Original article

Cancer incidence, mortality, and survival in Eastern Libya: updated report from the Benghazi Cancer Registry

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ABSTRACT

Purpose: Despite the increasing burden of cancer occurred over recent years in the African continent, epidemiologic data from Northern Africa area have been so far sparse or absent. We present most recently available data from the Benghazi Cancer Registry concerning cancer incidence and mortality as well as the most comprehensive survival data set so far generated for cases diagnosed during 2003 to 2005 in Eastern Libya.
Methods: We collected and analyzed data on cancer incidence, mortality and survival that were obtained over a 3-year study period from January 1st 2003 to December 31st 2005 from the Benghazi Cancer Registry.
Results: A total of 3307 cancer patients were registered among residents during the study period. The world age-standardized incidence rate for all sites was 135.4 and 107.1 per 100,000 for males and females, respectively. The most common malignancies in men were cancers of lung (18.9%), colorectum (10.4%), bladder (10.1%), and prostate (9.4%); among women, they were breast (23.2%), colorectum (11.2%), corpus uteri (6.7%), and leukemia (5.1%). A total of 1367 deaths for cancer were recorded from 2003 to 2005; the leading causes of cancer death were cancers of the lung (29.3%), colorectum (8.2%), and brain (7.3%) in males and cancers of breast (14.8%), colorectum (10.6%), and liver (7%) in females. The 5-year relative survival for all cancer combined was 22.3%; survival was lower in men (19.8%) than in women (28.2%).
Conclusions: This study provides an updated report on cancer incidence, mortality, and survival, in Eastern Libya which may represent a useful tool for planning future interventions toward a better cancer control.

Introduction

Cancer has become a major public health problem in Africa over the last decades. About 847,000 new cancer cases (6% of the world total) and 591,000 deaths (7.2% of the world total) occurred in 2012 on the continent. Critically, these numbers are expected to double in the next 20 years [1].

This increased burden of cancer mainly depends on the growth and aging of the African population, which is estimated to rise by 50% overall (from 1.03 billion to 1.52 billion) and by 90% for those

aged 60 years or more (from 55 million to 105 million) between 2010 and 2030. Furthermore, the adoption of new lifestyles associated with economic transition including smoking, lack of physical inactivity (leading to obesity), and reproductive behaviors will contribute to an increased number of cancer cases in Africa in the years to come [2]. In addition, late cancer presentation and inadequate or unavailable treatment facilities decisively lead to the poorer prognosis of African patients compared with those from high-income countries [3].

Nevertheless, in most African countries, cancer continues to receive a relatively low public health priority because of limited resources and other pressing public health problems, including communicable infectious diseases such as AIDS or human immunodeficiency virus infection, malaria, and tuberculosis [4].

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During the last decade, epidemiologic data have increasingly become available from several African cancer registries, such as the Benghazi Cancer Registry (BCR), which was established in 2002 in Libya [5,6]. However, high-quality cancer registration, according to the International Agency for Research on Cancer's criteria, is still largely unsatisfactory in Africa, covering only 1% of the whole population in 2007 [7,8]. Unfortunately, the dramatic civil war broke out in 2011 has unavoidably contributed to negatively affected cancer registration process in Libya.

Nonetheless, in the present study, we provide an update on cancer incidence and mortality from the BCR for patients diagnosed with cancer in Eastern Libya during 2003 to 2005. More importantly, for the first time, we reported herein the most comprehensive survival data set ever generated for the Libyan population over the same time frame.

The availability of an updated population-based cancer registration system is a crucial element to guide planning and evaluating cancer controls programs in Libya.

Materials and methods

We collected and analyzed data on cancer incidence, mortality, and survival that were obtained over a 3-year study period from January 1, 2003 to December 31, 2005 from the BCR [5,6].

