

Current Status of Knowledge on Tumor Patterns in Sudan's Eastern Darfur State

Mudather Elnoor Younis ¹, Fadwa Mohamed Ibrahim ², Saeed Hassan Saeed ³,
Mohamed Elhaj Abdurrahman ⁴, Abu baker Mohamed Yahya ⁵

¹⁻⁵ Faculty of Medical Laboratory Science El-Daein University, Sudan

Correspondence Author: mudtherelnoor@yahoo.com

Abstract One of the major causes of death in the globe is cancer. According to estimates, the number of people affected by cancer worldwide will continue to rise, reaching 21.4 million new cases and 13.2 million deaths by 2030. This study was carried out in the Sudanese state of East Darfur and it is a retrospective in nature. Clinical and Public Health Laboratory provided results, were collected, gathered then analyzed. The Statistical Package for Social Science (SPSS) version 25 was used evaluate demographic data and tumor cases. show that 87.3% of patients who were affected by were females, while only 12.7% of patients were males show that 15.87% of patients whom affected were 33 years old, followed by 9.52% their age were 34 and 45 years old endometritis accounted for (19.05%) of the abnormalities that affected the patients, followed by ovaries (14.29%), endometrial polyps (12.70%), Breast masses (7.94%), chronic endometritis, prostatic hyperplasia The data on the present status of the most common benign and malignant tumors in Sudan and the neighboring areas is scarce. There is a complex interaction between the impact of infectious agents, genetics and environmental risk factors on the risk of development of most of these tumors.

Keywords: Cancer; Epidemiology; Incidence; East Darfur.

1. INTRODUCTION

One of the main causes of death in the globe is cancer. According to estimates, the number of people affected by cancer worldwide will continue to rise, reaching 21.4 million new cases and 13.2 million deaths by 2030. As per the World Health Organization's forecast, cancer ranks second among the causes of mortality in underdeveloped nations (10.4%), while it ranks first among developed countries (26.6%). In 2008, there were around 681,000 new cases and 512,400 fatalities recorded in Africa. Therefore, due of the high expense of treatment and the high patient dropout rate, cancer puts a severe strain on Africa's health system and economy as a whole. The cancer burden in Africa is not as extensively documented as it is in industrialized nations, where cancer epidemiology is thoroughly studied. Although infectious diseases remain the primary focus of the health care system, Sudan, like most other sub-Saharan African nations, must prepare for an expected increase in the incidence of cancer due to factors such as gradually increasing life expectancy, widespread transmission of cancer-related infections, and growing pollution from urbanization, intensive agriculture, and industrialization. There is no national cancer registry based on population in Sudan. The primary sources of cancer data are hospital-based case series at the nation's two oncological centers, the National Cancer Institute of the University of Gezira (NCI-UG) in Wad Medani, Gezira State (formerly the "Institute of Nuclear Medicine Molecular Biology & Oncology," INMO), and the Radiation and Isotope Center in Khartoum (RICK), Khartoum State. Both

centers are located in the densely populated Central Sudan. The health system has all but disintegrated, especially in Darfur and Khartoum, the conflict's core. Primary healthcare facilities and hospitals have been targeted, taken over, or robbed. Healthcare personnel have suffered harm, lost their lives, or been internally and internationally displaced. Since the commencement of the conflict, those who are still employed have not received compensation. Since the battle began, there has been a significant disruption in cancer care. Regarding cancer treatment, the Ministry of Health is offering minimally charged radiotherapy along with free access to all major chemotherapy drugs. Poor resource planning and management, such as choosing brand names over generics, can result in shortages of essential medications that last for months at a time. Clinical oncologists receive training locally, but a deficiency in subspecialties—such as surgical oncologists and palliative care specialists—as well as in appropriate interprofessional collaboration and multidisciplinary meetings results in a lower standard of treatment. The most prevalent malignancies in both sexes, according to Globocan estimates, are esophageal, colorectal, non-Hodgkin lymphoma, breast, and leukemia. Despite the fact that the incidence of the disease is minimal when compared to other African nations. Nevertheless, the current effort aims to address the current Status of Knowledge and Tumor Patterns in Sudan's Eastern Darfur State.

