Review

Cancer mortality in Benghazi, Libyan Arab Jamahiriya, 1991–96

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SUMMARY We present a descriptive study of 1221 cancer deaths among Libyans in Benghazi for the period 1991–96. The cancer mortality rates per 10^5 person-years at risk for males, females and both sexes were 39.8, 26.5 and 33.3 respectively. The age-standardized cancer death rate per 10^5 standard world population was 91.5, 60.0 and 76.5 respectively. The 10 most common cancer deaths by site (comprising 67.7% of the total), in descending order of frequency, were: trachea, bronchus and lung , blood (leukaemia), colon/rectum, other lymphatic and haemo-poietic tissue (lymphomas), stomach, breast, prostate, liver, bladder, and larynx. The results point to the necessity for conducting comprehensive prospective studies, initiating a cancer registry and establishing a national cancer control programme.

Introduction

Cancer is a major public health problem worldwide. It is the second most common cause of death in industrialized countries and the fourth most common in developing countries [*1–3*]. The term cancer is used generically for approximately 100 different diseases including malignant tumours of different sites. such as the breast, cervix, prostate, colon, rectum, lung and mouth, and for leukaemia, sarcoma of bone and soft tissue, Hodgkin disease and non-Hodgkin lymphoma [*4*].

Among Arab countries, during the years 1982–87, cancer deaths made up more than 10% of all deaths in Bahrain, Iraq and Kuwait (compared to the recently estimated global figure of 12%) [*2,5,6*]. In the Libyan Arab Jamahiriya, among adults (≥ 15 years) who died in hospital during 1994, cancer deaths were the second highest cause of death after cardiovascular disorders [*7,8*].

More than 80 (mostly industrialized) countries regularly report data to the World Health Organization (WHO) on cancer deaths, by age, sex and site [*9*]. Among Arab countries, Egypt and Kuwait currently report such information and Bahrain has done so since 1988 [*9*]. Although deaths in the Libyan Arab Jamahiriya have been registered in urban centres since 1949, data on causes of death have not been reflected in each subsequent *WHO world health statistics annual* [*9*]. However, a few case reports and case series from the country have been published on non-Hodgkin lymphoma, breast cancer and cervical cancer [*10–12*]. The first documented cancer incidence, reported for 1977 from Benghazi, was 65.7 per 10^5 population at risk [*13*]. The commonest cancers diagnosed during the period 1974–

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85 at the Radiotherapy Department, Tripoli were cancers of the bronchus and lung, breast, head and neck, and lymphoma [*14,15*].

The WHO-sponsored symposium on early detection and prevention of cancer held in Tripoli in 1998 revealed how incomplete, unrepresentative and selectively biased are cancer data reported from hospitals, oncology units and pathology departments throughout the country [*14–16*]. Despite the increasing magnitude of the problem, cancer is still not considered a priority in Libyan public health. One reason for this neglect has been the lack of population-based information on the epidemiology of cancer. Hence, the present study was conducted to investigate the magnitude, pattern and epidemiological characteristics of cancer deaths in Benghazi, to identify the categories of preventable cancer and to suggest further areas of research and intervention.

Methods

The Benghazi Municipality has the second largest population in the Libyan Arab Jamahiriya, having increased from 60 000 in 1954 to 278 150 in 1973, 590 793 in 1990 and an estimated 671 400 in 1996 [*17,18*]. The Municipality covers an area of approximately 17 000 km^2, with 90.6% of its population concentrated in urban areas. The adult population (≥ 15 years of age) has increased from 49% in 1954 to 60.3% in 1996 [*17–19*]. Benghazi City is broadly divided into three areas, Benghazi Central, Berka and Salawi, each of which has a different population density and the residents represent different socioeconomic levels. The Municipality is rapidly modernizing, with efficient transport and communication systems, and adequate facilities for education, health care, sports and recreation, and air and sea transportation.

The system of registering vital statistics, such as births and deaths, was introduced in Benghazi in 1949 [*14*], and has been obligatory in certain municipalities since 1970. Within the Benghazi Municipality, the International Form of Medical Certificate of Cause of Death has almost replaced the national certificate since its introduction in 1990. Data for the present study were obtained from official death certificates registered and filed at the Benghazi Municipality office. All certificates showing cancer as the cause of death were selected — 1221 certificates out of a total 13 965 deaths, from 3 667 900 person-years at risk. All deaths are required by law to have a certificate completed by a doctor. During the study period, more than 90% of deaths took place in hospital (where the diagnoses were considered fairly reliable). Cause of death in the study was based on the underlying cause of death, defined as the disease or injury which initiated the train of morbid events leading directly to death, or to the accident or violence which produced the fatal injury [*20*]. The ICD-9 Basic Tabulation List was used to code the underlying cause of cancer death and to classify each death into the various categories [*20*].

The overall cancer mortality rate (CMR) by site per 10^5 person-years at risk was calculated for males and females separately, and the overall for both was obtained by halving their sum for each category. The age-specific cancer mortality rate (ASCMR) per 10^5 person-years at risk was the average of male and female rates in each age group. Direct age-standardized cancer death rates (ASCDR) per 10^5 standard world population were calculated using the WHO world standard population [*21*].