The BCR is a population-based registry established in 2002 and located in the Garyounis University, Faculty of Medicine, at the National Research Centre building, Benghazi. The area covered by the BCR is a wide region of Northeastern Libya with an estimated population of 1,582,160 inhabitants, according to 2006 estimates. Population data were derived from Libyan General Authority for Information, which release the estimation of the population resident in Libya by sex and age group. In the region of the Eastern district of Libya, cancer care services were provided predominantly by the adult Oncology and Hematology units in Aljumhuria Hospital, the Radiotherapy unit in the Radiodiagnostic and Therapeutic Center, and by the Pediatric Oncology and Hematology unit in the Children Hospital, which were all based in Benghazi. All cancer patients from the Eastern region were referred to these units. The data on cancer incidence and mortality were actively collected by the staff of the BCR using case finding from different sources. These included cancer service units, general and regional hospitals, university hospitals, private hospitals and clinics, specialized hospitals and centers out of the region, pathology and hematology laboratories, and the district death registration offices. The Department of Pathology of Garyounis University, located in the city of Benghazi, is the most important source of information because it provides histopathology and cytology services for the whole of Eastern Libya. The registry staff visited death registration offices routinely to collect data on cancer mortality based on death certificates. The cause of death from cancer was mandatory reported in all hospitals, and cases coded as death caused by cancer are matched with the data of the BCR. The death registration system was adequate but not complete in all parts of the Eastern district of Libya especially for the year 2003.

Data were provided up to the latest complete year of registration (2005). Registration included all malignant tumors with the exception of nonmelanoma skin cancer and myelodisplastic syndrome that was excluded from the analyses. Registrations were considered microscopically verified when diagnosis is based on a malignant histologic or cytologic reports.

Tumors were classified according to the third edition of the International Classification of Diseases for Oncology [9]. The staff of the Modena Cancer Registry, Italy, contributed to the training of registrars in coding techniques and in software use. Coding practices (including basis and the date of diagnosis) were defined according to the current international guidelines [10,11]. Age standardization of incidence rates was carried out using the direct method and the world standard population [12]. The registry used statistical and data entry software developed by the Modena Cancer Registry; it includes a variety of rules for checking the validity of the data, based on the International Agency for Research on Cancer or the International Association of Cancer Registries check programs [13]. To calculate the crude incidence rate from the BCR data, we summed the number of cases for each cancer type and the underlying Benghazi region population for each of the strata defined by age and gender within each year across the study period. Specifically, age was grouped into 18 categories (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, 70–74, 75–79, 80–84, and 85 years or more) and gender was coded as male or female. Survival was estimated using the actuarial method and defined as the time, in years, between the date of diagnosis and the date of death or last follow-up. We considered lost to follow-up the people alive with the last update before December 31, 2007. Relative survival (RS), expressing the probability of cancer survival after adjustment for competing causes of death, was estimated as the ratio of the observed survival among the cancer patients and the survival that would have been expected if they had experienced the same death rates as the general population from which they derive. The expected survival was estimated from the Libyan population life tables by the Ederer II method [14].

We constructed life tables of all-cause mortality in the general Libyan population, by single year of age, sex, and calendar year of death. We used the United Nations Population Division life tables (*World Population Prospects: The 2012 Revision*) for Libya for the calendar periods 2000 to 2005 and 2005 to 2010 to estimate the background mortality in the Eastern Libya population for the years 2003 to 2005. The life tables were obtained abridged by 5-year age group up to the age of 85 years. They were interpolated using the Elandt-Johnson method [15] and extended from ages 80 to 99 years using the Gompertz distribution to produce complete life tables up to the age of 99 years. To obtain life tables for single calendar years, life tables were assigned to the midyear of each period (i.e., 2003 and 2007) and linearly interpolated.

The 95% confidence intervals for RS were estimated from the standard error according to Greenwood's method [16]. Furthermore, we estimated 5-year age-standardized RS for each cancer and for all cancers combined, using the international Corazziari's standard for cancer survival analysis [17].

Results

Almost 80% of all cancers were verified by histology or cytology and only a small proportion were documented by a death certificate (death certificate only = 8.5%) or other (e.g., clinical evaluation = 12.5%; Table 1). Furthermore, 154 cases were recorded as unspecified (4.7%).

Incidence

Overall, excluding nonmelanoma skin cancer and myelodisplastic syndrome, a total of 3307 new cancer cases were diagnosed in Eastern Libya during the calendar period 2003 to 2005, with a slight male excess (52% of all cancer cases). The incidence of disease was found to increase with age, presenting a median age at diagnosis of 61 years for males and 50 years for females.

