Chapter 4
General Oncology Care in Egypt

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4.1 Egypt Demographics

4.1.1 Population

The Egyptian population is one of the largest in the Middle East and North Africa region. Egypt is home to a population of 99,842,504, according to the latest official census in January 2020 [1]. The population in Egypt represents 1.29% of the global population. It is ranked 14th in the list of countries sorted by population [2]. The rural areas encompass 57.2% of the total population, while the urban regions have 42.8%, where the percentage of males is 51.5%, and the percentage of females is 48.5%. Egypt is characterized by an expansive population pyramid with a youth bulge (Fig. 4.1a, b). It is estimated that 50.6% of the population is under the age of 24 years and only 5.3% are above the age of 65 years [4]. Cairo is the most populous city with about 9.9 million inhabitants. Ninety-five percent of the population density lives along the Nile valley [1].

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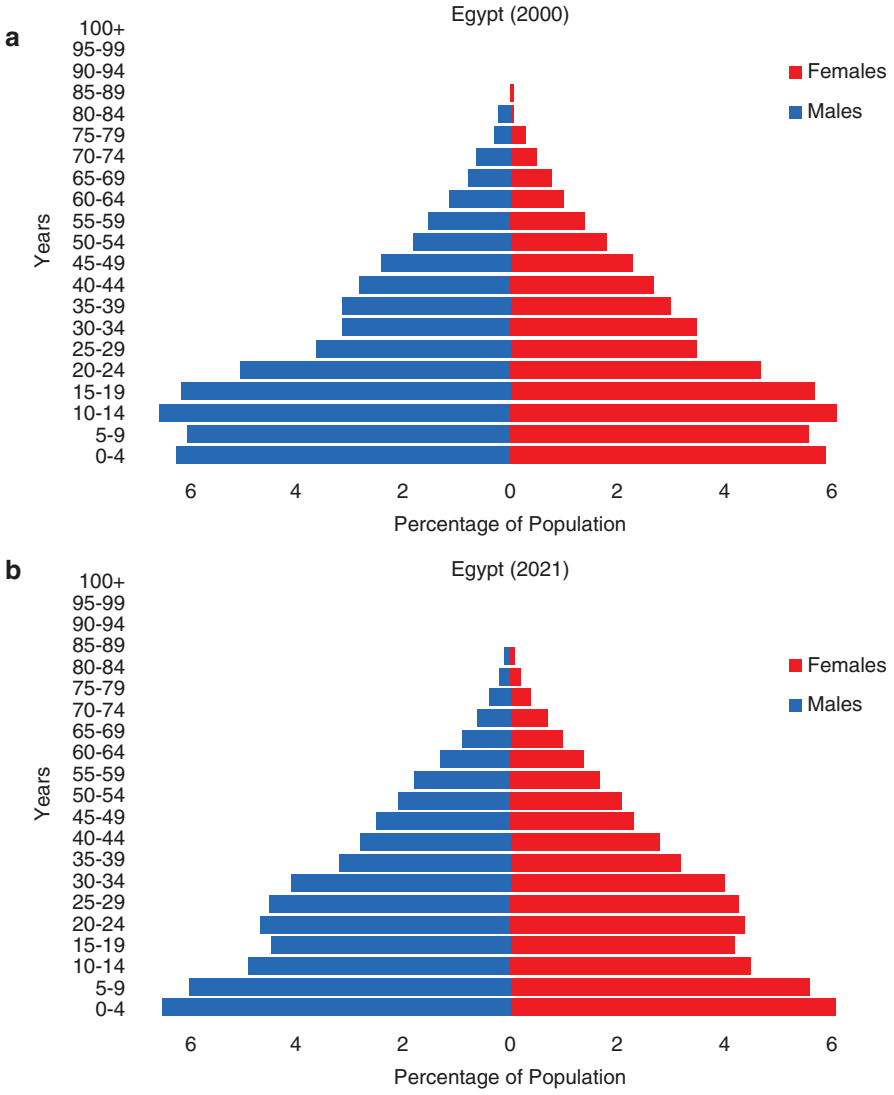

Fig. 4.1 (**a**) Population distribution in Egypt by age and sex in 2000 [1, 3]. (**b**) Population distribution in Egypt by age and sex in 2021 [1, 3]

4.1.2 Regions

Egypt has an area of approximately one million square kilometers. It is ranked 31st in the list of countries sorted by population [5]. Most of the Egyptian land is in the Northeastern part of Africa. Only the Sinai Peninsula is in the southwestern part of the Asian continent. Egypt has 27 governorates and is divided into four main geographical regions: the Nile River and Delta, the Sinai Peninsula, the Eastern Desert, and the Western Desert.

4.1.3 Economy

Egypt had an estimated Gross Domestic Product (GDP) of 363,092 million US dollars and an estimated GDP per capita of 3613 US dollars in 2020 [6]. Egypt is a developing country, with a Human Development Index (HDI) of 0.707 in 2019, which classifies it as a 'High Development Country' and ranks 116th out of 189 countries [7].