Table 1 **Proportional cancer mortality ratio (PCMR) and cancer mortality rate (CMR) in Benghazi Municipality, Libyan Arab Jamahiriya, 1991–96**

Year	Estimated population (person-years) at risk	Total deaths	Cancer deaths	PCMR per 1000 deaths[a]	CMR per 10^5 person-years at risk[b]
1991	554 300	2488	227	91.2	40.9
1992	575 900	2439	160	65.6	27.8
1993	598 400	2328	211	90.6	35.3
1994	621 800	2073	162	78.1	26.1
1995	646 100	2291	229	99.9	35.4
1996	671 400	2346	232	98.9	34.5
1991–96	3 667 900	13965	1221	87.4	33.3
Total male	869 900	8239	744	90.3	39.8
Total female	798 000	5726	477	83.3	26.5

[a] *(Cancer deaths/total deaths) × 1000.*
[b] *(Cancer deaths/estimated population at risk) × 100 000.*

Results

The annual number of cancer deaths and all deaths during the period from 1991 to 1996 ranged between 160 and 232 (cancer deaths), and 2073 and 2488 (total deaths) (Table 1). Over the period of the study, there were 13 965 deaths, of which cancer was the underlying cause in 1221 (8.7%) cases — 744 (60.9%) males and 477 (39.1%) females. The proportional cancer mortality ratio (PCMR) per 1000 deaths was 90.3 for males and 83.3 for females. CMR was 39.8 for males, 26.5 for females and 33.3 for all.

ASCDR was 91.5 for males, 60.0 for females and 76.5 for both (Table 2). The overall ASCMR for the period 1991–96, ranged from 5.7 for ages 0–4 years to 641.1 for ages ≥ 65 years (Table 3). CMR was lower among females than males for all age groups and for certain cancer sites, and between 1.4 and 4 times higher in Berka and Salawi than in Benghazi Central (Table 4). Site frequency ranged from 16.5% for trachea, bronchus and lung (TBL) to 1.1% for cervix uteri (Table 5). Using the ICD-9 Basic Tabulation List, the overall CMR by site ranged from 5.5 for TBL to 0.4 each for oesophagus and cervix uteri. Among males, the frequency of individual site or tissue in descending order were TBL, blood (leukaemia), colon/rectum, prostate, other lymphatic and haemopoietic tissue (lymphomas), stomach, bladder, liver and oesophagus. For females, the most frequent sites (in descending order) were breast, blood (leukaemia), colon/rectum, other lymphatic and haemopoietic tissue, stomach, liver, TBL, cervix uteri and lip, oral cavity and pharynx (Table 6).

Discussion

Overall cancer mortality

Cancer was the cause of 8.7% of all deaths in Benghazi Municipality during the 6 year period 1991–96. This compares to 2.0% in 1970–73 and 3.9% in 1980–83 [22].

Table 2 **Age-standardized cancer death rate (ASCDR) (based on World Health Organization standard world population) in Benghazi Municipality, Libyan Arab Jamahiriya compared to rates elsewhere**[a]

Country	Year	ASCDR per 10^5 population at risk		
		Both sexes	Male	Female
Africa				
Mauritius	1995	68.8	78.4	62.7
Seychelles	1985–87	52.5	78.5	25.4
South-East Asia				
Sri Lanka	1986	39.7	41.3	38.0
Thailand	1994	62.3	79.0	47.6
Eastern Mediterranean				
Bahrain	1988	78.3	93.5	63.9
Egypt	1991	29.1	36.0	23.1
Kuwait	1994	64.1	63.9	69.3
Libyan Arab Jamahiriya (Benghazi)	1991–96	76.5	91.5	60.0
Western Pacific				
Japan	1994	106.2	149.0	74.1
New Zealand	1993	142.2	170.3	122.3
Americas				
Belize	1995	63.9	72.1	58.1
United States of America	1994	130.0	160.6	109.9
Europe				
Albania	1993	59.9	85.7	37.5
Czech Republic	1995	170.2	229.7	127.9
Denmark	1995	156.3	178.7	142.5
Hungary	1995	191.5	266.4	139.1
Slovakia	1995	153.0	221.7	102.6
Tajikistan	1992	72.4	89.1	89.9

[a] *Source: [9].*
Countries are grouped according to WHO Region.

Among countries reporting cancer mortality statistics to WHO, the proportion of cancer deaths varied from 3.3% in Egypt to 28.4% in Japan [*9*]. During 1997, cancer deaths were estimated to form 8.9% of all deaths in developing countries, 21.6% in industrialized countries and 12.0% globally [*3*]. Among three Arab countries, Bahrain, Kuwait and Iraq, this proportion had reached around 10% [*6*]. In the present study, the PCMR of 8.7 per 1000 deaths was higher than that for Egypt, Guyana, Tajikistan, Turkmenistan and the Philippines, and was almost equal to that of Mauritius, Kyrgyzstan, Azerbaijan, Thailand, Belize and Nicaragua [*9*]. The PCMR in the present study was in fact, much lower than that for industrialized countries and similar to that for developing countries. However, cancer deaths as a percentage of all deaths in the Libyan Arab Jamahiriya (Benghazi) were four times that of 1970–73 and 1.7

Table 3 **Age-specific cancer mortality rate (ASCMR) per 10^5 person-years in Benghazi Municipality, Libyan Arab Jamahiriya and in other selected countries[a]**

Age group (years)	Sex	ASCMR per 10^5 person-years						
		Libyan Arab Jamahiriya (1991–96)	Egypt (1991)	Mauritius (1995)	Mexico (1995)	Japan (1994)	United States of America (1994)	Hungary (1995)
0–4	M	6.6	4.9	6.6	5.4	3.4	3.1	4.0
	F	4.8	3.7	2.9	4.3	3.0	2.7	6.6
	T	5.7	4.3	4.6	4.9	3.2	2.9	5.2
5–14	M	6.3	4.2	4.0	4.7	3.3	3.1	6.4
	F	4.2	3.2	4.2	4.1	2.4	2.4	5.0
	T	5.2	3.7	4.1	4.4	2.9	2.8	5.7
15–44	M	15.6	11.6	13.2	12.5	16.5	18.7	45.9
	F	10.5	11.2	17.3	17.5	17.9	21.1	37.5
	T	13.2	11.4	15.2	15.1	17.2	19.9	41.7
45–64	M	151.4	94.0	138.5	120.3	271.9	289.6	609.8
	F	103.0	59.2	158.5	158.9	147.1	234.4	322.3
	T	127.9	76.2	148.9	140.2	208.6	261.0	458.9
65+	M	798.5	169.0	650.0	754.7	1346.1	1463.6	1932.9
	F	490.6	84.9	425.7	554.0	642.5	909.3	991.6
	T	641.1	123.0	598.4	644.2	930.6	1134.5	1332.5
All	M	39.8	23.6	60.3	50.8	241.4	220.7	378.5
	F	26.5	17.3	63.0	54.9	153.0	190.5	270.2
	T	33.3	20.5	61.6	652.9	196.4	205.2	332.0
ASCDR/10^5 person-years	M	91.5	–	78.4	85.4	149.0	160.6	266.4
	F	60.0	–	62.5	78.9	74.1	109.9	139.1
	T	76.5	–	68.8	81.2	106.2	130.9	191.5

