Trends in the Incidence of Cancer in Eritrean Hospitals and Eritrean National Health Laboratory 2000-2010

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Abstract
Eritrea is one of the developing countries located in the Eastern Sub-Saharan Africa. Eritrea is experiencing a growing cancer problem, but little is presently known on tumor patterns, cancer epidemiology and ethnic or environmental cancer risk factors. A retrospective study was carried out on the cancer incidence in hospitals of Eritrea and Eritrean National Health Laboratory (ENHL) from 2000 to 2010 using data recorded from the Management Information System (MIS) in ENHL that recorded all cancer cases from across the country. The main objectives of this study were to review the current status of knowledge, summarizing local data, as well as to provide the first baseline data on the cancer incidence in Eritrea. This study was carried out retrospectively and quantitatively by collecting, abstracting, analyzing, coding and interpreting of data recorded in MIS at ENHL in the eleven years of study using CanReg5 software. Generally, 19,636 numbers of cases were confirmed by cytology and histology recorded at MIS through the year of 2000 to 2010; out of these 9,482 cases were positive for cancer. From the total positive cancer cases, 39.18% were males and 60.82% were females. The age standardized rate for all cancers in Eritrean hospitals and ENHL from 2000 to 2010 both in men and women combined were 20.3 per 100,000. The rate was higher in women 11.2 per 100,000 than men 9.1 per 100,000. In general, it can be concluded from this research that the incidence of cancer in Eritrean hospitals and ENHL were increased annually from 2000 to 2010, especially in females. The trend of the incidence is increasing with age, therefore the gradual aging of the population might increase the number of cancer cases in Eritrea.

1 Introduction
Cancer is a group of diseases characterised by the uncontrolled growth and spread abnormal cells1. Cancer is a major public health problem in most parts of the world. High-quality population-based cancer incidence data have been collected throughout the world since the early 1960s and published periodically in Cancer Incidence in Five Continents (CI5)2. Overall the age-standardised cancer rate (excluding non-melanoma skin cancer) is higher in more developed countries. There were about 268 cases of cancer diagnosed per 100,000 in more developed countries, compared to 148 in less developed countries in 2012. The rate was 1.8 times higher in more developed compared with less developed countries3,4.

The reason for the high incidence rates in western countries for some cancers may in part reflects detection practices in screening and imaging techniques, rather than true disease occurrence. Comparing with developed countries information on routine medical records and death certificates is more likely to be incomplete and population estimates are less likely to be accurate in less developed countries, affecting the accuracy of
the rates. But now the incidence and mortality rates for most cancers are decreasing in developed countries, they are increasing in several less developed and economically transitioning countries in Africa especially in Eastern and Sub-Saharan Africa, because of adoption of unhealthy western lifestyles such as smoking and physical inactivity and consumption of calorie-dense food².

Eritrea is one of the developing countries located in the Eastern Sub-Saharan Africa. It was under colonization until 1991. The Eritrean National Health Laboratory (ENHL) is the highest referral laboratory institution located the capital of the nation Asmara, officially established in the same year when the country was liberated in 1991. The ENHL has been working to upgrade the health laboratory services in the country. The ENHL structure is based on a three levels system of peripheral, regional and national referral hospital laboratories with the ENHL acting as national reference laboratory. The pathology department has been the center for the diagnosis of patients suspected for cancer throughout the country. Even though the laboratory shows a steady progress in diagnosing cancer patients, it is still going without having cancer registry and patient follow-up system. Currently, Eritrea is experiencing a growing incidence of cancers, but little is known on tumor patterns, cancer epidemiology and ethnic or environmental risk factors. The current retrospective study was carried out on cancer incidence in Eritrean hospitals and the Eritrean National Health Laboratory (ENHL) from 2000 to 2010.

2 Materials and Methods

2.1 Cancer study

The study data was collected from the regional and referral hospitals of the nation. Eritrea was divided into six Zobas, each zoba has its own regional referral hospital, community hospitals and health centers. The nation has also 8 national referral hospitals. The cancer data used in the present study was collected from all these hospitals and hence the data represents the national trends in the incidence of cancer in Eritrea. The ENHL that was based in Asmara is the only referral lab throughout the nation that received cancer cases from all the national referral hospitals, zonal referral hospitals and regional hospitals where all pathologic requests and specimens are processed.