The world age-standardized incidence rate (ASIR) was found to be 135.4 and 107.1 per 100,000 males and females, respectively, with a cumulative risk of being diagnosed with an invasive cancer during 0 to 74 year period which was higher for men than for women, accounting for 14.9% and 11.2%, respectively. Among men, cancers of lung (18.9%, 327 over 1.731), colorectum (10.4%), bladder

Table 1
Data quality indicators for all cancer cases (excluded nonmelanoma skin cancers)

Site	N	Missing FU %	DCO/autopsy (%)	MV (%)
All cases	3307	37.8	8.7	78.4
Nasopharynx	67	35.8	3.0	92.5
Larynx	74	45.9	10.8	83.8
Stomach	99	33.3	12.1	76.8
Colon-rectum	357	32.5	6.2	87.7
Liver	102	49.0	34.3	16.7
Pancreas	101	29.7	14.8	27.7
Lung	364	29.4	12.6	55.5
Melanoma	7	42.9	—	100
Breast female	365	21.1	2.7	93.7
Cervix uteri	62	33.9	8.1	88.7
Corpus uteri	105	40.0	6.7	92.4
Ovary	74	37.8	5.4	86.5
Prostate	162	45.1	5.6	79.6
Kidney	83	44.6	12.0	77.1
Bladder	200	51.5	5.0	91.5
Brain, CNS	137	34.3	16.1	57.7
Thyroid	77	52.2	6.5	89.6
HL	82	35.4	—	100
NHL	150	46.0	6.0	93.3
MM	34	50.0	14.7	76.5
Leukemia	162	27.2	6.2	93.8

CNS = central nervous system; DCO = death certificate only; FU: follow-up; HL = Hodgkin lymphoma; MM = multiple myeloma; MV = microscopically verified; N = number of case; NHL = non-Hodgkin lymphoma.

(10.1%), prostate (9.4%), and brain (5%) represented the most frequently reported malignancies, whereas the five most commonly diagnosed types of cancer among women were breast (23.2%), colorectum (11.2%), corpus uteri (6.7%), leukemia (5.1%), and ovary (4.7%), accounting for approximately 50% of all new cancer cases in women (Table 2).

Mortality

Regarding data on cancer mortality, a total of 1367 deaths for cancer were recorded in Eastern Libya during the calendar period

Table 2
Number of new cancer cases and W-ASIR by sex and cancer site in Eastern Libya (2003–2005)

Cancer	Incidence				Mortality			
	Male		Female		Male		Female	
	n	W-ASIR	N	W-ASIR	n	W-ASIR	n	W-ASIR
All cases	1731	135.2	1576	107.1	840	68.0	527	38.4
Nasopharynx	42	2.8	25	1.4	10	0.7	5	0.3
Larynx	66	5.5	8	0.7	31	2.6	2	0.2
Stomach	62	4.9	37	3.0	40	3.3	21	1.5
Colon-rectum	180	14.0	177	12.4	69	5.5	56	4.4
Liver	58	4.9	44	3.7	50	4.4	37	3.2
Pancreas	64	5.5	37	2.9	46	4.0	29	2.2
Lung	327	28.0	37	3.1	246	21.7	21	1.7
Breast, female	—	—	365	23.0	—	—	78	5.4
Cervix uteri	—	—	62	4.6	—	—	17	1.3
Corpus uteri	—	—	105	8.9	—	—	25	2.2
Ovary	—	—	74	4.6	—	—	27	1.8
Prostate	162	14.8	—	—	41	3.6	—	—
Kidney	55	4.2	28	2.1	23	1.9	7	0.5
Bladder	174	15.2	26	2.3	46	4.3	10	0.9
Brain, CNS	87	5.2	50	3.0	61	4.0	32	2.1
Thyroid	13	0.8	64	3.8	1	0.1	10	0.8
HL	38	1.6	44	1.8	10	0.5	7	0.3
NHL	81	5.3	69	4.4	31	1.9	19	1.2
MM	18	1.7	16	1.2	9	0.8	6	0.5
Leukemia	82	5.1	80	4.5	44	2.7	32	1.7

CNS = central nervous system; HL = Hodgkin lymphoma; MM = multiple myeloma; n = number of cases; NHL = non-Hodgkin lymphoma; W-ASIR = world age-standardized incidence rate x 100,000.