[a]*Source: [9].*
M = male. *F = female.* *T = total.*

times that of 1980–83 [*22*]. Similarly, the overall CMR has increased from 13.7 in 1970–73 and 19.6 in 1980–83 to 33.3 during 1991–96 [*22*]. The worldwide average CMR in 1997 was estimated to be 107.5, three times higher than the Libyan rate [*3*]. The increase in cancer mortality in the Libyan Arab Jamahiriya over this period may be due to the lack of improvement in survival rates for many of the major cancers over the past 3 decades or an actual increase in cancer incidence, or both.

The ASCDR of 76.5 found in our study (91.5 for males and 60.0 for females) compares with the *World health statistics annual* ASCDRs published during the period 1990–98, which ranged from a low of 29.1 for Egypt to a high of 191.5 for Hungary [*9*]. The ASCDR in the Libyan Arab Jamahiriya was higher than the rates documented for the WHO regions of Africa, South-East Asia and the Eastern Mediterranean (except for Bahrain). It was also higher than that of Albania and Tajikistan in

Table 4 **Cancer mortality rate (CMR) by cancer site and area, Benghazi Municipality, Libyan Arab Jamahiriya, 1991–96**

Cancer site	CMR per 10^5 person-years at risk		
	Benghazi Central	Berka	Salawi
Lung	2.2	7.1	7.5
Leukaemia and lymphoma	1.7	5.6	6.9
Colon and rectum	2.5	4.4	2.5
Breast	0.8	3.1	3.4
Stomach	0.7	2.9	2.3
Liver	0.6	1.0	2.0
Mouth and pharynx	0.2	0.3	3.1
Cervix	0.2	0.4	0.4

Europe, and Belize and Suriname in the Americas. For the period 1990–95, of 66 countries whose ASCDRs were published by WHO, 15 (22.6%) had rates below 100, 47 (71.25%) had rates between 100 and 149 and 4 (6.0%) had rates between 150 and 199 [*9*]. Among males, the ASCDR was even higher (202.1–266.4) among 8 European countries, including Poland, the Russian Federation and Hungary [*9*].

Age-specific mortality

The ASCMR for all age groups in our study was higher than that of Egypt and lower than that of Hungary (except for the 0–4 years age group) and others. The ASCMR for females 15–64 years was higher in Mauritius and Mexico than in the Libyan Arab Jamahiriya, while in the United States of America (USA) and Japan, it was higher only for females 15–44 years of age [*9*]. The ASCMR in the Libyan Arab Jamahiriya in the age group < 15 years was higher than that for Mauritius, Mexico, Japan and the USA [*9*]. The ASCMR in the present study for age groups ≥ 15 years has increased dramatically compared with previous data. This is consistent with what has been observed worldwide. However, while Libyan ASCMRs were similar to those of developing countries such as Mauritius and Mexico, they were much lower than those of industrialized countries, or countries in transition such as Hungary [*9*]. The ASCMRs by sex in our study were similar for the age group 0–14 years and lower for the ≥ 15 years group than those estimated by WHO for North Africa [*4*]. Cancer mortality in the Libyan Arab Jamahiriya has thus shown the dual phenomenon of higher mortality for age groups < 15 years and lower mortality for age groups ≥ 15 years when compared to most other countries in the world [*9*]. Epidemiological and laboratory studies are therefore required to investigate this phenomenon, as well as to identify the risk factors to prevent rising cancer incidence, especially among children, and to control cancer mortality among adults.

Mortality by sex

The percentage of cancer deaths among males and females respectively was 60.9% and 39.1%; the PCMR was 90.3 and 83.3 (per 1000 deaths); overall the CMR was 39.8 and 26.5; and the ASCDR was 91.5 and 60.0. Higher cancer morbidity and mortality rates have previously been reported among Libyan males [*13–16*]. Worldwide, men present more frequently than women with cancers of non-sexual sites, except for those of the thyroid, gall bladder and extrahepatic bile duct [*2–6*]. The reasons for this are not well understood. Women may either be constitutionally less susceptible to these neoplasms, or may be less exposed to whatever environmental factors are contributing to their development.

Table 5 **Cancer deaths by site in Benghazi Municipality, Libyan Arab Jamahiriya and in other selected countries**[a]