2. LITERATURE REVIEW

Definition of Tumor

When cells in a particular area of the body proliferate and replicate uncontrollably, it is called cancer. Cancerous cells have the ability to infiltrate and kill nearby healthy tissue, including organs. Sometimes a cancer starts in one place of the body and then spreads to others. We call this process metastasis.

The Epidemiology of Cancer in Sudan

The identification of various cancer causes and risk factors in populations is the main focus of attention. This is because different communities have varying cancer burdens, and cancer is distributed differently throughout populations due to the interaction of genetic, environmental, and personal risk factors. The increasing cancer burden in Sudan poses tremendous challenges to the health system and the entire country's economy due to lost productivity, premature death. And the high cost of cancer management. However, despite the increasing public awareness of cancer and its consequences in Sudan, the country is lagging in investing in cancer control programmes due to the instability of public health leadership,

catastrophic spending on health with perpetually limited public financing, heavy reliance on curative at the expense of preventative care and over 79.4% out of pocket (OOP) health expenditure . This is made worse on a geopolitical level by the ongoing civil turmoil, despicable governments, and ensuing economic sanctions. Additionally, there is a severe dearth of radiodiagnostic and laboratory facilities, a shortage of workers, a deficit of medications, and a persistent reduction in the number of radiotherapy facilities for cancer treatment. However, female Sudanese employees at secondary-level hospitals continue to have inadequate knowledge, attitudes, and practices surrounding breast cancer screening. Furthermore, there hasn't been much progress made in reducing the cervical cancer burden in Sudan, despite proven primary, secondary, and tertiary preventive treatments and the World Health Organization's (WHO) call to action toward eliminating cervical cancer. The majority of patients with prostate cancer appear at a late stage, making it the most common malignancy among males in Sudan. Studies on prostate cancer in Sudan are few. The World Health Organization (WHO) advises nations to set up cancer registries in order to carry out efficient initiatives for cancer control and prevention. The analysis of cancer epidemiology is made possible by the SNCR. Aspects of cancer in Sudan, including its occurrence, etiology, and environmental influences, have been examined in earlier research. An efficient cancer control policy intervention is urgently needed in light of the acknowledged rise in cancer incidence. Sudan faces significant challenges in addressing this important public health issue since there is insufficient data to support national cancer control initiatives. However, little is known about the cancer burden in poor nations. The cancer burden in Sudan has been calculated by a number of research. There were little attempts to report particular cancer kinds, postpone the diagnosis of breast cancer in Sudanese women, or analyze features of cancer in distinct states, such as Eastern and Central Sudan. Nevertheless, no thorough analyses exist that provide information on Sudan's cancer burden.

Cancer Incidence and Mortality in Sudan

Cancer is still a major cause of death and has been for the past three decades, despite amazing advancements in diagnosis, prognosis, and therapy. More people died from cancer in 2008 than from AIDS, tuberculosis, and malaria put together. By 2035, there will be 24 million cancer cases worldwide, up from an anticipated 15 million in 2010. Preventive strategies could reduce cancer mortality by 25–30% in conjunction with a drop in cancer incidence. Planning, analyzing, and assessing healthcare services all depend on cancer incidence data. Data on the prevalence of common childhood cancer types are crucial for tracking the percentage of cases among the next generations of survivors.

Due to the rising incidence of cancer in Sudan, accurate cancer registration statistics are essential for allocating resources, assessing the effectiveness of interventions, organizing suitable screening programs, and assessing preventative measures and therapeutic care. There aren't many statistics on the prevalence of cancer in Sudan, and the ones that exist were compiled from a small number of cancer registries utilizing hospital data. The comparison between these and the data collected worldwide is hampered by variations in the methodology employed to obtain the data.