4.1.4 Government

Egypt is a presidential republic. The current president of Egypt is Abdel Fattah el-Sisi, in-house, since May 2014. Egypt is ruled by a new constitution, approved by referendum in January 2014. The constitution states that Egypt is a democratic state with a division of power between the bicameral parliament (composed of the House of Representatives and the Shura Council), the Government and the Judicial system [8].

4.1.5 Life Expectancy

The average life expectancy of Egyptians has increased over the past decades. In 2020, the life expectancy at birth was 73 years (74.3 for males; 75.5 for females) [1], and the life expectancy at age 65 was 14.1 years [4]. In 1990, the average life expectancy at birth was only 63.5 years.

4.2 Cancer Statistics in Egypt

In 2019, 324,949 patients with malignant neoplasms were being treated in Egypt at the states' expense [1]. As estimated by Global Cancer Observatory (GLOBOCAN) in December 2020, the most prevalent cancers in Egypt are (5-year prevalence of all ages) [9]: breast (61,160), liver (28,977), bladder (26,986), Non-Hodgkin Lymphoma (19,096), leukemia (14,274), brain, and Central Nervous System (11,470), and prostate (10,523); with a total of 278,165 for all cancers. The highest incidence numbers for specific cancer cases in Egypt in 2020 were: liver (27,895), breast (22,038), bladder (10,655), Non-Hodgkin Lymphoma (7305), lung (6538), leukemia (5231), and prostate (4767); with a total of 134,632 for all cancers (Fig. 4.2a). The specific cancer distribution in males and females is shown in Fig. 4.2b and in Fig. 4.2c, respectively [9].

