

# Chapter 20

## General Oncology Care in the Republic of Yemen



Amen Bawazir, Huda Basaleem, Ahmed Badheeb, and Gamal Abdul Hamid

### 20.1 Yemen Demographics

The Republic of Yemen is situated at the southwestern corner of the Arabian Peninsula, at the entrance to the Bab-el-Mandeb Strait, which links the Red Sea to the Indian Ocean (via the Gulf of Aden) and is one of the most active and strategic shipping lanes in the world. Yemen is bordered by the North with Saudi Arabia and from the East by Oman and it occupies around 527,970 km<sup>2</sup> [1]. Administratively, 22 governorates were declared in the year 2014 [2]. The total population of Yemen is nearly 29,826,305 people (15,271,909 males and 14,973,391 females) at mid-year, and 61.6% of population residing in the rural area of the country [3–5] The population pyramid show a very young population, with a median age of 20.2 years and around 39.2% of the population were under 15 years of age, and only 2.6% are

---

A. Bawazir (✉)

Faculty of Medicine and Health Sciences, University of Aden, Aden, Yemen

College of Public Health and Health Informatics, King Saud Bin Abdulaziz University of Health Sciences, Riyadh, Saudi Arabia

e-mail: [bawazira@ksau-hs.edu.sa](mailto:bawazira@ksau-hs.edu.sa)

H. Basaleem

Department of Community Medicine and Public Health, Faculty of Medicine and Health Sciences, Aden Cancer Registry and Research Center, University of Aden, Aden, Yemen

A. Badheeb

Medicine and Medical Oncology, National Oncology Center (NOC), Hadhramout and Hadhramout Cancer Registry (HCR), Hadhramout University College of Medicine, Mukalla, Yemen

Oncology Center, King Khalid Hospital, Najran, Saudi Arabia

G. Abdul Hamid

Hematology and Laboratory Department, Faculty of Medicine and Health Sciences, University of Aden, Aden, Yemen

© The Author(s) 2022

H. O. Al-Shamsi et al. (eds.), *Cancer in the Arab World*,  
[https://doi.org/10.1007/978-981-16-7945-2\\_20](https://doi.org/10.1007/978-981-16-7945-2_20)

65 years [6]. According to the revised population estimates or the life expectancy at birth, both sexes combined for the Yemeni population rose from 58.2 years in the year 1990 to 66.4 in the year 2020 with around 4 years differences for the favor of females (64.7 years and 68.2 years, respectively) [3]. However, the projected data for the year 2030 showed a very slow increase in the life expectancy of the Yemeni population to only 67.8 years [7].

## 20.2 Cancer Statistics in Yemen

Accurate cancer incidence in Yemen is unknown due to many reasons, such as limited diagnostic and clinical resources, as well as the poor quality of medical records. Furthermore, ongoing civil conflict has recently contributed to the ambiguity of the burden of cancer at national level.

### 20.2.1 Current Status

According to the GLOBOCAN estimation of the overall Age-Standardized Rate (ASR) of cancer in Yemen (2020) of 97/100,000 population, with 92.7/100,000 in males and 102.2 in females [8]. These rates showed Yemen with lower rates of cancer in comparison to other countries in the region, which ranged from 108.7/100,000 in Oman to 170.9/100,000 in the United Arab Emirates [8], which is probably due to underreporting of cancer cases in Yemen. On the other hand, the Aden Cancer Registry (ACR) showed an ASR of 38.2/100,000 in males and 36.1/100,000 in females, respectively, for the period 1997–2011 [9]. However, the National Oncology Center (NOC) in Yemen reported for the year 2007, illustrated an ASR ranged from 17 to 28 per 100,000 population [10].

### 20.2.2 Cancer Mortality Rate

Deaths by cancer in Yemen for the year 2020 were estimated with a total of 12,103 cases with 76.5 ASR (world) per 100,000. Males showed a slightly higher rate than females (77.9 vs. 76.1 ASR (world) per 100,000, respectively) [8]. Among the sites of cancer, breast cancer ranked in the top of the death rates (12.1%), followed by colorectum (10.0%), stomach (9.7%), leukemia (8.6%), esophagus (8.3%), liver (6.5%), lung (6.2%), brain, CNS (6.0%), and non-Hodgkin lymphoma (3.2%) [11]. Precise mortality and survival rate from cancer is not easy to count, particularly for those coming from remote areas of Yemen, and thus, it

becomes difficult for them to access back the health care centers located in the main cities of the country [12].

### **20.2.3 Top Ten Cancers in Yemen**

The rank of cancer types in Yemen is probably not like what exists in the neighboring Gulf countries. According to the GLOBOCAN, estimated age-standardized incidence rates (World) in the year 2020 for both sexes and all ages shows breast cancer was ranked number one in Yemen with ASR 30.5 per 100,000 population, followed by colorectum (10.7), stomach (7.1), esophagus (6.4), lung (5.8), liver (5.1), leukemia (4.2), Non-Hodgkin Lymphoma (4.0), brain/Central Nervous System (3.8), and ovary (3.4 per 100,000 population), as shown in Table 20.1 [13]. However, the reported data from ACR counted leukemia the first (10.5%), Non-Hodgkin Lymphoma (NHL) (10.1%), colorectal (7.5%), Hodgkin diseases (6.1%), and stomach (5.1%) among male cases, while breast cancer ranking the top (30.0%), followed by leukemia (7.6%), NHL (6.6%), colorectal (4.9%), and ovarian cancer (4.5%) among females [9]. Another previous study from ACR (1997–2001) showed that head and neck cancers occupy the fourth position among all registered cancers (1734 cases) in a 5 year period [14]. Some differences in the reported data on cancer from the NOC was breast cancer at the top, however, followed with Non-Hodgkin's Lymphoma, leukemia, liver, and stomach cancers. Among children below 15 years, the most common types were leukemia, Non-Hodgkin's lymphoma, Hodgkin's lymphoma, and CNS tumors [10].