ICD–9 Code [20]	Death due to malignant neoplasms of:	Libyan Arab Jamahiriya (1991–96) No.	%	Egypt (1991) %	Kuwait (1993–94) %	Mauritius (1994–95) %	South Africa (1993) %	Malta (1994) %	Hungary (1995) %
140–149	Lip, oral cavity and pharynx	21	1.7	1.1	3.4	4.0	3.2	1.3	4.2
150	Oesophagus	15	1.2	1.7	2.7	3.8	10.7	2.3	2.1
151	Stomach	81	6.6	3.8	5.7	11.3	5.8	6.1	7.9
153/154	Colon and rectum	119	9.7	3.3	7.5	6.5	6.1	13.2	13.9
155	Liver as primary	38	3.1	11.6	–	–	–	0.4	3.2
161	Larynx	20	1.6	2.0	1.3	2.3	1.7	1.0	2.0
162	Trachea, bronchus and lung	202	16.5	8.2	13.9	13.1	17.5	16.5	22.9
174	Female breast	57	4.7	8.2	9.2	7.8	6.7	14.5	6.8
180	Cervix uteri	14	1.1	0.3	2.2	4.0	6.6	0.1	1.7
179/182	Uterus, other and part unspecified	35	2.9	2.2	0.7	6.1	1.1	1.7	1.6
185	Prostate	57	4.7	1.3	2.0	4.0	4.9	4.8	4.2
188	Bladder	34	2.8	16.0	3.8	1.8	1.7	5.6	2.3
204–208	Leukaemia	121	9.9	8.8	8.1	3.7	2.8	3.2	2.9
200–203	Other lymphatic and haemopoietic tissue	83	6.8	3.8	6.8	2.8	3.7	4.8	2.8
	Other sites	324	26.5	28.1	32.7	28.1	27.2	24.5	21.4
	Total cancer deaths	1 221		11 776	739	1 334	20 533	691	32 941

[a]*Source: [9].*

Table 6 **Cancer mortality rate (CMR) per 10^5 person-years at risk by sex and site in Benghazi Municipality, Libyan Arab Jamahiriya and in other selected countries**[a]

ICD-9 Code [20]	Death due to malignant neoplasm of:	Sex	Libyan Arab Jamahiriya (1991–96)		Egypt (1991)	Mauritius (1994–95)	USA (1994)	Hungary (1995)	Japan (1994)
			No.	CMR	CMR	CMR	CMR	CMR	CMR
140–149	Lip, oral cavity	M	13	0.7	0.3	3.1	4.1	25.0	4.0
	and pharynx	F	6	0.4	0.2	0.8	2.0	3.7	1.4
150	Oesophagus	M	15	0.8	0.4	2.6	6.4	12.2	11.1
		F	–	–	0.2	2.4	2.0	8.0	2.2
151	Stomach	M	51	2.7	0.9	7.5	6.3	30.4	50.2
		F	30	1.7	0.7	6.4	4.2	20.7	27.2
153/154	Colon and	M	72	3.9	0.8	5.2	22.2	48.0	26.1
	rectum	F	47	2.6	0.6	2.8	21.6	42.2	21.0
155	Liver as primary	M	19	1.1	2.9	–	2.6	11.8	25.0
		F	19	1.0	1.8	0.1	1.0	8.7	8.1
161	Larynx	M	14	0.7	0.6	1.5	2.5	12.0	1.4
		F	6	0.3	0.2	0.9	0.6	0.9	0.1
162	Trachea, bronchus	M	183	9.8	2.4	11.9	72.3	117.0	52.1
	and lung	F	19	1.1	0.9	4.2	43.2	34.2	18.6
174	Female breast	M	–	–	–	–	–	–	–
		F	57	3.2	3.4	9.6	32.7	92.0	11.3
180	Cervix uteri	M	–	–	–	–	–	–	–
		F	14	0.8	0.1	5.0	3.5	10.2	3.0
179/182	Uterus, other and	M	–	–	–	–	–	–	–
	part unspecified	F	35	1.9	0.9	7.5	4.6	9.7	4.2
185	Prostate	M	57	3.0	0.5	4.9	27.5	28.2	7.8
		F	–	–	–	–	–	–	–
188	Bladder	M	28	1.5	5.2	1.3	5.9	11.4	4.0
		F	6	0.3	1.3	0.9	2.8	3.6	1.8
204–208	Leukaemia	M	72	3.9	2.0	3.0	8.5	10.5	5.5
		F	49	2.7	1.6	1.5	8.6	8.5	4.1
200–203	Other lymphatic	M	58	3.1	0.9	1.8	13.6	9.9	7.8
	and haemopoietic tissue	F	30	1.7	0.6	1.7	12.1	8.5	6.0
–	Other sites	M	164	8.8	7.4	18.8	51.5	64.5	52.9
		F	157	8.7	5.4	18.8	56.7	79.0	48.9
	Total cancer	M	744	39.8	23.6	60.3	220.7	378.5	241.8
	deaths	F	477	26.5	17.3	63.0	190.5	270.2	153.1

[a] *Source: [9].*
M = male. *F = female.*

Interestingly, the ASCDR was higher for females than males in developing countries such as Ecuador, Guatemala, Mexico, Suriname and Kuwait [*9*]. While the predisposing factors for this have not yet been documented, it may be due to the high rate of reproductive organ cancers generally reported by these countries (cervical cancer was the most common cause of cancer deaths for most of the above-mentioned countries) [*9*]. The higher cancer mortality among Libyan males in the present study is consistent both with previous results from the country and from other countries, except for some in Latin America. Gender differences in cancer mortality are not expected to change in the near future in the Libyan Arab Jamahiriya, mostly due to the almost total absence of active tobacco consumption by females.

Mortality by area

The CMRs in Berka and Salawi were more than 2.5 times higher than Benghazi Central. Rates varied between 2 and 4 times higher for cancers of the lung, stomach, breast, lymphatic and haemopoietic tissue and cervix.

The frequency of occurrence of many cancers has been reported to vary among social groups living in the same city or country, and among racial groups living in different geographical areas [*23*]. Studies on migrants have shown clearly that such differences are largely due to variations in environmental factors and not to any genetic predisposition or susceptibility to carcinogens [*23–25*]. Mortality for all cancers in both sexes has been reported to be significantly higher among lower socioeconomic and high-density populations [*25*]. This may partly be due to environmental exposure, fewer and less-informed choices for healthy lifestyles, greater stress, and delays on the part of such populations (due to lack of information or resources) in seeking medical attention [*23–25*].