2003 to 2005. The world age-standardized mortality rate was 68 and 38.4 per 100,000 in males and females, respectively. Among men, cancers of the lung (29.3%), colorectum (8.2%), and brain (7.3%) were the most common cause of cancer death; lung cancer alone accounted for almost one third of all cancer deaths in men. The three leading causes of death for cancer among women were breast (14.8%), followed by colorectum (10.6%), and liver (7%; Table 2).

Survival

Five-year age-standardized RS for all cancer cases was 22.3%.

Males were less likely than females to survive to cancer, in fact, among men the reported 5-year standardized RS for all cases was 18.5%; contrariwise, among women, the standardized 5-year RS was 29.5% (Fig. 1).

The most lethal cancers in both sexes combined were lung cancer showing a 5-year RS of 2.3%, followed by liver cancer with a 5-year RS 2.4%, and stomach cancer with a 5-year RS of 3.3%.

Thyroid, breast, and colorectal cancers were associated with a best prognosis showing a 5-year RS of 64.9%, 56%, and 29.5%, respectively.

Cancer survival estimates by selected cancer are summarized more in detail in Table 3.

Discussion

Herein, we present data collected from BCR during the calendar period 2003 to 2005, providing an update of previous publications on cancer incidence and mortality in Eastern Libya. Additionally, we compiled the most comprehensive survival data set so far reported for Libya over the same time period. To better read our results nowadays, a civil war scenario dominates the overall landscape in Libya. Hence, since the beginning of 2011, it has been increasingly complicated to obtain any sort of official documents or acts from Libyan institutions.

Cancer incidence rates in Libya remain much lower than rates in western industrialized countries. For example, ASIRs for all cancers combined were 135.4 and 107.1 in men and women, respectively in Libya compared with ASIRs of 358.1 and 281.7 in men and women respectively in the United States (US-Surveillance, Epidemiology, and End Results [SEER] 18 registry), over a similar time frame [18]. Among Northern Africa countries, Libyan ASIRs were similar to those of Egypt (ASIR = 132.6 in males and 122.1 in females) but they were found to be slightly higher than those observed in Tunisia (ASIR = 122.6 and 94 in males and females, respectively) and Algeria (ASIR = 94.4 and 95.5 in males and females, respectively) [19].

Cancers associated with high burden and with remarkable epidemiologic impact on Libyan population were those originating from lung, breast, and colorectum.

Lung cancer continue to be a leading cause of morbidity and mortality among males in Libya, ranking first and causing 30% of all cancer-related deaths. Currently, about one-fourth of the Libyans older than 24 years are smokers, whereas around 12.4% of the students between the age of 13 and 15 years are smoker (17.1% of males and 7.2% of females). A rising trend in cigarette consumption involving Libya population is expected for the next years, mainly due to the adoption of Western behaviors associated with economic growth. Thus, implementation of already existing tobacco control measures as well as new legislation and educational programs are urgently required to avoid such preventable cause of cancer deaths.