### **20.2.4 Age-Specific Related Cancer**

Figure 20.1 illustrated the increasing trend in cancer cases as age increases with the peak of the ASR per 100,000 population incidence was seen to be higher among females, predominantly in the young and middle age groups (30–59 years), which could be explained as due to the higher rate of breast cancer in this female age group, but was then surpassed by higher incidences in males, particularly in those 60 years and older according to the data reported from GLOBOCAN 2020 [8].

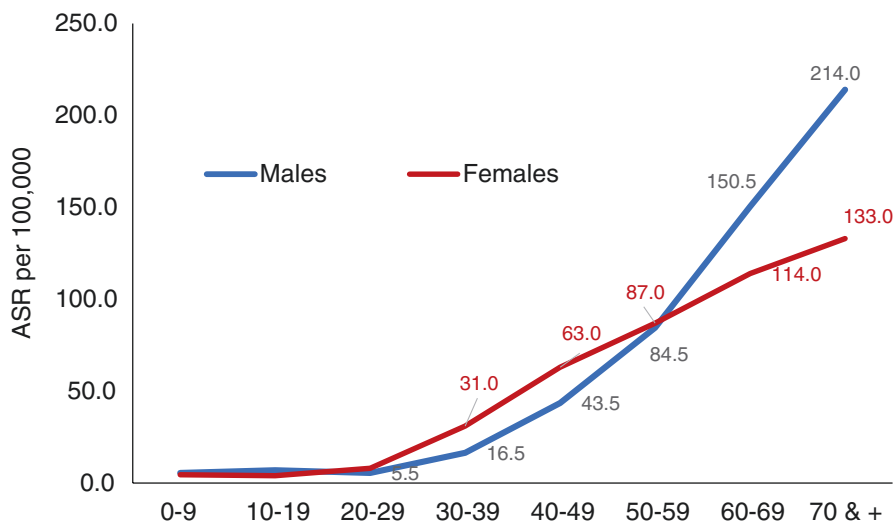
For better understanding of the most common cancers by gender (Fig. 20.2), five categories of classification were used: children <15 years old; adolescents and teenagers: 15–24 years; young adults: 25–49 years; adults: 50–69 years; and elder adults: ≥70 years. Accordingly, males, for example, showed leukemia as the most common in children and teenagers <25 years of age; NHL was the most common in the cohort of 25–49 year; colorectal cancer was the most common type in the 50–69 year cohort; whereas esophageal cancer was found the most common among the elderly cohort aged ≥70 years [9].

**Table 20.1** Estimated age-standardized incidence and mortality rates (World) in 2020, both sexes, all ages. Yemen [13]

All cancers	Incidence	Mortality	Male	Incidence	Mortality	Female	Incidence	Mortality
Breast	30.5	18.9	Colorectum	12.0	8.6	Breast	30.5	18.9
Colorectum	10.7	7.7	Stomach	8.9	8.0	Colorectum	9.5	6.9
Stomach	7.1	6.4	Liver	7.1	7.0	Esophagus	7.2	7.0
Esophagus	6.4	6.2	Lung	6.7	6.5	Stomach	5.7	5.1
Lung	5.8	5.5	Esophagus	5.3	5.2	Lung	5.1	4.8
Liver	5.1	5.0	NHL <sup>a</sup>	5.0	3.9	Leukemia	4.0	3.4
Leukemia	4.2	3.6	B/CNS <sup>b</sup>	4.9	4.7	Thyroid	3.9	1.3
NHL <sup>a</sup>	4.0	3.0	Larynx	4.4	3.8	Liver	3.5	3.4
B/CNS <sup>b</sup>	3.8	3.5	Leukemia	4.4	3.8	Ovary	3.4	2.9
Ovary	3.4	2.9	Bladder	4.0	2.9	NHL <sup>a</sup>	3.2	2.2

<sup>a</sup>NHL Non-Hodgkin lymphoma

<sup>b</sup>B/CNS Brain, central nervous system



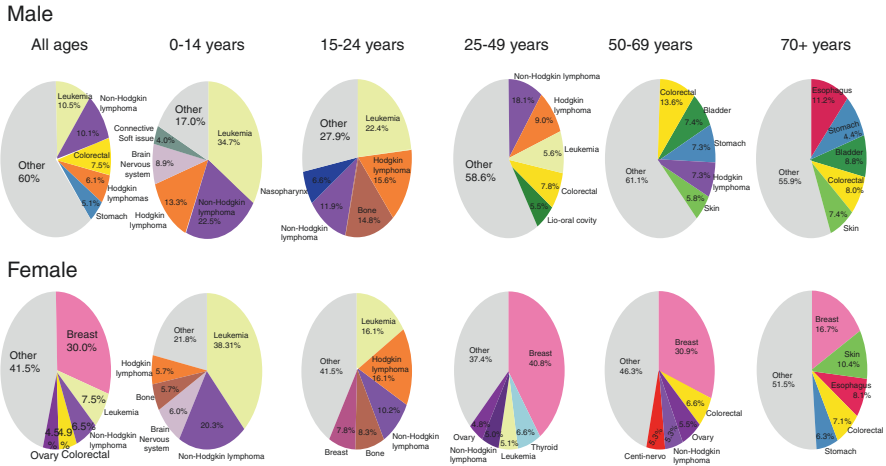
**Fig. 20.1** Age-specific incidence rate per 100,000 population of cancer cases [8]. Copyrights—Cancer Today—IARC, 150 Cours Albert Thomas, 69,372 Lyon CEDEX 08, France—powered by GLOBOCAN 2020