Berka's and Salawi's inhabitants are of comparatively lower socioeconomic status than Benghazi Central and their population densities generally higher. Differences in diet, tobacco use and occupational exposure (including exposure to the sun) are the most likely underlying factors, something which could not be investigated in our study. Variations in health care use between areas may also be contributing to some of the difference. Cohort and correlational studies are needed to confirm the differences by area, and identify the risk factors for variation in cancer mortality by socioeconomic status and population group.

Mortality by site

The 10 most common sites/types of cancer-caused death in the Libyan Arab Jamahiriya were TBL, leukaemia, colorectal, lymphoma, stomach, prostate, breast, liver, uterus and bladder. The 5 and 10 most common sites among them were responsible for, respectively, 49.6% and 67.7% of all Libyan cancer deaths (world-wide, 44.5% and 65.8%) [*4*]. In individual countries, the proportions are: Egypt 27.9% and 67.2%; Kuwait 42.0% and 56.7%; Mauritius 39.4% and 59.1%; South Africa 35.9% and 50.2%; Malta 43.8% and 70.8%; and Hungary 50.2% and 69.1% [*9*]. Among the 5 most common types of cancer deaths in the present study, congruency was observed for two types in South Africa, three each in Mauritius and Malta, and four each in Kuwait and Egypt [*9*]. By site, trachea, bronchus and lung, stomach, colorectal and breast were among the 6 most common types of cancer deaths in all the above-mentioned countries.

Cancer of the trachea, bronchus or lung

TBL cancer was the most common type of cancer death in the present study, comprising 16.5% of all, and almost one-fourth of male cancer deaths. Since 1970 in Benghazi, TBL cancer has constituted the highest proportion of total, and male cancer deaths [*13,16*]. Lung cancer has also been the most common type of cancer registered at the Radiotherapy (Oncology) Department in Tripoli since 1974 [*14,15*]. It ranks first among cancer deaths in industrialized countries and worldwide. The proportion of cancer deaths due to lung cancer ranges from 8.2% in Egypt to 22.9% in Hungary [*3,5,9*].

The CMR per 10^5 person-years at risk among males for TBL in our study was 9.8, compared to 2.4 in Egypt and 117.0 in Hungary [*9*]. Among females, TBL cancer deaths are among the 7 most common cancer deaths by site in the Libyan Arab Jamahiriya, and among the 5 most common in 22 other countries (Turkey, Hungary, China and USA, Kuwait, Morocco, Oman and Qatar) [*9*]. In the present study, 4.0% of cancer deaths among females were also due to TBL cancer, something that, given the very low rate of cigarette smoking among Libyan females, requires further investigation.

The often-labelled cancer "epidemic" in the Libyan Arab Jamahiriya, is actually an epidemic of lung cancer due to cigarette smoking. Although statistics on smoking in the country are not published, it has been a widespread habit among men for the last 40 years. In Tripoli, one study showed that 85% of lung cancer cases were smokers, more than 50% of whom had been heavy smokers for more than 20 years [*15*]. A recent survey of male medical students in Benghazi found a prevalence of 20.8% of current smokers and 34.7% of ever smokers [*26*]. It is generally believed that more than 60% of men (≥ 15 years old) but less than 1% of women regularly consume tobacco in the Libyan Arab Jamahiriya. The risk of lung cancer is estimated to increase by 30% in non-smoker members of households with a resident smoker [*27*]. Passive smoking is the most likely reason for the lung cancer deaths among females seen in the present study. Similar to most developing countries, lung cancer deaths are likely to increase in the Libyan Arab Jamahiriya in future (with similar gender differences) unless well-planned interventions are instituted to control and prevent smoking.

Leukaemia

Among cancer deaths worldwide, leukaemia ranks tenth and is responsible for 3.4% of cancer deaths globally [*3*]. It was the second most common cause (9.9%) of all cancer deaths in the present study, and has been similarly ranked among child (< 15 years old) cancer deaths in both Benghazi and Tripoli [*13,16*]. Earlier, leukaemia constituted only 2.7% of cancer patients of all ages registered in Tripoli [*14*]. The CMR per 10^5 person-years at risk among both males and females was higher than that of Egypt and Mauritius but much lower than the USA, Hungary and Japan (Table 6) [*9*].

Among 12 (mostly developing) countries spread over five continents, leukaemia ranks among the five most common types of cancer deaths: in Egypt, Morocco, Botswana, Qatar, Kuwait, Cyprus, Oman, Turkey, Thailand, Venezuela, USA and Greece [*9*]. Reasons for the higher rate of leukaemia mortality in the Libyan Arab Jamahiriya are uncertain. However, epidemiological studies throughout the world have revealed that ionizing radiation has caused a variety of human neoplasms, including leukaemia [*28,29*]. Sources of ionizing radiation in the country most probably include natural background sources, such as cosmic rays and naturally occurring ele-

ments in the Earth's crust (uranium, thorium and radium), although these have not yet been measured. The liberal use of diagnostic radiographs (often on the insistence of patients) and repeated X-ray screening by the National Tuberculosis Control Programme since the 1970s are other possible external sources of ionizing radiation.

Colorectal cancer

In the present study, colorectal cancers were the third most common cause of cancer death (9.7% of the total). Of all registered cases of malignant neoplasms at the Tripoli Radiotherapy Department, colorectal cancer, insignificant between 1974 and 1980, constituted 4.8% of cancer deaths between 1981 and 1985 [*14,15*]. Globally, colorectal cancers rank third (8.4%) [*3*], and second in industrialized countries [*5*].

Although predominantly a problem in industrialized countries, colorectal cancer is one of the five most common types of cancer death in at least 15 developing countries, including Morocco, Egypt, Oman and Qatar, as well as Mauritius, South Africa and Thailand [*9*]. Colorectal cancer is emerging as an important cancer problem in the Libyan Arab Jamahiriya. The CMR per 10^5 person-years at risk in the present study was 3.2. This compares to a CMR of 45.1 in Hungary, the country with the highest cancer mortality in the world [*9*]. Diet is probably the major risk factor for the development of colorectal cancer, with consumption of meat and animal fat increasing the risk and consumption of fibre, fruit and vegetables reducing risk [*27,30*].