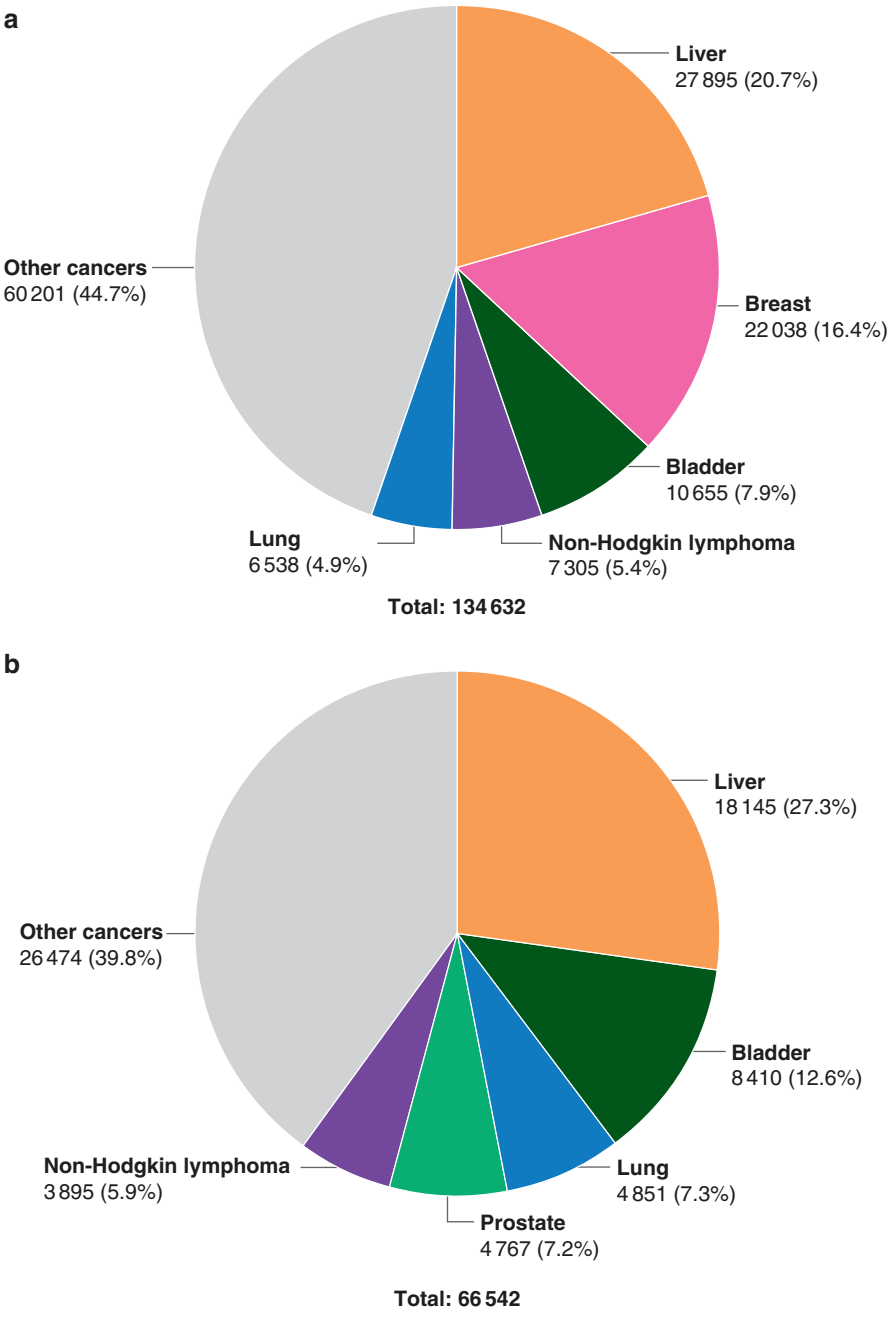

Fig. 4.2 (**a**) Number of new cases in 2020, both sexes, all ages (GLOBOCAN) [9]. (**b**) Number of new cases in 2020, males, all ages (GLOBOCAN) [9]. (**c**) Number of new cases in 2020, females, all ages (GLOBOCAN) [9]

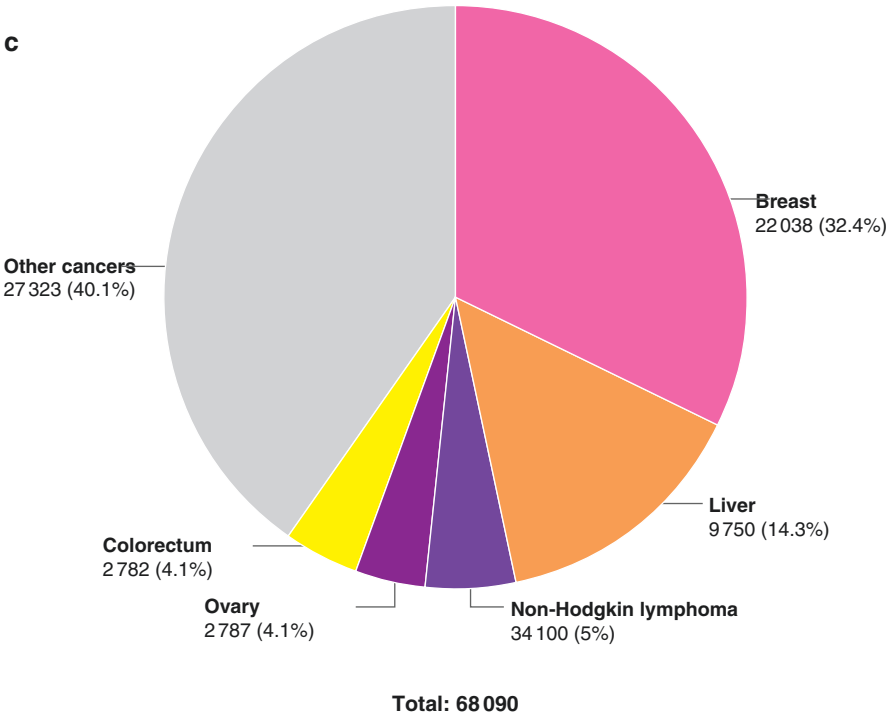

Fig. 4.2 (continued)

The highest mortality numbers for 2020 in Egypt were: liver (26,523), breast (9148), bladder (6170), lung (5817), Non-Hodgkin Lymphoma (4078), leukemia (3858), and brain and Central Nervous System (3686); with a total of 89,042 for all cancers [9].

A gradual increase in mortality numbers over the years can be seen in the WHO Cancer Mortality database report for 2015 (Tables 4.1 and 4.2) [10].

4.3 Oncology Care in Egypt

Cancer care in Egypt is provided by the Ministry of Health (MoH), university hospitals, Non-Governmental Organizations (NGOs), military and police oncology units, and the private sector.

There are 11 oncology centers supervised by the Ministry of Health, which contain 943 beds. The number of all physicians registered in the ministry is 120,606. Yet, there is not an official count of the number of oncologists [1].

University hospitals are major elements of the healthcare sector. There are 24 public medical schools, ten private medical schools, and 109 university hospitals covering most of Egypt. Each medical school has an oncology department with a radiotherapy unit, nuclear medicine, surgical oncology, and chemotherapy unit.