### 20.2.5 Public/Private Sector

Since 1990, most of the cancer diagnosing and treatment centers were publicly located in the main hospitals in the big cities such as Sana'a and Aden. As the strategy of the health system changed to incorporate the private sector in taking part of the health care load, thus many private hospitals and diagnostic laboratories were established, and oncology activities were expanded [15].

### 20.2.6 Cancer Registry in Yemen

Cancer surveillance plays a critical role in the development and implementation of health policy. Currently, five cancer registries were minimally functioning to collect the data on cancer patients and analyzing the findings: Aden Cancer Registry (the pioneer in the country since 1997 under the authority of Aden University), Hadhramaut cancer registry in Al-Mukalla City, Hadramout Valley and Desert Oncology Center (HVDOC), National Oncology Center in Sana'a, and the last one established was Taiz cancer registry (under the authority of the Ministry of Public Health and Population). However, all these registries often struggle with insufficient health services, transient populations, lack of finances, lack of qualified workforces, inadequate or imprecise data due to incomplete coverage, difficulty in establishing a trustworthy, reasonable cancer registry in the nation, and difficulty to obtain data on cancer mortality [9].



**Fig. 20.2** The most common five cancer types by gender and age category from the ACR (1997–2011) [9]. Copyrights—\*Bawazir AA. Cancer incidence in Yemen from 1997 to 2011: a report from the Aden cancer registry. BMC cancer 2018;18(1):540

For better understanding of the most common cancers by gender (Fig. 20.2), five categories of classification were used: children <15 years old; adolescents and teenagers: 15–24 years; young adults: 25–49 years; adults: 50–69 years; and elder adults: ≥70 years. Accordingly, males, for example, showed leukemia as the most common in children and teenagers <25 years of age; NHL was the most common in the cohort of 25–49 year; colorectal cancer was the most common type in the 50–69 year cohort; whereas esophageal cancer was found the most common among the elderly cohort aged ≥70 years [9].

### 20.3 Healthcare System in Yemen

Health care is guaranteed by the state as a right to all citizens under the Yemeni constitution. Historically, the Ministry of Public Health and Population (MoPHP) was responsible for the delivery of health care and overall health system governance [16]. According to the World Health Organization/Regional Office for the Eastern Mediterranean (2018), Yemen’s health situation is one of the least favorable in the world, with various factors such as poverty (GNP = 7\$/year), poor access to water and sanitation, low educational level mainly among women, and high fertility rates which led to worsening the health of Yemeni people. The three-tier system of primary care, based on health units, health centers, and hospitals, is insufficient to cover the health needs of the population, especially since the population growth rate is faster than the expansion rate of available health facilities. Moreover, the general government expenditure on health was only 3.9%; thus, the out-of-pocket

expenditure is much higher per capita [17]. These findings illustrate the weaknesses of the health system in Yemen with insufficient functionality and provision of health services and public health programs with more disruption of the health system due to the ongoing conflict [17].

## **20.4 Cancer Risk Factors**

The main risk factor attributed to cancer in Yemen was Tobacco use (16.3%), followed by overall infections (13.4%), including Hepatitis B infection, obesity (2.5%), and occupational risks (1.4%) [3, 18, 19].

### **20.4.1 Smoking Epidemiology**

A study in Yemen reported that the majority (83.8%) of lung cancer cases were smokers [20]. The WHO report on the global tobacco epidemic in 2017 indicated an increased prevalence rate of smokers in Yemen by 18.7% with higher prevalence in males than females (20.7% vs. 6.0%, respectively) [18]. Despite the increase in tobacco taxes of retail price  $\leq 25\%$ , no tobacco control policy, strategy, or active action plan exists in the country.

### **20.4.2 Khat Chewing (*Catha edulis*)**

Based on the Family Health Survey carried in 2003 in Yemen, it was estimated that 58% of males and 29% of females aged 10 years and older chewed Qat during their lifetime [21]. The evidence linking Khat use to cancer is sparse and circumstantial [22, 23], although there is some suggestion that oral leukoplakias (perhaps pre-cancerous) are more frequent in users of Khat [24]. Smoking of cigarettes and/or Waterpipe are commonly practiced during Khat sessions and considered as a direct or indirect risk for the people in the settings [25, 26]. However, various pesticides and insecticides are known to be used by Khat growers, and they, and consumers of the leaves, are probably exposed to elevated levels of various chemicals [27, 28]. This may therefore pose a further hazard to health.