This quantitative study was carried out retrospectively in the collection, abstracting, analyzing, coding and interpreting of data. An internationally standardized cancer abstract form that has the same format with the CanReg5 software was used to abstract the data. During entry, the data was analyzed using the pre-determined and developed built-in analysis tools of CanReg5 software version 5.00.35build1471. After all data were entered and analyzed, the international classification of disease for oncology 10 (ICD-10) for coding the primary site, histology, behaviour, and grade of diagnosis was given. Demographic data was captured using a format, which was prepared for coding the residence, place of birth, ethnicity (tribe), and hospital facility of diagnosis with other common socio-demographic variables. In order to provide for international comparisons, the collected and abstracted data was converted into the international classification of disease and related health problem (ICD-10) format. All positive (for any type of cancer) patients of all ages, ethnic groups, gender, types of patients (whether they were drug monitoring or not), all data from alive or dead patients were included in the study. Moreover, all negative cases of cancer and non-Eritrean citizens were excluded from the study.

2.2 Population

Eritrean population pyramid (age-sex distribution) for 2005 adopted from United Nations, department of economic and social affairs, population division, International data Base was used as population data set for generating the cancer incidence rate per 100,000 population during the period of 2000-2010 (Figure 1)².

2.3 Statistical Methods

The age standardized incidence rate of Eritrean hospitals and ENHL were calculated for all age groups by sex in each of the eleven years of the study. This age-standardized rate (ASRs) was calculated using the world standard population for each sex, for those cancer sites with minimum one case registered in the CanReg5 software during analysis of the data recorded from 2000 to 2010.

3 Results and Discussion

Totally 19,636 cases were recorded in the pathology department from 2000 to 2010; out of these 9,482 cases were positive (for any cancer). From the total positive cancer cases, 3,715 (39.18%) were males and 5,767 (60.82%) were females. Generally the cancer cases for females in both benign and malignant cases were higher than the incidence of cancers in males in each year (for 11 years). The highest incidence of benign cancer cases in females was observed in 2010 with the case number of 656. Whereas the highest number of cases observed in males was in 2008 (case number 448). The lowest incidence was seen with 72 cases in female in 2000 and 29 cases in males in 2003.

The highest malignant incidence in females was 204 cases in 2009 and 127 cases in males in 2001. The lowest incidence in females was 92 cases in 2000 and 68 cases in males in 2000.

Figure 2 represents general overview of incidence of both malignant and benign cases in Eritrean hospitals and ENHL through the year of 2000 to 2010. In general the incidence of malignant cancer had been increasing in all years except in 2002 and 2004. Similarly, the incidence of benign cancers had...
been increasing significantly in almost all the years except in 2003. Even though the incidence of malignant cancers gradually increased in all the years, the incidence of benign cancer was higher than the malignant cancer in the latter 6 years of the study. The incidence of benign cases was dramatically increased in the year 2005 (from 146 in 2004 to 872 in 2005).

Figure 1: Eritrean population pyramid (age-sex distribution) for 2005 generated by CanReg5.

Figure 2: General overview of both malignant and benign cases in Eritrean hospitals and ENHL from 2000 to 2010

From the total positive cases (n= 9482) 6,652 (70.15%) were benign cases and 2,830 (29.85%) were malignant cases.

The incidence of cancers calculated per 100,000 population by age group was generated by the CanReg5 software and is shown in figure 3 and figure 4 for male and female respectively.

The age-standardized rates of the most common ten cancer incidence per 100,000 population are shown in figures 5 and 6 in men and women respectively. The incidence of bone cancer in men was the highest (ASR around 0.8 per 100,000) and the lowest was breast cancer (ASR approx. 0.4 per 100,000). The highest incidence of cancer in females was breast cancer (ASR approx. 2.7 per 100,000) and the lowest incidence was colon cancer (ASR approx. 0.3 each per 100,000).

In this study cancer incidence increases steeply with age, reaching the value of 46.50% and 33.31% in male and female, respectively, in the ≥ 60 year age group (Figure 7). In this group, the most prevalent cancers were prostate, bone, and connective and soft tissue in males; and breast, cervix uteri, and esophagus in females (Table 1 and 2).

The cancer abstract form used by the global cancer registries together with CanReg5 software was used to extract cancer data from the pathology request form of the Eritrean National Health Laboratory of Eritrea for positive cancer cases.

The main challenge faced during the current study was the process of extracting data from the pathology request form to the standardized abstract form. In some of the pathology request forms of ENHL, important information such as surname, address, birth date, and age was missing. On the top of this, there was also a problem in giving the morphological details of benign cancers. The ICD-10 is organized by behaviour, anatomic site involved (topography), and morphological code. However, there was no such detailed information in the form. The above challenges were resolved by using the International Classification of Disease (ICD, 10th revision) codes, and using a differentiating table for benign and malignant cancers based on tissue organs from the pathology book 7, 10, 11.