Table 4.1 Number of deaths, all cancers, females, all ages, WHO cancer mortality database [10]

Year	Deaths	Crude rate	ASR(W)	Cumulative risk
1955	1043	9.14	14.78	–
1956	1125	9.59	14.73	–
1957	1068	8.86	13.19	–
1958	1245	10.05	15.02	–
1959	1346	10.57	15.75	–
1960	1354	10.35	14.67	–
1961	1348	10.03	13.93	–
1962	1454	10.53	14.49	–
2000	6773	19.82	25.21	–
2001	7764	22.29	28.14	–
2002	8446	23.81	29.82	–
2003	9130	25.27	31.61	–
2004	9530	25.92	32.29	–
2005	9904	26.46	32.82	–
2006	10219	26.84	33.08	–
2007	10149	26.20	32.08	–
2008	10915	27.68	33.72	–
2009	11357	28.28	34.22	–
2010	12042	29.40	35.57	–
2011	12370	29.58	35.50	–
2014	14321	32.02	38.26	–
2015	14533	31.78	37.78	–

Table 4.2 Number of deaths, all cancers, males, all ages—WHO cancer mortality database [10]

Year	Deaths	Crude rate	ASR (W)	Cumulative risk
1955	1596	13.51	25.93	–
1956	1791	14.76	26.59	–
1957	1583	12.69	21.76	–
1958	1845	14.39	25.35	–
1959	1951	14.80	25.45	–
1960	1999	14.75	24.93	–
1961	2092	15.02	25.31	–
1962	2360	16.50	26.02	–
2000	9544	27.54	40.08	–
2001	10851	30.72	44.21	–
2002	11538	32.04	46.14	–
2003	12716	34.65	49.70	–
2004	12957	34.64	49.71	–
2005	13136	34.48	49.33	–
2006	13474	34.73	49.16	–
2007	13514	34.22	48.23	–

Table 4.2 (continued)

Year	Deaths	Crude rate	ASR (W)	Cumulative risk
2008	14262	35.47	49.52	–
2009	15139	36.95	51.63	–
2010	15651	37.44	52.40	–
2011	16283	38.13	53.14	–
2014	18547	40.59	55.85	–
2015	17855	38.22	52.77	–

Examples include [11]: Cairo University hospitals (Kasr El Ainy), Ain Shams University hospitals (El-Demerdash), Alexandria University hospitals, El-Mansoura University hospitals, and Asyut University hospitals.

"National Cancer Institute (NCI)" is an organization affiliated with Cairo University. The primary institute is in the heart of Cairo and has been operating since 1969. In 2012, The "National Cancer Hospital and Institute: Breast Cancer Hospital" started operating in the First Settlement, New Cairo, to cover the increased demand caused by the increased breast cancer incidence in Egypt [9]. A third hospital "New National Cancer Institute 500500" is currently under construction, expected to open in 2023. It is located at Sheikh Zayed City, Giza. The hospital will have 1020 beds in the inpatient department, 500 beds in the day-care department, 60 operating theaters, 15 radiotherapy machines, and a research center [12].

Charity hospitals play a major role as cancer treatment can be very expensive for many. Shefaa El-Orman Hospital is a big comprehensive center in upper Egypt. The number of beds in the inpatient unit at the adult cancer hospital is 150, and 26 beds in the Intensive Care Unit (ICU). A children's cancer hospital has recently opened on February 23, 2021. It includes 100 beds in the inpatient department and 20 beds in the ICU unit [13].

In Cairo, Children's Cancer Hospital Egypt 57,357 is a child cancer hospital founded in 1999 and operated in 2007. It is located at El-Sayeda Zinab distract, Cairo. It has reported an average overall survival rate of 72% and it received 3355 new patients in 2020 [14].

Baheya Hospital is a specialized hospital for breast cancer. It is located at El-Haram, Giza. The hospital reported the monthly rate as screening 3000 women, 3000 chemotherapy sessions, and 1000 radiotherapy sessions [15].

The Non-Governmental Organizations (NGOs) are also active players in the health field in Egypt, as they help by increasing the awareness of the disease, offer financial, professional aid and psychological support to breast cancer survivors. Examples of NGOs: Breast Cancer Foundation of Egypt, operating since 2004, Egyptian Society of Women's Health and CanSurvive.

Other providers are military and police oncology units that treat both military and civilian patients, private cancer centers, and oncology clinics inside private hospitals.

4.3.1 Liver Cancer

Liver cancer, especially Hepato-Cellular Carcinoma (HCC), is a significant health burden in Egypt, which ranks above the 90th percentile worldwide in liver cancer incidence. There is a strong male predominance of 45.9% in comparison with 22.7% for females [16, 17]. Male predominance is presumably due to higher exposure of males to HCV. Some authors attributed this difference to the fact that males were more affected by schistosomiasis. Hence, males were the main target of parenteral anti-schistosomal therapy campaigns, causing iatrogenic transmission of infection [18].

4.3.2 Breast Cancer

Breast cancer is the leading malignancy among females in Egypt [9]. The most common tumor histology is infiltrating duct carcinoma (83.2%), followed by infiltrating lobular carcinoma (9.1%) and medullary carcinoma (3.2%). The most prevalent type is luminal A subtype (41.2%), followed by triple-negative subtype (28.5%), then Her2-expressing subtype (19.4%), and luminal B subtype (13.9%) [19]. The reasons for this trend are not clear yet. It is possible that different environmental factors affecting the younger generation lead to this consequence. Examples of these factors are the delayed age of marriage (i.e., late age of first birth), the smaller number of offspring and delayed age of breastfeeding (as more young women are educated and working than before) can be responsible for this trend.