Breast cancer is still a major health problem among women in Libya, both in terms of number of patients and number of deaths. It accounted for almost one-fourth of all new cancer cases and caused
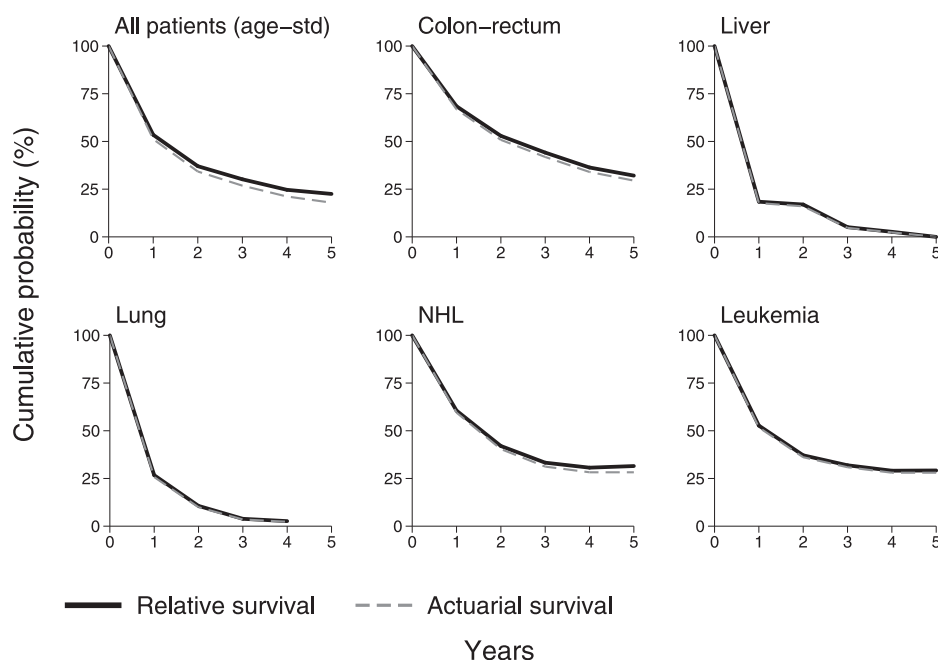
Fig. 1. Five-year observed and relative survival in the BCR for selected cancer types during 2003 to 2005.

almost 15% of all cancer-related deaths in females. With respect to developed countries, it affected a younger population (median age of 45 years), presents mostly in stage III or IV because of diagnostic delay, lack of screening programs and therefore results in a poorer outcome. Of note, a study showed that signs and symptoms of breast cancer presentation tend to be underestimate not only by the patients but also by the physicians; still, the absence of mammography or other screening programs for early detection of breast cancer also contribute to postpone the diagnosis [20]. With the aim of improving the prognosis of patients, it may be worthwhile to encourage strategies for early detection, including breast self-examination and mammographic screening in high-risk patients, as well as improve breast cancer awareness among the population and the general practitioners.

Table 3
Number of deaths, OS, and RS for 14 selected cancer sites in Benghazi for patients diagnosed in 2003 to 2005

Cancer site	N	OS	RS (95% CI)
Standardized			
All cancers	1593	17.9	22.3 (18.7–26.5)
Not standardized			
All cancers	1593	23.5	26.0 (22.9–29.3)
Nasopharynx	25	23.7	24.7 (6.5–49.4)
Stomach	64	3.3	3.8 (0.0–15.8)
Colon-rectum	139	29.5	32.1 (20.8–44.2)
Liver	88	2.4*	2.6 (0.3–11.0)*
Lung	298	2.3*	2.6 (0.7–6.8)
Breast, female	95	56.0	60.6 (52.9–67.7)
Corpus uteri	35	15.7	16.9 (1.7–47.4)
Ovary	39	21.1	22.0 (10.1–37.0)
Prostate	58	24.2	34.0 (14.2–58.3)
Bladder	67	26.6	34.7 (16.4–56.1)
Brain, CNS	93	7.2	7.4 (1.4–20.6)
Thyroid	14	64.9	67.3 (40.3–85.1)
NHL	68	28.2	31.5 (19.8–44.2)
Leukemia	92	28.0	29.2 (20.7–38.3)

CI = confidence interval; OS = observed survival (projected at 5-year of follow-up). Standardized survival according to Corazziari's method.
* Survival reported at 4-years at follow-up.

An emerging health problem in Libya is represented by colorectal cancer, which is the second most frequently diagnosed cancer and the second common cause of cancer death, both in men and women. Akin to breast cancer, colorectal cancer was mostly diagnosed in advanced stage, with roughly 40% of all patients presenting with metastatic disease at diagnosis, as demonstrated by a recent local report [21]. This seems to be largely explained by the total lack of a colorectal cancer screening program in the Libyan medical practice, which thereby limits the high potential curability of early stage disease. Moreover, the adoption of western world-associated risk factors such as unhealthy diet and sedentary lifestyle together with the subsequent rise of obesity among Libyan population are responsible for the high incidence of colorectal cancer particularly in the urban areas and below the age of 40 years [22]. Nowadays, 30% of the Libyan adults are obese and 33% of them are overweight, whereas 22% of Libyan children under 5 years are obese [23]. Although over time different definitions of obesity have been adopted, the burden of disease has undoubtedly increased since 1984 in both sexes [24]. Although it is currently not easy to apply in Libya, diet control, regular exercise, and implementation of screening program, at least in the high-risk population, remain fundamental recommendations in controlling colorectal cancer burden.