Lymphomas

In the present study lymphomas ranked fourth (6.8%) among cancer deaths. They had previously been estimated, in both the eastern and western regions of the Libyan Arab Jamahiriya, to be the most common cancers among children, and the fourth most common over all [*13,16*]. In Tripoli, lymphoma prevalence is reported to have increased dramatically, from 9.8% during the period 1974–80, to 16.9% in 1981–85 [*14,15*]. The highest incidence rates for lymphomas have been reported in Europe, North America, Australia and New Zealand [*2–5*]. These cancers constitute 3.6% of cancer deaths globally. Among Arab countries, the percentages range from 3.8% in Egypt to 6.8% in Kuwait [*3,9*]. The CMR per 10^5 person-years at risk in the Libyan Arab Jamahiriya is 2.4 (compared with 9.2 in Hungary) [*9*]. Lymphomas rank among the three most common causes of cancer deaths in Bahrain, Kuwait and Oman. Globally, they are between the sixth and tenth most common causes of cancer deaths [9]. The reasons for the increasing of mortality in the Libyan Arab Jamahiriya as a result of lymphomas need prompt investigation.

Stomach cancer

Stomach cancer was the fifth most common type of cancer death in the present study (6.6.% of the total, compared to 2.1% of all cancer cases registered at the Radiotherapy Department, Tripoli) [*14,15*]. There is widespread variation in both stomach cancer morbidity and mortality rates. Of all cancer deaths, stomach cancer is responsible for 12.3% globally (ranked second most common) [*3*], and for 3.8% in Egypt, 5.7% in Kuwait, 11.3% in Mauritius and 22.1% in Japan [*9*]. It ranks first among cancer deaths in Mongolia, Oman, Chile, Colombia, Costa Rica and Ecuador and between second and fifth among another 26 countries including Japan [9]. The CMR per 10^5 population among males ranges between 0.9 for Egypt and 50.2 in Japan [*9*]. The CMR of 2.2 in the Libyan Arab Jamahiriya, although higher than that of Egypt, is still much lower than most countries reporting statistics to WHO [*9*].

The risk of stomach cancer is increased by high salt and preserved food intake and by the presence of infection in the stomach of the bacterium *Helicobacter pylori* [*31*]. It is well known that Benghazi's drinking water has been very salty since the 1970s (due to seepage of seawater). Salt intake in diets is generally high, as is the prevalence of *H. pylori* infection [*31*]. There is good evidence that fresh fruit and vegetables protect against stomach cancer, suggesting its incidence might be reduced by their liberal consumption [*30*]. Stomach cancer could, therefore, be reduced in future by changes in dietary habits, elimination of *H. pylori*, and early detection and treatment of gastric ulcers.

Breast cancer

In the present study, breast cancer was the most common cancer death among females (12.0% of the female total). At the Tripoli Radiotherapy Department, breast cancer increased steeply in magnitude between 1974 and 1980 (17.5%) and 1981 and 1985 (29.8%) [*14,15*]. Risk of breast cancer in the Libyan Arab Jamahiriya is highest among women < 50 years of age — 10 years younger than reported in other parts of the world [*3,6,10,15*]. Almost all women diagnosed with breast cancer had breastfed a number of children [*10,15*].

In the present study, breast cancer constituted 4.7% of total (male and female) cancer deaths, compared with 6.2% globally [*3*]. It ranks first in industrialized, and third in developing country all-cancer mortality [*3,9*], and sixth both in the Libyan Arab Jamahiriya and globally. It is responsible for 2.7% of all cancer deaths in Japan, 8.2% in Egypt and 9.2% in Kuwait [*9*].

Most women probably have subclinical breast cancer and its growth is related to hormone levels in the breast and stimulation by local factors [*32,33*]. Overall, breast cancer risk is associated with urban residence, high social status, early age at menarche, late age of menopause and high dietary fat intake [*33*]. These factors might generally be considered to be operating in the Libyan population, but require confirmation among individual cases. Breast cancer has been shown, beyond reasonable doubt, to be amenable to secondary prevention by mammographic screening for women both under and over 50 years of age. Attention should be given in further studies in the Libyan Arab Jamahiriya to menstruation patterns, and hormonal levels in pre-menopausal women, and in particular, to the relationship between breast cancer and obesity, fat distribution and exercise.

Prostate cancer

Prostate cancer was found to be the fourth most common type of cancer death among males (7.6% of the male total). It was responsible for 4.7% of all cancer deaths in the present study (3.8% globally [*3*]) and ranks fourth among male cancer deaths in industrialized countries [*6*]. The CMR per 10^5 person-years at risk in our study was 3.0, in contrast to 0.5 in Egypt, 4.9 in Mauritius and 28.2 in Hungary [*9*]. African–Americans in the USA have the highest rate of prostate cancer in the world [*27*].

The ratio of elderly (≥ 65 years of age) to children (< 5 years) in a population tends to be directly proportional to its CMR [*9*]. For example, in the Libyan Arab Jamahiriya the ratio of those ≥ 65 years to those < 5 year and the CMR for prostate cancer respectively were 0.2 and 3.0; in Hungry, it is 2.6 and 28.2 [*9,34,35*]. The percentage of elderly in the Benghazi population increased from 2.6% in 1973 to 4.0% in 1995 [*18,35*]. The incidence of prostate cancer is higher in regions with large numbers of

elderly, ranking the fifth most common cause of cancer deaths in industrialized countries and eleventh in developing countries, where populations are considerably younger [*3,6*]. Prostate cancer also ranks high among male cancer deaths in 16 developing countries, most of which are in South America and many of which have large (or majority) populations of African descent. For example, it is responsible for most male cancer deaths in the Bahamas, Barbados, Guyana, and Trinidad and Tobago [*9*]. Prostate cancer has been linked, to some extent, to a high consumption of meat and fat, as well as to endocrinological factors [*2,3,6,27*]. It is likely to increase in the Libyan Arab Jamahiriya for demographic, dietary and other reasons.