Duplication of subjects was another problem the researchers faced throughout the study. Patients with the same first name; middle name, but may or may not have similar cancer in topography/morphology, were given a surname by using the first letter of their middle name. As a result the percentage of duplication was significantly decreased. Meanwhile, 64 patients had duplicated data with the same name and tumour records, for which the latest one data was used. Another two patients were duplicated with the same patient record but with different topography. These patients were considered as patients with multiple tumours and were added to the total number. Therefore the number of the total recorded patients were reduced from 9,548 to 9,482.
Figure 3: Snapshot of incidence rate (ASR) per 100,000 by age group in Eritrean hospitals and ENHL (2000-2010): Male

19,636 cases were recorded in the pathology department of the Eritrean National Health Laboratory from 2000 to 2010; 9,482 cases were positive for cancer (both benign and malignant). The total malignant cases were 2,830 (29.85%) and the total benign cases were 6,652 (70.15%). The incidence of cancer in the current study was unevenly distributed as can be seen in figure 2.

In general malignant cancers had been increasing in all years except in 2002 and 2004. Similarly, benign cancers increased significantly in almost all the eleven years except in 2003. Even though the incidence of malignant cancers gradually increased in all the eleven years, the incidence of benign cancer were higher than the malignant cancers in the last 6 years of study.

The incidence of benign cases was dramatically increased in the year 2005. Although there is no cancer registry that would support in finding out the real reason in Eritrea, the significant increase in cancer cases can be attributed to the fact that 2005 was the year with the highest number of HIV cases in Eritrea. Globally, breast and cervical cancers are the most commonly diagnosed malignant cancers in females. Similarly, both breast (cases 432) and cervix uteri (211 cases) cancers were found to be the most commonly diagnosed malignant cancers in females in the current study. In addition, bone, esophagus, ovary, connective and soft tissue, thyroid, skin, rectum, and colon were also commonly diagnosed malignant cancers in females (Figure 6).
Figure 4 shows the ASR of cancer incidence in females. The most commonly diagnosed cancer among females were breast cancer 2.7, cervix uteri 1.4, esophagus 0.7, bone 0.6 and ovary 0.5 per 100,000 populations. As this figure indicates some cancers like Kaposi sarcoma, cancer of placenta, and leukemia were not commonly diagnosed among females.
The most common malignant cancers in males were bone and prostate gland. Moreover, connective and soft tissue, skin, rectum, esophagus, bladder, colon, stomach, eye, and breast were also commonly diagnosed in males (Figure 5).

Similar studies have been conducted in Sudan, the most commonly diagnosed cancer in females were breast (29.3%), cervix uteri (8.2%), leukemia (7.2%), ovary (6.8%), and oesophagus (5.9%) whereas in males the highest was prostate (7.6%), followed by leukemia (7.0%)\textsuperscript{12}. Same study of one year trend also conducted with similar incidence in both sexes. Almost all the most common cancers in Sudan where also commonly diagnosed in the current study except leukemia in both sexes\textsuperscript{13}.

There were nearly 14.1 million new cases and 8.2 million cancer deaths were reported in 2012 worldwide. Of these 7.4 million cases were men and 6.7 million were women. This number is expected to increase to 24 million by 2035\textsuperscript{14}.