4.3.3 Bladder Cancer

Egypt has a very high prevalence rate of bladder cancer compared to global rates. In 1987, Egypt was ranked the top worldwide in bladder cancer mortality rate (Age-specific mortality rate of 10.8 per 100,000 in males) [20]. Over the past 26 years, a significant change in the histopathological types of bladder cancer in Egypt has been noticed. The relative frequency of Transitional Cell Carcinoma (TCC) increased from 22% in 1980 to 73% of bladder diagnosed in 2005, while Squamous Cell Carcinoma (SCC) decreased from 78% of diagnosed bladder tumors in 1980 to 27% of diagnosed bladder tumors [21]. A significant decrease in the relative frequency of bladder cancer at the National Cancer Institute in Cairo was also noted [20]. Even though, bladder cancer remains the second most common cancer among Egyptian males [9, 22]. There is a strong male predominance of the disease with 4:1 male to female ratio [21, 23]. This may be due to higher rates of schistosomiasis hematobium among male farmers who are more exposed to the Nile water [24].

4.4 Cancer Risk Factors

4.4.1 Liver Cancer

The global burden of diseases study in 2015, reported the etiological factors for HCC in Egypt as HCV (63%), HBV (13%), alcohol (12%), and other factors (12%) [25]. This significantly high prevalence of viral Hepatitis C among the Egyptian population is linked to HCV. 92.5% of anti-HCV-positive Egyptians are found to be infected with Genotype 4 (Genotype 4a alone constitutes about 63% of Hepatitis C genotypes) and are thus less responsive to interferon therapy [26–29]. A two-fold increase in HCC incidence rate in the last two decades was reported among chronic liver disease patients in Egypt, accompanied by a significant decline of HBV and a slight increase of HCV as risk factors [26]. HCV is the main risk factor for HCC, as a study reported, anti-HCV antibodies in 71% of HCC cases [27].

The high prevalence of viral Hepatitis B and C has been largely attributed to iatrogenic transmission of infection in mass treatment campaigns of schistosomiasis in the 1960s through 1980s [30]. Environmental factors, especially aflatoxins, have also been linked with the high prevalence of liver cancer in Egypt [31], and have been shown to contaminate more than 20% of silage, due to improper grain storage [32].

4.4.2 Bladder Cancer

Schistosoma-Associated Bladder Cancer (SABC) is different from non-Schistosoma-Associated bladder carcinoma, and it is often regarded as a separate type of bladder cancer. Schistosoma hematobium's eggs trigger a chronic local inflammatory response in the urinary bladder leading to the formation of "sandy patches." This chronic wear and tear process triggers the release of various carcinogenic compounds. It should be noted, however, that a latent period of 20–30 years exists between the peak of the schistosomal catch of infection and the manifestation of SABC. This explains why the incidence rate is highest among 40–59 year-old patients (42% of cases), while the schistosomal peak is during their 30s. Egypt has been largely successful in controlling schistosomiasis. Starting from the early 1920s, tartar emetic was the only available treatment. This has lowered the disease prevalence to around 50% [33]. The Snail Control program was initiated in the late 1930s, aimed at interrupting the life cycle of the parasites by destroying their snail host [34]; however, the prevalence hardly changed [35]. The major shift happened after the approval of praziquantel in 1980, especially when the National Schistosomiasis Control Project (NSCP) supplied ten million children in school-age

in rural Egypt and all residents of more than 500 villages were at high risk of infection with praziquantel. This success changed the prevalence of schistosomiasis from 20% to 10% in 1999 and then lowered again to 3.5% in 2002 [36]. Also, there is an emerging trend whereby the proportion of SABC is decreasing in comparison to TCC. Hence, Egypt is becoming more "Westernized" in terms of its bladder carcinoma subtypes [20, 37]. Another risk factor for bladder cancer is cigarette smoking, which increased the risk of bladder urothelial carcinoma as male smokers had a 1.8-fold higher risk of urothelial carcinoma than males who never smoked [37]. The prevalence of smoking among the Egyptian population in 2010 was 22% [38] and is thought to be increasing [39]. Its prevalence could explain why bladder cancer remains among the top killers in Egypt.

4.5 Cancer Screening Programs

In September 2018, the government announced, "100 Million Healthy Lives," the initiative of President Abdel Fatah el-Sisi to eradicate Hepatitis C and detection of Non-Communicable Diseases. It is an initiative that is targeted for screening and documentation of the exact number of current HBV, HCV, hypertension, and diabetes mellitus patients in the Egyptian population. It was expanded by launching a sub-campaign "Egyptian Women's Health Initiative," a three-phase project, aiming at early detection of breast cancer by screening 28 million women [40]. One of the initiatives' goals is to link all oncology centers that provide breast cancer management service in a single network to ensure the integration between institutions and the high quality of the service provided [40].