Liver cancer

Liver cancer ranked eighth (3.1%) of all cancer deaths in the present study, compared to a global ranking of five (8.1% of all cancers deaths) [*3*]. In developing countries, which have 75% of global liver cancer deaths, it ranks third among male cancer deaths [*32*], first in Thailand, and between second and fourth in Egypt, Bahrain, Botswana and Japan [*9*].

The highest incidence of liver cancer is reported from sub-Saharan Africa, and east and south-east Asia, where the prevalence of hepatitis B infection is common [*6*]. Hepatitis B is also endemic in the Libyan Arab Jamahiriya [*36*]. The proportion of liver cancer deaths in the present study was 2–6 times higher in males than females, which is similar to the proportion observed globally. It is expected that liver cancer due to hepatitis B infection will likely decline because of the obligatory vaccination of all infants in the Libyan Arab Jamahiriya since 1993. However, other risk factors for liver cancer and the effectiveness of intervention methods require further study.

Uterine cancer

Cancer of the uterus was estimated at 2.9% of all and 7.3% of female cancer deaths in the present study, ranking ninth and fourth respectively. In Tripoli, it has previously been estimated at 2.1% of all and 5.6% of female cancer deaths, ranking eighth and fourth respectively [*14*]. Globally, uterine cancer is responsible for only 1.0% of total cancer deaths and ranks quite low globally for all female cancer deaths (twelfth most common) [*3*]. It is ranked first for all female cancer deaths in Paraguay, second in Ecuador, third in Guyana, Egypt and Thailand, and between fourth and fifth in Brazil, Trinidad and Tobago, Mongolia and Japan [*9*]. The CMR per 10^5 person-years at risk due to cancer of the uterus was 1.9 in our study, compared to 0.9 in Egypt, 7.5 in Mauritius and 9.7 in Hungary [*9*].

Uterine cancer has also been linked to high consumption of meat and fat, as well as endocrinological and reproductive factors [*27,37*]. Risk of endometrial cancer is known to increase with gravidity [*27*]. The fertility rate of Libyan women was 5.4 in 1973, 7.6 between 1981 and 1985 and 4.1 in 1995 [*18,35,38*]. The epidemiology of uterine cancer in the Libyan Arab Jamahiriya requires further investigation in the near future.

Bladder cancer

Bladder cancer ranked tenth (2.8%) of all cancer deaths in the present study, with a CMR of 0.9 for both sexes combined (1.5 in males and 0.3 in females). Bladder cancer was observed to decline from 5.2% between 1974 and 1980, to 0.5% between 1981 and 1985 in cancer cases registered in Tripoli [*14,15*]. Bladder cancer was responsible for 16.0% of cancer deaths in Egypt [*9*]. Deaths from bladder cancer rank first in Egypt and Iraq [*39,40*]. The estimated bladder cancer CMR in our study

was, with a small number of exceptions, lower than for most other countries. It was 1.7 times higher among males than females. Globally, the sex ratio of male to female bladder cancer deaths is 3.6, the highest of all the non-gender-specific cancer deaths [2,3].

Cancer of the lip, oral cavity and pharynx

Lip, oral cavity and pharynx cancers ranked eleventh (1.7%) of all cancer deaths in the present study and had a CMR of 0.6 in both sexes (0.7 in males, 0.4 in females) (Tables 5 and 6). Oral cancers are common in South-east Asia, where one-third of the world's cases occurs [6], due in large part to the chewing of lime with betel nut.

Increased risk of lip cancer has been shown among individuals exposed to agricultural chemicals [41]. Cigarette smoking, tobacco chewing and using snuff have been shown to result in a four-fold increase in oral cancer [42]. Nasopharyngeal cancer is possibly caused by the Epstein–Barr virus [27]. To facilitate effective prevention, these cancers needed further investigation to isolate the relative importance of risk factors, causes and pre-cancerous conditions.

Cancer of the larynx

Cancer of the larynx ranked twelfth (1.6%) of all cancer deaths in the present study. However, it was the fourth most common (10.2%) of all male cancers registered at the Radiotherapy Department, Tripoli [14,15]. A high incidence of laryngeal cancer has been previously reported from Iraq [39]. Among male cancer deaths, it is the sixth most common in Hungary, and in Arab countries between the eighth and tenth most common. [9]. Larynx cancer constituted 1.6% of all cancer deaths in our study, which is similar to many other countries (Table 5).

An eight-fold greater risk of cancer of the larynx among smokers compared to non-smokers has been reported [27]. Cigarette smoking among males in the Libyan Arab Jamahiriya is highly prevalent. Reasons for the wide difference observed in morbidity and mortality of laryngeal cancer is not known, but may be due to early detection and better survival in the Libyan Arab Jamahiriya. Further investigation is required.

Oesophageal cancer

Oesophageal cancer ranked thirteenth (1.2%) of all cancer deaths in the present study, with a CMR of 0.4 in both sexes (0.8 in males). Globally, cancer of the oesophagus is the sixth most common (5.7%) of cancer deaths [3]. It is the most common type of cancer death in Botswana (18.4%) [3]. Mainly a problem in Africa and south-east Asia [6], cancer of the oesophagus ranks fourth in males and fifth in females in developing countries [32]. The strongest evidence for a protective effect of micronutrients (including retinol, riboflavin, ascorbic acid and zinc) has been reported for oesophageal cancer [30]. As there is a three-fold higher risk among smokers than non-smokers [27], cancer of the oesophagus in the Libyan Arab Jamahiriya will most likely continue to increase, especially among males.