More interestingly, although these are not the first published, survival data reported herein represent the broadest ever generated for the Libyan population. Indeed, by using life tables, specifically constructed for Libya, we were able to estimate RS (i.e., survival for cancer patients after controlling for competing risks of death) for 14 different cancer types (Table 3). By difference, the broadest global analysis of cancer survival from the CONCORD-2 study was limited to only 10 cancer types, namely stomach, colon, rectum, liver, lung, breast (women), cervix, ovary, prostate, and leukemia [25].

Keeping in mind all possible limitations of our results, we found particularly dismal outcomes for patients diagnosed with cancer of the lung (2.3), liver (2.4), and stomach (3.3), even poorer than those expected based on data coming from neighboring Northern African countries. Still, 5-year RS for patients with potentially early detectable cancers, such as prostate (24.2%) and colon-rectum

(29.5%), was found to be significantly lower than those reported for Algeria (58.5% and 57.2%, respectively). Given the lack of clearly recognized factors that may explain differences in survival between countries sharing sociocultural and economic features, we emphasized the urgent need of implementing cancer prevention strategies in Libya.

Of interest, taking into account all possible biases including time frame, we also sought to establish a comparison between the aforementioned Libyan survival data and those most recently available from developed regions of the world. The probability of surviving cancer was found to markedly vary worldwide upon socioeconomic status. For instance, age-standardized 5-year RS for all cancer cases diagnosed in the United States from 2004 to 2010 (SEER 9) [18] was 68%, compared with 22.3% in Benghazi, with a significant difference that was maintained across all cancer types. Notably, the same huge gap was replicate by comparing Libyan survival to those of high-income European countries. Indeed, in Italy the 5-year RS for cases diagnosed during 2005 to 2007 was 57% and 63% in men and women, respectively [26].

Major factors that may have contributed to such disparities include differences in exposure to known and unknown risk factors, access to screening programs, timing of diagnosis, and availability of adequate anticancer treatments. This suggests how the different availability of economic and health resources may affect the outcome of patients, even across countries placed face to face within Mediterranean basin. Unfortunately, with the recent war scenario in Libya these results are not supposed to improve.

Conclusions

In summary, cancer is expected to rapidly spread across African continent over the following years, including in Libya; at the same time, the prognosis of patients still remain dismal. However, preventive measures to remove lifestyle-associated risk factors as well as the implementation of low-tech early detection methods appeared to be the most feasible and cost-effective strategies to reduce this deadly epidemic. High-quality cancer registration system plays an essential role in assessing the burden of cancer and subsequently in planning cancer control programs.

This study represents a unique attempt to define the burden of cancer in Eastern Libya. Data presented in this report are overall of good quality also compared with those generated from neighboring countries. However, some limitation should be considered to better interpret our results. First, the population covered by the present study amounts to approximately 1.5 million inhabitants, representing overall 26.5% coverage of the national population. Second, our survival analysis was influenced by a considerable proportion of cases missing follow-up. Finally, the civil war that was started in the country is supposed to exert major effects not only on the quality of our data but also on the burden of cancer as a consequence of the war deaths, of the massive migration fluxes and of the dramatic changes in the demographic and economic structure of the Lybian population.

Taken into account previously mentioned limitations concerning data quality and methods estimation, the present article compiles the most updated epidemiologic statistics regarding cancer in Libya. More relevant, here reported cancer survival data are the broadest so far available for the Libyan population. Thus, they represent a worthy starting point that may pave the way for future improvement in the quality of cancer registration in this Northern African country.

Lastly, with this epidemiologic report we are confident to provide useful data for clinicians but especially for health planner and policy makers to plan control strategies toward the burden of cancer in Libya.

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