Currently, there is no national screening program for cervical cancer as Papanicolaou (PAP) smear screening for cervical cancer is arguably cost-ineffective, given the relatively low rates of cervical cancer screening among Egyptian females in comparison to western countries [41]. By 2015, only 0.3% of the Egyptian females had a Pap smear [42]. Moreover, the new HPV vaccine, which was released in 2007, is very expensive and it is doubtful that it can be integrated into Egypt's compulsory vaccination schedule any time soon. And the same could be stated about colon or prostate cancer screening programs.

However, many local initiatives provide this screening tool. The first locally organized service to offer regular screening to women was established at the Ain Shams University, in the Early Cancer Detection Unit (ASU-ECDU), in 1981 [43]. After this initiative, other universities and teaching hospitals in different governorates have started similar units.

4.6 Cancer Prevention Programs

4.6.1 Anti-Schistosomiasis Campaigns

Aiming to eradicate the high prevalence of schistosomiasis hematobium; the government founded 172 bilharzia centers, 449 bilharzia groups, and 1624 bilharzia units in Egypt [1]. There are regular local campaigns in areas with a reported recent increase in the number of new cases.

4.6.2 Anti-HCV and HBV Campaigns

As is mentioned earlier, hepatocellular carcinomas' prevalence in Egypt is significantly high as compared with global rates. Hence, prevention of its top etiological factors in Egypt, i.e., HBV and HCV, is a priority.

The Egyptian National Committee for the Control of Viral Hepatitis (NCCVH) started the national treatment program for HCV in 2007, based on sofosbuvir, pegylated-interferon, and ribavirin regimen [44].

MoH set up a web-based registry to arrange patient appointments and visits, and to record their patient data using a central database. A total of 49,630,319 individuals from a target population of 62.5 million (79.4%), spontaneously participated in the screening between October 1, 2018, and April 30, 2019. The overall HCV seroprevalence in the 48,345,948 individuals tested was 4.61%. 1,148,346 (76.5%) had viremia, and 91.8% of those with viremia had started their treatment. 465,992 of patients who started their treatment, reached the 12-week follow-up after the end of therapy. 386,103 of these 465,992 patients (82.9%) had a known treatment outcome, and 381,491 (98.8%) of those with a known outcome had a sustained virologic response. NCCVH worked on making oral Direct-Acting Antivirals (DAAs), available for the national treatment program at affordable prices. The cost of the HCV testing and treatment component of the program amounted to $207.1 million. The cost of screening a patient with HCV viremia is $85.41, and the cost of screening and curing a patient is $130.62 [45, 46].

Hepatitis B vaccination has become mandatory for all newborns in Egypt, as the hepatitis B vaccine (HB-Vaccine) was included in the compulsory vaccination program for Egyptian children in 1992 [47]. It is part of the "Expanded Programme on Immunization", planned to be given in 3 doses for all newborns at 2, 4, and 6 months after birth. Some studies showed that the hepatitis B coverage rate was markedly increased from 91% in 1996 to 97.3% by 2005 [48, 49].

4.7 Cancer Diagnosis

Carcinogenesis is a multi-step process that may be silent through most of its natural history. This fact is often more complicated in Egypt. A retrospective, multicenter study, held in two pediatric oncology units found that delay in diagnosis is correlated to socio-economic status, parental education, and family, being worse in lower-income families and among illiterate individuals [50]. Application of Guideline-Directed Management and Therapy (GDMT) faces technical and financial limitations. The absence of rich, nationwide medical literature limits standardization and validation of diagnostic protocols designed specifically for Egyptian patients.

Cancer diagnosis involves multiple modalities such as biochemical markers, imaging modality, and histopathological examination. The combination of these methods usually leads to accurate preoperative staging and risk-stratification. However, few cancers are still staged surgically. Post-treatment diagnosis of recurrence remains underestimated in Egypt, with some cases passing undiagnosed due to patients' preferences in a quiet end of life.

4.7.1 Imaging

A variety of imaging modalities are used to screen or diagnose cancer in Egypt, starting from x-ray, which may show an accidental discovery of a mass that necessitates further assessment to detect its nature. Continuing with Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI), both can be enhanced by an external contrast. For breast cancer, mammograms and bilateral ultrasound are the most used modalities for screening. Positron Emission Tomography (PET) scan is used for the detection of remote metastases, especially for bony lesions. CT and MRI are accessible almost everywhere in Egypt. However, PET scans are only available in large centers. The financial cost of them is to be paid either by the patient's own money, health insurance, or by the government for specific cases.

4.7.2 Molecular Testing

There are several technologies for the detection of sequence variations that have been developed and used in the oncology field in Egypt. There are three main groups of these technologies: Polymerase Chain Reaction (PCR), Hybridization, and Next-Generation Sequencing (NGS).

A tumor biopsy, followed by molecular testing is a common procedure in the daily practice of oncology medicine in Egypt. It is broadly used to detect hereditary

cancers and select the most effective treatment based on the molecular characteristics of the tumor biopsy.