### **20.4.3 Diet, Physical Activity, and Obesity**

There have been no studies in Yemen on the possible role of dietary intake on cancer risk. Furthermore, population surveys, providing accurate data on intake of different nutrients, on levels of physical activity, or even on the height/weight of the

population are lacking. The WHO estimates the prevalence of overweight as 37.5% in women and 29.7% in men [29]. A local study from Yemen suggested that the mean BMI was significantly higher overall in females (23.9%) than in males (21.8%). However, this trend was also associated with age, mainly in the age group between 35 and 44 years of age [30].

## 20.5 Cancer Screening Programs

Very limited access for cervical and breast cancer screening in the main hospitals, where the facilities for performing screening tests coexist. Organized screening is known to be effective for cancers of the cervix, large bowel, and breast; however, it is difficult to establish in countries with major limitations in health-care services [31]. Therefore, the development of a program of early detection of breast cancer through public and professional education, and establishment of diagnostic and treatment facilities to deal with cases discovered, should be a priority [32, 33].

## 20.6 Cancer Prevention Programs

Prevention involves minimizing or eliminating exposure of the population to the known causes of cancer and promotion of lifestyles known to protect against cancer. Prevention is the most cost-effective long-term cancer control approach and offers the greatest public health impact. Among the successful strategies to combat hepatocellular cancer, vaccination against HBV was used with a reported coverage of 88% among the Yemeni infants [34]. The Human Papillomavirus (HPV) vaccine as considered to protect against cervical cancer was not yet included in the National Vaccination Program [35].

In spite of the fact that most cancers are related to a modifiable risk factor, such as tobacco control, encouraging lifestyle, physical activity, and balanced diet, it remains a major public health problem in Yemen [36]. The involvement of primary healthcare physicians in counseling patients about smoking cessation or obtaining screening CT scan for high-risk patients is very limited. Digital mammography should be allocated in the main care centers in the main cities as the crucial first step with the training of female doctors to perform breast imaging. The same for colorectal cancer, colonoscopy units led by trained doctors in colonoscopy, is of great importance for early detection and to provide good outcomes. Educational campaigns should target tobacco control, encouraging hepatitis vaccination programs, use of mammograms, and human papilloma vaccination.



## **20.7 Cancer Diagnosis**

Imaging diagnostic and interventional diagnostic services such as multi-slice CT scans, MRI, digital mammography also the facility of imaging guided minimally invasive biopsy, were available in many private centers in the country [37]. Similarly, the unique functional nuclear medicine departments are in Sana'a that include the PET CT scan, technical bone scan, thyroid iodine scan, other cancer type-specific scans, in addition to the radioactive iodine therapy service, which are crucial for hematological malignancies, mainly acute leukemia and aggressive lymphomas diagnosis [37].

### **20.7.1 Laboratory**

Diagnostic pathology centers were available in Sanaa, Aden, Taiz, Hudaidah, and Hadramout. Molecular testing in addition to the other diagnostic facilities like flow cytometry, cytogenetics, and PCR machines were also available in Sanaa and Aden. However, immunohistochemistry analysis, molecular profiling to confirm the diagnosis, and hematological malignancies laboratory services were found only in Sana'a city [37].

## **20.8 Treatment**

### **20.8.1 Medical Oncology**

Currently, eight public centers under the umbrella of the National Cancer Control Program (NCCP) in Yemen are providing cytotoxic chemotherapy treatment free for patients with cancer. They are distributed as one in each of the following cities: Sana'a, Aden, Hudaidah, Taiz, Mukalla, Siyun, Ebb, and in Ataq [37]. Other two will be soon established in Al-Mahra and Mareb. Other chemotherapy centers are also functioning in about five more private hospitals; however, the patient must provide the medication. Although Leukemia is considered among the top cancers in the country, Stem Cell Transplantation is not available. Moreover, immunotherapy/targeted therapy/biological agents were also not available in Yemen; therefore, patients must travel to other countries with available facilities such as to India, Egypt, and Jordan.

Currently, few numbers of oncologists were known in the country based on their career of specialty, but most of them were not registered officially in the Ministry of

health as a medical oncologist, and no precise number is currently available, moreover, some general practitioners due to lack of specialists, use to work by practice to prescribe chemotherapy and for some general surgeons to deal with cancer surgeries. Worldwide, the NCCN guidelines are the most widely accepted, cost-effective and evidence-based guidelines that are usually adopted in Yemen as is the case in most of the developed and developing countries.

### **20.8.2 Radiation Therapy**

Three centers in Yemen were responsible for radiotherapy services; one in a public hospital (National Oncology Center) and the other two in private hospitals (Yemeni-German Hospital and the Azal Hospital), all in Sana'a. However, it does not satisfy the long queue of patients waiting for a long time (up to more than 4 months). The available machines in Sana'a were Cobalt Machine, Simulator (conventional old Toshiba one) at the NOC and one linear machine in Azal hospital. However, a number of the following machines in Yemen like gamma knife, cyberknife, Brachytherapy, or any other radiation services such as 3D, VMAT, SBRT, SRS, except the IMRT located in Sana'a only.

According to the registered Radiation oncologist or clinical oncologist provides Radiation and gender information were counted as 17 radiation oncologists (3 females and 14 males) in the year 2021. Programs of expanding radiotherapy facilities at NOC were planned but not started. Additional three radiotherapy units were planned to be established in Aden, Taiz, and Hadhramaut, but no action [37].

### **20.8.3 Surgery**

Despite the large number of surgeons in Yemen who received their career from different schools of surgery in the world, centers for oncological surgery were not available. So usually, surgery is performed in any tertiary level hospital or referral hospital in the main cities. Moreover, robotic surgeries for cancer, and Hyperthermic Intraperitoneal Chemotherapy (HIPEC) procedure, were not available in the country [37].

