous system, these the 10 most commonly diagnosed cancers during the period from 2001 to 2010. For the age parameter, the estimated coefficient of levels for the age parameter is comparing to age 70 and over, given the other variables is held constant. The difference in the logs of expected counts of the response variable is expected to be less for the all ages compared to age 70 and over, while the ages 65, 60, 50, 55, 45, 40, 35, 30, 15, 20, 5, 25, 10, and 0 (sorted by decreasing) less than 70 and over, holding the other variables constant. For the males, the estimated coefficient comparing males to females, given the other variables are held constant. The difference in the logs of expected counts of the response variable is expected to be 0.0913 units higher for males compared to females, while holding the other variables constant.

DISCUSSION

From the analysis, we can observe that there is a significant decrease in most of the cancer IRR in Ninawa in the second and third period relates to the first period.
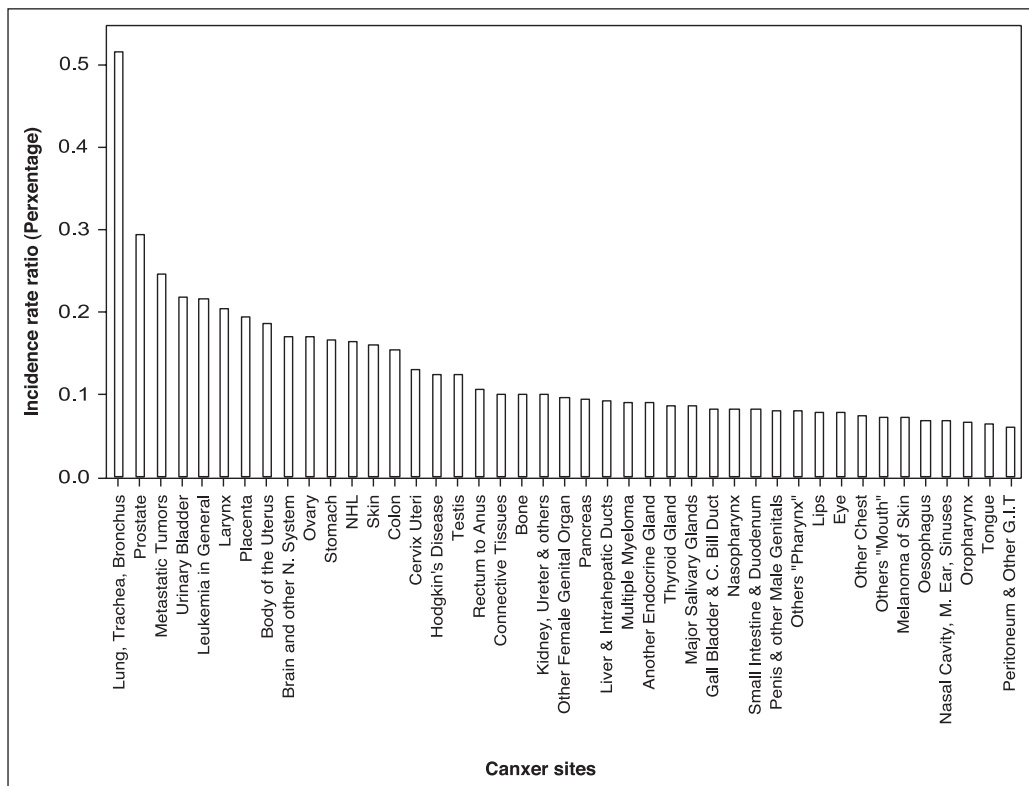

Figure 12: Distribution for all cancer sites (reference cancer site=Female breast), males and females combined according to Incidence rate ratio, Ninawa/Iraq 2001-2010

For the three periods, there was no significant difference in the years, indicating that the trend over time between the groups is the same for each of the three periods. The cancer IRR in men is decreased from more than 33% than those of females in the first period, and more than 39% in the second period, regressed to 9.56% in the third period, holding the other variables constant. Female breast cancer IRR is in the top list of the three periods, while the lung, trachea, and bronchus decrease from 5.75% less than breast in the first period to 21.5 and to 48.5% less than breast in the second and third period, respectively. A significant decrease of the cancer IRR for the age 60-64 in the third period, it is 20.5% less than age 70 and over, while it is in the first and second period 0.47 and 2.64% more than age 70 and over, respectively. The other age groups revealed modestly in decreasing, its few rate ratio in younger age groups, while its substance in the older age groups. Larynx decrease significantly from 47.5% less than breast in the first period to 59.5 and 79.5% less than breast in the second and third periods, respectively. Cervix uteri and body of the uterus and ovary, as the most commonly diagnosed cancers in females, approximately 73.5% less than breast in the first period, are decreased to 78.5, 80.5, and 76% respectively in the second period and to the 87, 81.5, and 83%, respectively in the third period. Placenta decreased from 73.5% less than breast in the first period to 81.5% in the second period, an increase in the third period to 80.5%, but it is less than it was in the first period. Stomach, colon, small intestine and duodenum, rectum to anus, liver and intrahepatic ducts, gallbladder, and common bile duct and pancreas decrease from 76.5, 81.5, 86.5, 82%, 87, 83, and 81.5%, respectively, less than breast in the first period to 79, 85, 90, 85%, 87.5, 88, and 87%, respectively, less than breast in the second period to 83.5, 85, 92, 89.5, 91, 92, and 91%, respectively, less than breast in the third period. Lips, tongue, major salivary glands, oropharynx, nasopharynx, esophagus, peritoneum and other gastrointestinal (GIT), nasal cavity, middle ear, sinuses, other chest, bone, melanoma of skin, eye, and multiple myeloma decrease in the third period by some 30% than in the second period and by some 50% than in the first period. Others "mouth", others "pharynx", skin, kidney, ureter and others, connective tissues, another endocrine gland, eye, and thyroid gland decrease in the second period by some 20% than in the first period, decreased in the third period by some 35% than in the second period and by some 50% than in the first period. Brain and other nervous system and NHL decrease in the third period by some 30% than in the first period, while Hodgkin's disease have decreased by some 40% than in the first period. Prostate and penis and other male genitals increase from 77 and 100% respectively, less than breast in the first period to 71.5 and 95%, respectively, in the second period to the 70.5 and 92%, respectively in the third period. Metastatic tumors remained relatively stable throughout the duration of the study period. Leukemia regressed 70.5% in the first period to 82.5% less than breast in the second period, then rose to 78.5% less than breast in the third period.

Overall, it is encouraging that there is evidence of a reduction in the cancer IRR in Ninawa in the third period as well as in the second period. Our analyses found that breast cancer remained the most common cancer, while the lung, trachea, and bronchus the second in spite of decreasing as dramatically. Modest increases in incidence of prostate, penis, and other male genitals for the duration of the study period, and stability in incidence of colon in the second and third periods, modest increases in incidence of placenta and metastatic tumors; while the highest increase is in leukemia in the third period relates to the second period, but not to the first period. The result of leukemia is consistent with those of Busby et al.,[3] who found high risk in all leukemia; Alrudainy et al.,[4] and Hagopian et al.,[8] found a high incidence in children in Basrah in compared with other countries. Leukemia is a concern and requires further epidemiological studies.

CONCLUSION

Our paper confirms the media reports that there is increase in the number of cancer cases, but when it analyzed statistically with the population growth in the Ninawa province, there were decrease in incidence rates of the most cancer types.

ACKNOWLEDGEMENT

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