4.7.3 Cytogenetics and Genetic Testing

Cytogenetics testing for chromosomal aberrations and their corresponding fusion genes in specific cancers as Acute Myeloid Leukemia (AML), is a novel field in Egypt. It is still only available in major institutions such as NCI and university hospitals.

Since the introduction of advanced Fluorescence in Situ Hybridization FISH-based methods in the late 1980s, they greatly improved the cytogenetic analysis of hematopoietic and solid tumors. Several chromosome alterations are specific to a particular disease, such as the Philadelphia chromosome which is the translocation between chromosomes 9 and 22 in Chronic Myeloid Leukemia (CML), resulting in the BCR-ABL fusion protein.

Genetic testing for hereditary cancers and acquired mutations is available in university hospitals and central private hospitals. Examples include BRCA1 and BRCA2 mutations in breast cancer hospitals, Philadelphia chromosome mutations in leukemia cases and KRAS mutations in colorectal cancer.

4.8 Treatment

In Egypt, matching with the global trend, cancer care is progressively becoming a matter of multidisciplinary management. This reduces discrepancies in classification, management and improves the quality and prognosis. However, this approach still faces technical and financial problems, limiting its nationwide implementation. Cancer treatment involves oncological surgeries, radiation therapy, medical oncology, palliative care, and pain management. Cancer patients may deal with one or more medical specialties during their treatment journey, which demands data-driven practices to support faster decision-making [51].

4.8.1 Medical Oncology

Medical oncologists carry most of the burden of cancer management. They are responsible for stabilizing patients' other conditions—with the help of internists—before, through, and after the therapeutic plan, in addition to, choosing the medical plan and administering the selected chemotherapy. To specialize in medical oncology in Egypt, medical graduates must apply for the Egyptian fellowship in medical oncology. Fellowship's duration is 5 years, 2 years of general internal medicine

training, and 3 years of specialty training. The capacity of the fellowship's training program in 2020 was 50 doctors, and 150 in 2021.

Cancer care is always a multidisciplinary process that necessitates the cooperation of medical oncologists, surgical oncologists, and radiation therapists. For example, breast cancer patients need a throughout risk stratification to choose the best treatment modality. Some patients may need neo-adjuvant chemotherapy and/or hormone therapy. Others may undergo surgery directly, either Breast Conservative Surgery (BCS) or mastectomy, some patients may need radiotherapy either ordinary regimens or Accelerated Partial Breast Irradiation (APBI).

4.8.2 Radiation Therapy

Radiation-based surgical knife modalities include Stereotactic Radiosurgery (SRS), Gamma knife systems, Linear Accelerator (LINAC) systems and Proton beam therapy or cyclotron. Radiation therapy modalities include Fractionation, 3D Conformal Radiotherapy (3DCRT), Intensity-Modulated Radiation Therapy (IMRT), and Image-Guided Radiotherapy (IGRT).

To specialize in radiotherapy in Egypt, medical graduates must apply for the Egyptian fellowship in radiotherapy. Fellowship's duration is 4 years of specialty training. The capacity of the fellowship's training program in 2020 was 28, and 46 in 2021.

4.8.3 Surgery

Surgery always walks hand in hand with medical intervention. This can be noticed in liver cancer patients, who can be treated surgically with either liver transplantation, or surgical hepatectomy. However, due to the limited supply of organs and advanced cirrhosis, many patients are not eligible for surgery and many of them opt for Radiofrequency Ablation (RFA) or Trans-arterial chemoembolization (TACE). Also, bladder cancer patients in Egypt are treated with either radical cystectomy or Transurethral resection of the bladder (TURBT) if resectable, or with cisplatinum-based multi-agent chemotherapy, if unresectable.

4.8.4 Pediatric Oncology

All university hospitals in Egypt have specialized pediatric oncology units. There are specialized hospitals in pediatric oncology such as Shefaa El-Orman Hospital and Children's Cancer Hospital Egypt 57,357. In 57,357 hospitals, 59% percent of

patients had solid tumors and 41% had hematopoietic cancers. The most common cancers were leukemia, lymphoma, CNS tumors, and neuroblastoma [52].

4.8.5 Survivorship Track

As a part of the management plan, those with reported good outcomes are set on a follow-up plan, ranging between 2 and 5 years on average. Regular checkup dates include full physical examination, laboratory, imaging investigations, and counseling for lifestyle modifications and psychological support. Patients are advised to seek help immediately if any new symptom is developed.

Psycho-oncological service remains a cornerstone in management. In a recent meta-analysis study, it became evident that 38.2% of cancer patients suffered from any type of mood disorder, and 31.6% suffered from depression or anxiety, which is underestimated in Egyptian oncological care [53]. Palliative care and End-of-life care (EOLC) is a growing medical specialty in Egypt. However, it also faces a few financial and technical limitations [54].