### **20.8.4 Pediatric Oncology**

Pediatric oncology statistics is part of the main sources for adult cancer statistics which are mainly in the main hospitals, and some were collected at the available cancer registries in Yemen. However, centers providing comprehensive pediatric

cancer treatment were not available in the country, except in Sana'a (NOC) and in Aden (Al-Sadaka Teaching Hospital). Therefore, the future needs to consider pediatric oncology as part of the medical oncology services that should be provided to patients with cancer [37].

### **20.8.5 Survivorship Track**

According to the WHO report in 2019, more investment in cancer care, such as the provision of radiation therapy equipment, is needed to guarantee a multidisciplinary approach to achieve Universal Health Coverage for this category of patients [38]. As more patients are successfully treated for cancer, a new challenge awaits navigating the physical and emotional challenges of being a survivor. No survival registry is found in the country, and no previous research work in this field to determine the survival track in the country.

### **20.8.6 Palliative Care Track**

At present, no oncology center is dedicated for the provision of palliative care, and even those hospitals providing specialist services (radiotherapy and chemotherapy) care make no provision for supportive or terminal care once a patient is terminal and not fit for therapy. Centers for physical rehabilitation (e.g., for amputees) are present, but there are no specialized services in pain control or palliative care in Yemen. Opioids (e.g., oral morphine) are available but used with much restriction in some hospitals and require special authorization for general physicians to prescribe it [37].

## **20.9 Research and Education**

Scientific research works on cancer have been published in regional and international peer-reviewed journals concerning cancer in Yemen [9, 10, 13, 20, 25, 26, 31, 39–47]. However, most of these publications were in concern based around clinical series from a variety of hospital departments and laboratories. There are several areas where research is clearly indicated to assist in planning and evaluation for cancer control in Yemen. It is important to establish the true cancer profile in Yemen, as well as important indicators such as stage at diagnosis and survival from common cancers. Some studies conducted on the potential carcinogenicity of Khat, focusing initially on oral or esophageal cancers. Other publications were focused on knowledge and behavior of the population in some common cancers such as breast,

colorectal, leukemia, and head and neck cancers. Previous studies by Ba-Saleem et al. (2005) and Kahiry W (2011) suggest that the most common cases (generally at advanced stage) include are: breast, leukemia, lymphoma (NHL, HL) head and neck, especially nasopharynx, gastrointestinal (especially esophagus and gastric, colorectal, hepatocellular carcinoma) [39, 41, 43, 44]. Some authors recently showed that there is a significant decrease in patients presenting with advanced-stage cancers such as breast cancer, where stage IV breast cancer diagnosis decreased from 20% to 6% [41].

## **20.10 Cost-Effective Cancer Care**

Increasing numbers of cancer cases in the country to be treated in public and private hospitals require a cost-sharing in public facilities, cost-recovery of drugs and cost exempted treatments in public facilities, which is high in country with marked population poverty. Out-of-pocket payments in times of illness are very high, and in most cases, people seek for better treatment abroad, at the same time, they try to avoid the expensive medications (such as targeted therapy and immunotherapy). In recent years, the principal drugs for cancer therapy were received as grants from some countries outside (donations mainly from King Salman Center, Kingdom of Saudi Arabia through the World Health Organization). Thanks to the generous support of the donors, all cancer centers are currently open and providing cancer care across the country [12]. Therefore, people pay for the low-cost generic drugs (mainly from India). Other NGOs donations also contribute to the treatment cost in some areas, such as the example of “Selah” Foundation in Hadhramaut.

## **20.11 Challenges and Advantages**

### ***20.11.1 Human Resources***

Human resources are a key factor for the appropriate implementation of the program at different levels. A gap still exists between what might be and what is running. Capacity building including training programs in different disciplines technical and managerial should be established through short-term and long-term programs mainly for surgeons, medical oncologists, radiation oncologists, pediatric oncologists, histopathologists, hematologists, epidemiologists, registry clerks, nurses, and other paramedics. Moreover, the main defect in the health allied team is the qualified oncology pharmacists and nurses.

### ***20.11.2 Role of Non-Governmental Organizations (NGOs)***

Partnership between local and international organizations is an important factor for the success of a program. In Yemen, some local NGOs are already active in providing services to the patient and contributing to some educational campaigns. However, probably more actions were needed to work in cooperation with the government in some other areas, such as producing health educational materials, supporting scientific work, establishing, and funding of cancer registries, hospice/palliative/terminal care, and patient and family support. Among these NGOs are Yemen Cancer Society based in Aden, Yemeni Cancer Foundation (mainly in Sana'a), and Hadhramaut Cancer Foundation (based in Hadhramaut).

### **20.12 The Future of Cancer Care in Yemen**

The national cancer program in Yemen is planned to improve the future care for patients with cancer. A road map was established for capacity building of principal elements through local and abroad training programs in different disciplines technical and managerial using a short-term and long-term training mainly for surgeons, medical oncologists, radiation oncologists, pediatric oncologists, histopathologists, hematologists, epidemiologists, registry clerks, nurses, and other paramedics. Establishment of reliable cancer profile in Yemen, which includes accurate data reporting of the registered cases, improve staging at diagnosis, counting the survival rate of at least the common cancers. Establish a dedicated unit in the main hospitals for provision of palliative care with the training of the oncologists in this field. Strengthening cooperation and collaboration with other oncology centers in the region as well as some international agencies to support in the training and exchange of opinions in oncology medication. Encourage local capitals to invest in the diagnosis and treatment of patients with cancer, particularly those who need specific interventions such as stem cell transplantation and HIPEC procedures [37].