### Table 1: ASR per 100,000 of the most common cancers by site and age interval in male

<table>
<thead>
<tr>
<th>Cancer Site</th>
<th>Cases</th>
<th>ASR among the highest cases age interval</th>
<th>ASR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone</td>
<td>130</td>
<td>9.40;(85+years old)</td>
<td>0.80</td>
</tr>
<tr>
<td>prostate</td>
<td>72</td>
<td>13.10;(75-79 years old)</td>
<td>0.70</td>
</tr>
<tr>
<td>Connective and soft tissue</td>
<td>86</td>
<td>5.60;(85+ years old)</td>
<td>0.60</td>
</tr>
<tr>
<td>Other Skin</td>
<td>81</td>
<td>7.50;(70-74 years old)</td>
<td>0.60</td>
</tr>
<tr>
<td>Rectum</td>
<td>62</td>
<td>7.50;(70-74 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Esophagus</td>
<td>55</td>
<td>8.10;(70-74 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Bladder</td>
<td>46</td>
<td>7.50;(70-74 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Colon</td>
<td>54</td>
<td>3.70;(70-74 years old)</td>
<td>0.40</td>
</tr>
<tr>
<td>Stomach</td>
<td>47</td>
<td>5.00;(70-74 years old)</td>
<td>0.40</td>
</tr>
<tr>
<td>Eye</td>
<td>44</td>
<td>5.60;(70-74 years old)</td>
<td>0.40</td>
</tr>
<tr>
<td>Breast</td>
<td>39</td>
<td>4.70;(80-84 years old)</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Globally, the age-standardized rate for all cancers (excluding non-melanoma skin cancer) for men and women combined was 182 per 100,000 in 2012. The rate was higher for men (205 per 100,000) than women (165 per 100,000)\(^\text{14}\). The estimated age-standardized incidence rates in Eastern Africa in 2012 in females for cervix uteri (ASR) was around 42.7 per 100,000 and breast cancer (ASR) 30.4 per 100,000. The age-standardized mortality rates in females in cervix uteri (ASR) was around 27.6 per 100,000 and in breast (ASR) around 15.6 per 100,000\(^\text{15}\).

Table 2: ASR per 100,000 of the most common cancers by site and age interval in female

<table>
<thead>
<tr>
<th>Cancer Site</th>
<th>Cases</th>
<th>ASR among the highest cases age interval</th>
<th>ASR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>432</td>
<td>13.10; (70-74 years old)</td>
<td>2.70</td>
</tr>
<tr>
<td>Cervix uteri</td>
<td>211</td>
<td>6.80; (60-64 years old)</td>
<td>1.40</td>
</tr>
<tr>
<td>Esophagus</td>
<td>90</td>
<td>5.60; (65-69 years old)</td>
<td>0.70</td>
</tr>
<tr>
<td>Bone</td>
<td>104</td>
<td>4.50; (65-69 years old)</td>
<td>0.60</td>
</tr>
<tr>
<td>Ovary</td>
<td>79</td>
<td>2.60; (60-64 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Connective and soft tissue</td>
<td>78</td>
<td>2.80; (70-74 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Thyroid</td>
<td>73</td>
<td>3.40; (65-69 years old)</td>
<td>0.50</td>
</tr>
<tr>
<td>Other Skin</td>
<td>60</td>
<td>3.00; (65-69 years old)</td>
<td>0.40</td>
</tr>
<tr>
<td>Rectum</td>
<td>59</td>
<td>2.60; (65-69 years old)</td>
<td>0.40</td>
</tr>
<tr>
<td>Colon</td>
<td>47</td>
<td>2.60; (65-69 years old)</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Similarly, the estimated age-standardized incidence rate in males for prostate cancer (ASR) was around 23.3 per 100,000, 15.1 for Kaposi sarcoma and 11.9 for esophagus. The age-standardized mortality rate in males for prostate cancer, Kaposi sarcoma, and esophagus was 18.7, 14.2, and 11.2 per 100,000 population respectively\(^\text{14}\).

The age-standardized rate for all cancers in the current study, both in men and women combined was 20.3 per 100,000. The rate was higher in women with ASR of 11.2 per 100,000 than in men with ASR of 9.1 per 100,000 population. The highest age-standardized incidence rates of cancers in this study in females were breast cancer 2.7, cervix uteri 1.4, esophagus 0.7, bone 0.6 and ovary 0.5 per 100,000 populations respectively (Figure 6). In males, the highest age-standardized incidence rates of cancers were bone 0.8, prostate 0.7, connective and soft tissue 0.6, skin 0.6, and rectum 0.5 per 100,000 population respectively (Figure 5).

Data regarding the mortality rates of cancers in the current study was not calculated because there was no cancer registry and follow up of cancer patients. When compared to that of Eastern Africa, the highest incidence rates of cancer in males in the current study were bone, connective and soft tissue, skin, and prostate. However, the highest incidence rates of cancers in Eastern Africa for males were prostate, Kaposi sarcoma and esophagus\(^\text{14}\).

Study that has been conducted in Uganda, shown marked increase in breast and prostate (3.7% and 5.2% annually) respectively\(^\text{14,16}\). Cancer of cervix also the most frequent cancer of females in Uganda\(^\text{17}\). Similarly, in Ethiopia the highest estimated age-standardized incidence rate in males were colorectum ASR 10.5, Kaposi sarcoma ASR 10.5, Prostate ASR 6.6, and Leukaemia ASR 9.8\(^\text{14}\).