Cervical cancer

Cervical cancer ranked ninth (2.9%) of all female cancer deaths in the present study. Worldwide, it makes up 3.1% of all cancer deaths (compared to 1.1% in our study), and occupies fifth position among female cancer deaths [2,3]. Among females in most developing countries, cancer of the cervix ranks first both in cancer morbidity and mortality [32]. The proportion of cancer deaths due to cervical cancer varies

among countries (Table 5). It is mostly a problem in developing countries where sexually transmitted diseases are highly prevalent. There are 21 countries (mostly Latin American) in which death due to cervical cancer is counted among the five most common types of female cancer death, ranking first in Botswana, Guyana, Mexico and Nicaragua [*9*]. In Arab countries, it ranks second in Morocco and between the fourth and fifth most common in Bahrain, Oman and Qatar [*9*].

Cytological screening is considered the most effective way of preventing cervical cancer mortality. Cervical cytology is commonly practised in urban areas of the Libyan Arab Jamahiriya, both in case-finding and for diagnosis. The incidence of cervical cancer in the Libyan Arab Jamahiriya has declined from 10.5% in 1979–80 to 4.5% in 1981–85 among all female cancer cases registered at the Radiotherapy Department in Tripoli [*14,15*]. The low cancer mortality due to cervical cancer in the present study was probably due to declining incidence of cervical cancer, early detection and better survival after treatment. Preventive screening for cervical cancer will probably reduce mortality further. However, the cost–effectiveness of such procedures needs to be calculated before taking any national initiative.

Conclusion

Epidemiological studies have strongly suggested that the great majority of cancers are caused by radiation, and chemical and biological agents [*27,29,31,36*]. WHO has estimated that about two-thirds of global cancer deaths are due to four categories of risk factors [*2,3*].

- diet-related — e.g. stomach, colorectal, liver, prostate and mouth and pharynx
- tobacco-related — e.g. lung, bronchus, trachea and larynx
- infection-related — e.g. liver, cervix and lymphomas
- hormone-related — e.g. breast cancer

In the present study, the above-mentioned four categories accounted for 25.6%, 16.8%, 10.5% and 4.7% of cancer deaths respectively. Together, they constituted more than half (57.6%) of all cancer deaths in the present study.

The Libyan population is at present undergoing demographic, epidemiological and socioeconomic transitions. The process of rapid modernization, urbanization and industrialization is bringing a stream of new risk factors related to changes in lifestyle (cigarette smoking, high calorie/fat/meat diets and lack of physical activity), overcrowding, and exposure to environmental and occupational hazards. During the last four decades, average life expectancy has increased from 42.9 to 65.0 years, and the proportion of elderly from 2.6% in 1954 to 4.0% in 1995 [*17,18,35,43*]. Per capita daily consumption of calories is among the highest in the world, increasing from less than 2000 kcal in the 1960s to 2570 kcal in 1975 and 3459 kcal since 1980; currently 40% higher than the normal daily requirement [*17,34*]. The diet is principally made up of animal fat, eggs, meat and refined sugar. Cigarette smoking is prevalent — more than 60% of men are estimated to be regular smokers. In Tripoli, 85% of lung cancer patients were regular cigarette smokers (50% were heavy smokers for 20 years or more) [*14*]. Although active cigarette smoking among women is rare in the Libyan Arab Jamahiriya, passive smo-king is common. Infection with hepatitis B virus and *H. pylori* is prevalent. Sedentary life and obesity are increasingly becoming medicosocial problems [*31,34*].

The criteria for a cancer control programme in the Libyan Arab Jamahiriya should include mapping out the nature and

size of the problem, identification of modifiable risk factors, assessment of the efficiency and cost–effectiveness of interventions, selection of suitable indicators, and ensuring comprehensiveness of organizational structure, programme sustainability and continuity of monitoring and evaluation.

While there is public consensus on the desire to prevent dangerous communicable diseases, malnutrition and environmental hazards, there is not uniform agreement on the roles of the state and the medical profession in the prevention and control of chronic diseases such as cancer, heart disease and diabetes, and their precursors (e.g. smoking, high-fat diets). However, the welfare state is obliged to take anticipatory action to facilitate prevention and control, early detection and suitable intervention, as well as providing palliative care for those with chronic diseases and conditions, including incurable cancers.

The results of well-planned epidemiological descriptive and analytic surveys on cancer could be used to educate people and to motivate health planners and administrators. There is an urgent need for an explicit national policy, a national cancer control programme (NCCP), which should be integrated with the overall policy for the control of chronic diseases and health conditions. This will assist in setting goals for a balanced control programme and prioritizing objectives, and will indicate the resources and measures needed to improve outcomes.

There can be no doubt that cancer will be a major challenge in the Libyan Arab Jamahiriya in the years ahead. So far, there exists no organized cancer prevention programme in spite of a long-held desire by many pathologists, oncologists, epidemiologists and administrators that one be established [*16*]. The necessity for such a control programme was strongly emphasized at the 1998 WHO symposium [*16*], where it was suggested that the programme be unified, consensual, empowering, realistic and sustainable.

A uniform model for national cancer statistics containing a minimum data set would improve the efficacy of health delivery. However, in the near future the boundaries and scope of the programme are expected to be defined by social, economic, medical and administrative needs. In the meantime, a cancer registry should be started, initially hospital-based, then population-based, which would ultimately become an integral part of an NCCP.

Further studies are required in cancer epidemiology and in the evaluation of alternative, cost-effective cancer-control measures. The Libyan Arab Jamahiriya has shifted from a preponderance of infectious, parasitic and nutritional diseases towards the dominance of noncommunicable diseases (including cancer) within a single generation. It is therefore essential that steps be taken now to prepare the country's health services to face the challenges presented by this shift.

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