### **20.13 Conclusion**

Priority and emphasis on the burden of breast cancer among Yemeni women should be given special consideration due to the high incidence and consequently high rate of deaths. Hence, efforts are needed to increase breast cancer awareness in Yemen for early detection at all age groups and to target women living in areas that have lower access to health care services. Research is needed to study the factors related to equity in health services for diagnosis, screening, and management of cancer

patients in different regions of the country, with more focus, should be given for most people residing in the rural areas. Yemen has been characterized by three decades of scattered, fragmented, and unfocused cancer research. Furthermore, much is needed to improve cancer care in Yemen through redesigned, better organized, and well-functioning cancer facilities in the country according to clear developmental programs. Moreover, the National Cancer Control Plan seeks to address the inadequacy of cancer patient care services through integrating different services and aiming for the most effective and efficient use of existing, and, hopefully, additional resources, in an equitable way, for the whole population. It is necessary to focus on some priority areas, to ensure that some concrete steps are taken and that the best does not become the enemy of the good.

**Conflict of Interest** Authors have no conflict of interest to declare.

## References

1. UN. In: The United Nations in Yemen: sociodemographic profile. Sana'a Yemen: United Nation; 2020. <https://yemen.un.org/en/about/about-the-un>.
2. NIC/Yemen. In: Republic of Yemen administrative governorates. National Information Center; 2014. <https://yemen-nic.info/yemen/gover/#>.
3. WM. In: Yemen demographics: life expectancy in Yemen. Worldometers; 2020. <https://www.worldometers.info/demographics/yemen-demographics/#life-exp>.
4. WM. In: Worldmetric: Yemen population. Worldmetric; 2020. <https://www.worldometers.info/world-population/yemen-population/#:~:text=Yemen%202020%20population%20is%20estimated,146%20people%20per%20mi2>.
5. UN. Prospects 2019: Highlights (ST/ESA/SER.A/423): United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population; 2019. [https://population.un.org/wpp/Publications/Files/WPP2019\\_Highlights.pdf](https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf).
6. UNFPA. In: Population pyramid, Yemen. United Nations Population Fund; 2020. <https://www.unfpa.org/ageing>.
7. UNESCWA. In: The demographic profile of Yemen: population trend. 2020. [https://www.unescwa.org/sites/www.unescwa.org/files/yemen\\_2017-single\\_pages\\_jan\\_8.pdf](https://www.unescwa.org/sites/www.unescwa.org/files/yemen_2017-single_pages_jan_8.pdf).
8. IARC. In: Cancer today: estimated age-standardized incidence rates (world) in 2020, all cancers, all ages (Yemen). Lyon: World Health Organization/International Agency for Research on Cancer; 2021. [https://gco.iarc.fr/today/online-analysis-map?v=2020&mode=population&mode\\_population=continents&population=900&populations=900&key=asr&sex=2&cancer=39&type=0&statistic=5&prevalence=0&population\\_group=0&ages\\_group%5B%5D=0&ages\\_group%5B%5D=17&nb\\_items=10&group\\_cancer=1&include\\_nmsc=1&include\\_nmsc\\_other=1&projection=globe&color\\_palette=default&map\\_scale=quantile&map\\_nb\\_colors=5&continent=0&rotate=%25B10%252C0%25D](https://gco.iarc.fr/today/online-analysis-map?v=2020&mode=population&mode_population=continents&population=900&populations=900&key=asr&sex=2&cancer=39&type=0&statistic=5&prevalence=0&population_group=0&ages_group%5B%5D=0&ages_group%5B%5D=17&nb_items=10&group_cancer=1&include_nmsc=1&include_nmsc_other=1&projection=globe&color_palette=default&map_scale=quantile&map_nb_colors=5&continent=0&rotate=%25B10%252C0%25D).
9. Bawazir AA. Cancer incidence in Yemen from 1997 to 2011: a report from the Aden cancer registry. *BMC Cancer*. 2018;18(1):540. <https://doi.org/10.1186/s12885-018-4411-9>.
10. Afif A, Algharati AM, Hamid GA, Al-Nehmi AW, Shamlan A. Pattern of cancer in Yemen: first result from the National Oncology Center, Sana'a. *Eur J Pharm Med Res*. 2017;4(1):149–54. [https://www.ejpmr.com/home/abstract\\_id/1880](https://www.ejpmr.com/home/abstract_id/1880)
11. ICCP. In: Cancer country profiles Yemen 2020: WHO-international cancer control partnership. The International Cancer Control Partnership; 2020. <https://www.iccp-portal.org/who-cancer-country-profiles-yemen-2020>.