The low incidence rate of Kaposi sarcoma in this study can be attributed to the fact that it is related to HIV/AIDS and the prevalence of HIV/AIDS in Eritrea is relatively low and because of availability of antiretroviral drugs in the country\(^\text{15,17}\). The high incidence rate of bone cancer in the current study needs further epidemiological studies, whereas the incidence rate of prostate cancer in the current study had a similar incidence with that of Eastern Africa. The highest incidence rate was seen in the age group 75 – 80, with age standardized incidence rate of 13.1 (Table 1).

Breast cancer dominates the pattern of cancer incidence for females in the current study as it is the most commonly diagnosed tumour. 2.7 females in every 100,000 living females were diagnosed with breast cancer. When compared to the incidence rate of Eastern Africa, breast cancer has the same projection. The two highest incidences of cancers in the current study were breast cancer followed by Cervix uteri whereas in Eastern Africa they were reversed, but when the incidence compared to estimated ASR in Ethiopia it has shown more or
less same projection with the current study in breast cancer and Cervix uteri with ASR 31.5 and ASR 17.3 respectively\textsuperscript{14,17}.

A number of cancers in the present study show overlapping in both sexes. These are bone, connective and soft tissues, skin, rectum, oesophagus, and colon cancers. Besides being the top 6 cancers in both sexes, they are higher in males than in females (Figure 8). Exception is cancer of the oesophagus, where incidence is higher in females than in males.

Figure 8: Six most common cancers cases in Eritrean hospitals and ENHL (2000-2010): both sexes

4 Conclusions

With respect to the Eritrean context the incidence of malignant cancer had been increasing in all years except in 2002 and 2004, whereas the incidence of benign cancer also shows a significant increase in almost all the years except in 2003. Even though the incidence of malignant cancer gradually increased in all the years, the incidence of benign cancer was higher than the malignant cancer in the last 6 years of study. The incidences of benign cases were dramatically increased in the year 2005 with 872 cases. The ratio in percentage of malignant cancer incidence is 39.96\% in men and 60.04\% in women. Among the most top 6 cancers found during this research study: bone, connective and soft tissue, skin, rectum, colon and esophagus are common for both sexes, but have higher incidence in males than in females, especially in those of bone and connective tissue. Collectively the incidence of most common cancers in this study has same figure with Eastern African countries such as Uganda, Sudan, and Ethiopia with the exception of Kaposi sarcoma and Leukaemia which has low incidence in Eritrea. The age standardized rate for all cancers in Eritrean hospitals and ENHL from 2000 to 2010 both in men and women combined were (ASR) 20.3 per 100,000. The rate was higher in women (ASR) 11.2 per 100,000 than men (ASR) 9.1 per 100,000.

In general, it can be concluded from this research that the incidence of cancer in Eritrea increased annually from 2000 to 2010, especially in females. The trend of the incidence is increasing with age, therefore the gradual aging of the population might increase the number of cancer cases in Eritrea. The current research was based on cancer data from 2000 to 2010 is enough to project the cancer incidence clearly, it provides a clear picture of the statistical data on occurrence of cancer incidence in Eritrea.

We kindly recommend that the Eritrean Ministry of Health (EMOH) could make use of this first cancer incidence base line data as it will help in: 1) developing a framework for assessing and controlling the impact of cancer in Eritrea, 2) use as a foundation for establishing a national cancer registry in Eritrea, 3) develop strategic plans that could support cancer prevention and control program, and 4) further cancer epidemiological studies.

5 Acknowledgements

The authors are very grateful to the Eritrean Ministry of Health and health research and documentation (HRD) division committee for approving the research ethically and allowed access to the cancer data. Our gratitude also goes to the D.G. Department of public health, Dr. Andebrhan Tesfazion, M/director of ENHL, Mr. Asmeromsium, Director of HRD, Dr.Birhane Debru, Mr. Yossief, and all staff members of the pathology department of ENHL for providing access to the recorded cancer data and comfortable environment to conduct our research.

6 Competing Interests

Authors have declared that no competing interests exist.

7 Authors’ Contributions

This work was carried out in collaboration between all authors. Authors HA, DT, HW and MH contributed equally to the study design, wrote the protocol, collected the data, performed all software analyses, managed literature searches and drafted the manuscript. Author TM provided access to the cancer cases.
Authors DE and GS contributed to the study and drafting of the manuscript. FMF overlooked the study design, managed the literature review, supervised the analyses of the study and contributed to the drafting of the manuscript. All authors read and approved the final manuscript.

8 References


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