4.8.6 Palliative Care Track

Palliative care is care given to improve the quality of life of patients in terminal stages. It targets several physical symptoms such as pain, fatigue, loss of appetite, nausea, vomiting, shortness of breath, and insomnia. This can be done using non-therapeutic doses of chemotherapy and/or radiotherapy. Surgery is also an option for oncological emergencies such as spinal cord compression. Emotional and spiritual support is also given to patients and their families to cope with the difficulties of the situation.

4.9 Research and Education

The main academic research and education sector in Egypt is covered by public and private universities. There are 24 public and ten private medical schools in Egypt. Each is run by a varsity of academic staff who publish hundreds of publications annually. In addition to teaching thousands of undergraduate and postgraduate medical personnel. The number of medical graduates in December 2019 was 7–8 thousand [55].

Theodor Bilharz Research Institute in Warrak district, Giza, Egypt is an institute primarily focused on schistosomiasis prevention and control. The institute was founded in 1964, after an agreement between the Federal Republic of Germany and the Egyptian Government [56]. There are high prevalence and incidence rates of

schistosomiasis in Egypt as mentioned earlier, which is responsible for the high incidence rate of Transitional Cell Carcinoma (TCC). Successful management of schistosomiasis and breaking its life cycle, especially the freshwater snail—the intermediate host—will subsequently cause a noticeable decrease in Transitional Cell Carcinoma (TCC) incidence rate.

Although Theodor Bilharz Research Institute was mainly founded to control schistosomiasis, the institute's mission is to control endemic tropical diseases in Egypt such as viral hepatitis and to be a leading center in research and training. The institute has 300 hospital beds and is managed by manpower of 482 researchers [57].

Few charity hospitals have their research centers, such as Shefaa El-Orman Hospital, Children's Cancer Hospital Egypt 57,357, and Baheya Hospital. They run both clinical and academic trials, benefiting from the high number of patients registered in each hospital, opening the door for more future private-funded trials.

The Egyptian Cancer Research Network launched on November 5, 2016, is a collective of research professionals, groups, organizations, and institutions involved in Cancer research in Egypt. The goal of the network is to connect oncology researchers in Egypt and to facilitate the conduction of large-scale multicenter [58].

4.10 Cost-Effective Cancer Care

Being a developing country, assuring cost-effectiveness is an important side of the healthcare sector in Egypt. Especially for oncology patients, as managing their condition is almost always very expensive.

A study that used Egypt as a case study for hepatitis C screening and treatment in the developing countries found implementing hepatitis C screening and treatment of non-symptomatic, average-risk Egyptian adults would be cost-saving with triple-therapy and very cost-effective with dual-therapy [59].

4.11 Challenges and Advantages

Some of the challenges faced by the Egyptian healthcare system are mentioned as follows:

- Affected by the sustained increase in incidence rates of neoplasms in the Egyptian population through the years; the health sector is facing many challenges especially with the number of facilities and manpower needed to operate them and provide the standard quality of care.
- Mostly guided by local institutional guidelines for cancer management, providing the same medical service in all regions can be quite challenging. Hence, the need to adhere to a unified national guideline is becoming a priority for the healthcare sector in Egypt.

- As shown in the WHO Cancer Mortality database's report for 2015 [10], there has been a sustained increase in the mortality rate in Egypt since the 1950s; further work should be conducted to investigate this trend. On one hand, it may be due to the increase in population number and consequently, the increase in population at risk which caused the increase in incidence rates. On the other hand, it may be caused by strict and more accurate documentation and advanced screening and investigative tools. Other occult factors may also be responsible.
- One of the challenges facing cancer care in Egypt is the late stage at first presentation, leading to reduced effectiveness of therapy and higher morbidity and mortality rates. For example, one of the most important reasons is the lack of health awareness in Egyptian women about the early warning signs of breast cancer and the importance of early consultation. Eighty-five percent of Egyptian women were found to have insufficient knowledge about the disease in some studies [60].
- As a developing country, the expensive cost of cancer treatment is a magnificent problem. It can be an obstacle in the road of providing newly released treatment modalities.
- Many facilities do not integrate a multidisciplinary team approach into their cancer management plans. Its implementation should be taken into consideration to improve the quality of healthcare.

4.12 The Future of Cancer Care in Egypt

Cancer care in Egypt is a progressive sector due to the ongoing increase in the number of oncology-specialized hospitals, in addition to receiving more attention from both the government and the community, subsequently increasing the fund given to healthcare-providing hospitals and institutes and research cuts. Yet, more focus should be given to the prevention and screening of specific types of cancers that do not have an existing system.

4.13 Conclusion

Egypt has the potential to become an eminent country in the field of oncology. Having the required manpower, growing infrastructure, and endemic diseases and factors that are rarely found in advanced countries, which is an excellent opportunity for research. More oncology-specialized hospitals, trained oncologists, and medical personnel will be needed to keep up with the actively growing Egyptian population and subsequently, the prevalence of cancers.

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