12. WHO/EMRO. In: Cancer patients in Yemen face the compounded pain of disease and conflict. Cairo: The World Health Organization/Eastern Mediterranean Region; 2020. <http://www.emro.who.int/yemen/news/cancer-patients-in-yemen-face-the-compounded-pain-of-disease-and-conflict.html>.
13. Basaleem HO, Bawazer AA, Al-Sakkaf KAZ. Head and neck cancer: is it a problem among Yemeni patients? (A five year retrospective study). *J Nat Appl Sci*. 2005;9(1)
14. IARC/WHO. Global Health Observatory. In: World Health Organization. 2018. Global health observatory. Geneva: International Agency for Research on Cancer/World Health Organization; 2018. <https://gco.iarc.fr/today/home>.
15. MOPHP. National Health Strategy: toward better health for all through developing a fair health system. Sana'a: Ministry of Public Health and Population; 2010. [https://extranet.who.int/countryplanningcycles/sites/default/files/planning\\_cycle\\_repository/yemen/nat\\_health\\_strategy\\_-\\_yemen\\_eng.pdf](https://extranet.who.int/countryplanningcycles/sites/default/files/planning_cycle_repository/yemen/nat_health_strategy_-_yemen_eng.pdf)
16. Qirbi N, Ismail SA. Health system functionality in a low-income country in the midst of conflict: the case of Yemen. *Health Policy Plan*. 2017;32(6):911–22.
17. WHO/EMRO. Yemen: Health Systems Profile; 2018. <https://rho.emro.who.int/sites/default/files/Profiles-briefs-files/YEM-Health-System-Profiles-2018.pdf>.
18. WHO. WHO report on the global tobacco epidemic, 2017: monitoring tobacco use and prevention policies. Geneva: World Health Organization; 2017. Report No.: 9241512822. <https://apps.who.int/iris/bitstream/handle/10665/255874/97892415?sequence=1>.
19. WHO. Report on the global tobacco epidemic, 2015: raising taxes for tobacco. In: EMRO. Algeria: World Health Organization; 2015. [https://www.who.int/tobacco/global\\_report/2015/en/](https://www.who.int/tobacco/global_report/2015/en/).
20. Abdul Hamid G, Al-Nabhi A, Baom N, Algalabi A. Lung cancer in Aden, Yemen. *World J Pharm Res*. 2015;4(7):324–32. [www.wjpr.net](http://www.wjpr.net)
21. MOPHP. Family Health Survey 2011. Sana'a: Ministry of Public Health and Population; 2003. [www.mophp-ye.org/](http://www.mophp-ye.org/)
22. Hassan N, Gunaid A, Murray Lyon I, Khat [Catha edulis]: health aspects of khat chewing. *East Mediterr Health J*, 13 (3), 706–718, 2007 2007.
23. El-Zaemey S, Schüz J, Leon M. Qat chewing and risk of potentially malignant and malignant oral disorders: a systematic review. *Int J Occup Environ Med*. 2015;6(3):129–43.
24. Ali AA, AlSharabi AK, Aguirre JM, Nahas R. A study of 342 oral keratotic white lesions induced by qat chewing among 2500 Yemeni. *J Oral Pathol Med*. 2004;33(6):368–72.
25. Laswar AK, Darwish H. Prevalence of cigarette smoking and khat chewing among Aden university medical students and their relationship to BP and body mass index. *Saudi J Kidney Dis Transpl*. 2009;20(5):862–6. *SaudiJKidneyDisTranspl\_2009\_20\_5\_862\_55381* [pii]. <http://www.ncbi.nlm.nih.gov/pubmed/19736493>
26. Marway R. Oral health: the destructive effects of Khat. *Br Dent J*. 2016;221(1):2. <https://doi.org/10.1038/sj.bdj.2016.468>.
27. Date J, Tanida N, Hobara T. Qat chewing and pesticides: a study of adverse health effects in people of the mountainous areas of Yemen. *Int J Environ Health Res*. 2004;14(6):405–14.
28. Hassan AA, Abdullah SM, Khardali IA, Oraiby ME, Shaikain GA, Fageeh M, et al. Health impact of Khat chewing and pesticides: detection of 8 pesticides multi-residues in Khat leaves (Catha edulis) from Jazan region. *KSA Adv Environ Biol*. 2016;10:30–6.
29. Bagchi K. Nutrition in the eastern Mediterranean region of the World Health Organization. *East Mediterr Health J*. 2008;14:S107–13.
30. Gunaid A. Obesity, overweight and underweight among adults in an urban community in Yemen. *East Mediterr Health J*. 2012;18(12):1187–93.
31. Bawazir A, Bashateh N, Jradi H, Breik AB. Breast cancer screening awareness and practices among women attending primary health care centers in the Ghail Bawazir District of Yemen. *Clin Breast Cancer*. 2019;19(1):e20–9. <https://doi.org/10.1016/j.clbc.2018.09.005>.
32. Sancho-Garnier H, Khazraji YC, Cherif MH, Mahnane A, Hsairi M, El Shalakamy A, et al. Overview of cervical cancer screening practices in the extended Middle East and North Africa countries. *Vaccine*. 2013;31:G51–7. <https://doi.org/10.1016/j.vaccine.2012.06.046>.

33. Nasher AT, Al-hebshi NN, Al-Moayad EE, Suleiman AM. Viral infection and oral habits as risk factors for oral squamous cell carcinoma in Yemen: a case-control study. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2014;118(5):566–572.e1.
34. WHO/UNICEF. WHO and UNICEF estimates of immunization coverage: 2019 revision. Yemen: The World Health Organization and UNICEF; 2020. [https://www.who.int/immunization/monitoring\\_surveillance/data/yem.pdf](https://www.who.int/immunization/monitoring_surveillance/data/yem.pdf)
35. Bruni LAG, Serrano B, Mena M, Gómez D, Muñoz J, Bosch FX, de Sanjosé. Human papillomavirus and related diseases report YEMEN: summary report. ICO/IARC Information Centre on HPV and Cancer (HPV Information Centre); 2019. [www.hpvcentre.net](http://www.hpvcentre.net).
36. WHO. An annotated bibliography of scientific studies done on tobacco topic in WHO South-East Asia Region countries: 2003–2014: surveillance, health effects, economics and control efforts. World Health Organization; 2015. Report No.: 9290224940. <https://apps.who.int/iris/handle/10665/204785>.
37. Abdul Hameed G. Cancer diagnostic pathology centers in Yemen: annual report. National Cancer Control Program. Ministry of Public Health and Population. Aden. Yemen. 2021.
38. WHO. WHO report on cancer: setting priorities, investing wisely and providing care for all. Cairo: World Health Organization; 2020. Report No.: 9240001298. <http://www.quotidianosanita.it/allegati/allegato4849716.pdf>.
39. Al-Kahiry W, Omer H, Saeed N, Hamid G. Late presentation of breast cancer in Aden, Yemen. *Gulf J Oncolog.* 2011;9:7–11.
40. Al-Maweri SA, Addas A, Tarakji B, Abbas A, Al-Shamiri HM, Alaizari NA, et al. Public awareness and knowledge of oral cancer in Yemen. *Asian Pac J Cancer Prev.* 2015;15(24):10861–5.
41. Al-Naggar R, Al-Maktari LAS, H A, J T, B S, SI M. Critical assessment of three decades of breast cancer research in Yemen. *Syst Rev Biomed Res Health Adv.* 2020;2(1):1008. <http://www.medtextpublications.com/biomed-research-and-health-advances-articles-in-press.php>
42. Badheeb A, Baamer A. The pattern and distribution of malignancies reported in Hadramout sector, Yemen-2002-2011. *Alandalus For Soc Appl Sci J.* 2012;5:7–16.
43. BaSaleem H, Bawazir AA, Moore M, Al-Sakkaf KA. Five years cancer incidence in Aden Cancer Registry, Yemen (2002-2006). *Asian Pac J Cancer Prev.* 2010;11(2):507.
44. Basaleem HO, Al-Sakkaf KA. Colorectal cancer among Yemeni patients. Characteristics and trends. *Saudi Med J.* 2004;25(8):1002–5.
45. Bashamakha G, Bin Sumait H, Bashamakha M, Al Serouri A, Khader Y. Risk factors of breast cancer in Hadramout Valley and Desert, Yemen. *Int J Prev Med.* 2019;10 [https://doi.org/10.4103/ijpvm.IJPVM\\_251\\_17](https://doi.org/10.4103/ijpvm.IJPVM_251_17).
46. Bawazir AA. Deaths, DALY and other related measures of breast cancer in Yemeni women: findings of the global burden of disease study (1990–2010). *J Cancer Res Pract.* 2017;4(1):14–8.
47. Salim EI, Jazieh AR, Moore MA. Lung cancer incidence in the Arab league countries: risk factors and control. *Asian Pac J Cancer Prev.* 2011;12(1):17–34.



**Amen Bawazir**, MBBS, Epi DR, PhD, is the Professor and consultant of Epidemiology and Community Medicine at the Faculty of Medicine and Health Sciences, University of Aden, Yemen. He has graduated from Liverpool School of Tropical Medicine, UK. He was a former head of the Aden Cancer Registry and Research Center and the chairman of the Yemeni Society for cancer control/Aden. He has worked as Deputy Dean at the Faculty of Medicine and Health Science, Aden University and consistently contributed to the academic activities for over 35 years in Aden and in KSAU-HS, Saudi Arabia. His publications on cancer were highly cited. Moreover, he has been awarded for his contribution in reviewing articles from many journals.





**Huda Basaleem** is the Professor and consultant in Community Medicine Public Health, Director of Aden Cancer Registry and Research Center, Faculty of Medicine and Health Science and Vice Dean, Faculty of Postgraduate Studies, University of Aden, Yemen. She is a WHO expert for the Eastern Mediterranean Countries on NCDs Surveillance. Dr. Basaleem is the Principal Investigator and consultant for several international organizations like WHO, UNICEF, World Bank, UNHCR, IOM and the Foundation for Future. She is the Editor-In-Chief, Yemeni Journal of Medical and Health Research and editorial member in several journals (regional and international). She was also the winner of the Elsevier Award in Life Sciences for Women Scientists in the Developing World (Arab Region).



**Ahmed Badheeb**, MD, is the Professor of Internal Medicine and Medical Oncology. He is the founder and former director of the National Oncology Center-Hadhramout-Yemen. Prof. Ahmed was the former Vice Dean for academic affairs, Hadhramout University, College of Medicine. He has published many papers in the field of Medicine and Oncology. He has a special interest in medical education and the quality of healthcare.



**Gamal Abdul Hamid** has received his German board in internal medicine and PhD in hematology-oncology from the faculty of medicine, University of Dresden during the period between 1987 and 1993. Currently, he is working as general director of the National Program of Cancer Control, Yemen Republic. Moreover, he is the head of hematology and clinical laboratory in the Faculty of Medicine, University of Aden, general secretary of Yemen Cancer Society and consultant of hematology-oncology in the national oncology center, Aden. He serves as an editorial member of several national and international medical journals. He is a member of ESMO, ASCO, INCTR, Pan Arab Oncology and WAMS.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