Risk Factors for Cancer in Sudan

There are four types of risk factors for cancer: biological, physical, environmental, and individual. Recently, there has been an emphasis on the role that certain lifestyle choices play in the rising disease incidence. Every year, more than 300,000 children worldwide, from birth to age 14, receive a cancer diagnosis. Worldwide, cancer incidence is still a major health concern. Millions of people die from it annually in less developed parts of the world, where it ranks as the second greatest cause of mortality in developed nations. The cancer rate adjusted for age is increasing. In 2000, almost 6 million individuals will lose their lives to cancer worldwide, accounting for around 10 million new cases of the disease. Concerning Sudan's cancer risk factors, nothing has been done thus far. An attempt has been made to identify the recognized risk factors in the current investigation.

Future Directions and prospective

In Sudan, cancer illnesses rank as the leading cause of morbidity and mortality. The national cancer epidemiology data are not accessible. A few regional population-based cancer registries provide the only data that are currently accessible. The Cancer Register Unit of the Ministry of Health was based on five regional cancer registers from Sudan. As of December 2017, the Khartoum pediatric cancer registry had reported a total of 2625 children with cancer (0–14 years of age).(26) However, because the aforementioned registries only cover a limited area, the observed cancer incidence figures are understated. According to Globocan 2018, there were 20,471 cancer cases and 12,775 cancer-related deaths in Sudan in total. Kaposi sarcoma is thought to be the most common cancer in Sudan, with non-Hodgkin lymphoma, colon, breast, lung, prostate, liver, and leukemia following closely after. There are gender differences in the frequency of cancers, with some being more frequent in females, such as breast, ovary, and uterus, and others being more frequent in males, such as Kaposi sarcoma, non-Hodgkin lymphoma, neck, and liver. The cancer death rates were estimated to be the highest in North Africa compared to the rest of Africa. The government of Sudan has recognized the growing

burden of non-communicable diseases (NCD) including cancer for more than 15 years that was established in 2003.

3. METHODOLOGY

This study was carried out in the Sudanese state of East Darfur and is retrospective in nature. Clinical and Public Health Laboratory provided results, were collected, gathered then to protect confidentiality and privacy, identifiable information was anonymized using pseudonyms and participant codes during data collection and analysis. The Statistical Package for Social Science (SPSS) version 25 was used evaluate demographic data and the conditions. Ten male and fifty-three female data points total were gathered for the study. During the study period, all patients, regardless of gender or age, who were diagnosed and treated in El-Daein Teaching Hospital and referral public health laboratory who were clinically suspected for tumors were enrolled.

4. RESULTS

The table [1] below show that 87.3% of patients who were affected by were females, while only 12.7% of patients were males.

This result shows that females' shows higher cases than males; it indicates that there is significant difference between the genders of patients.

Table [1] showing the significant differences between patients gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	8	12.7	12.7	12.7
	Female	55	87.3	87.3	100.0
	Total	63	100.0	100.0	

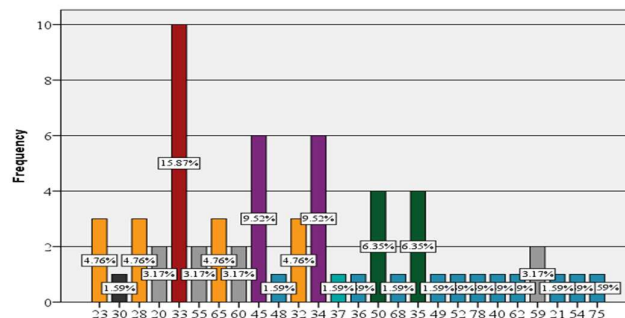


Figure [1] showing the frequency of patient's age groups

The above Figure[1] show that 15.87% of patients whom affected were 33 years old, followed by 9.52% their age were 34 and 45 years old, 6.35% their age were 35 and 50 years old, 4.76% their age were between 23, 28, 32 and 65 years old, 3.17% their age were 20, 55, 59 and 60 years old and 1.5% their age were 21, 36, 37, 40, 48, 49, 52, 54, 62, 68, 75,78.

This result shows that the highest infection age group were patients whom age were 33years old followed by 34, 45, 35, 50 23, 28, 32, 65, 20, 55, 59, 60, 21, 36, 37, 40, 48, 49, 52, 54, 62, 68, 75,78. The result indicates that there is significant variation between patients' age and infections.

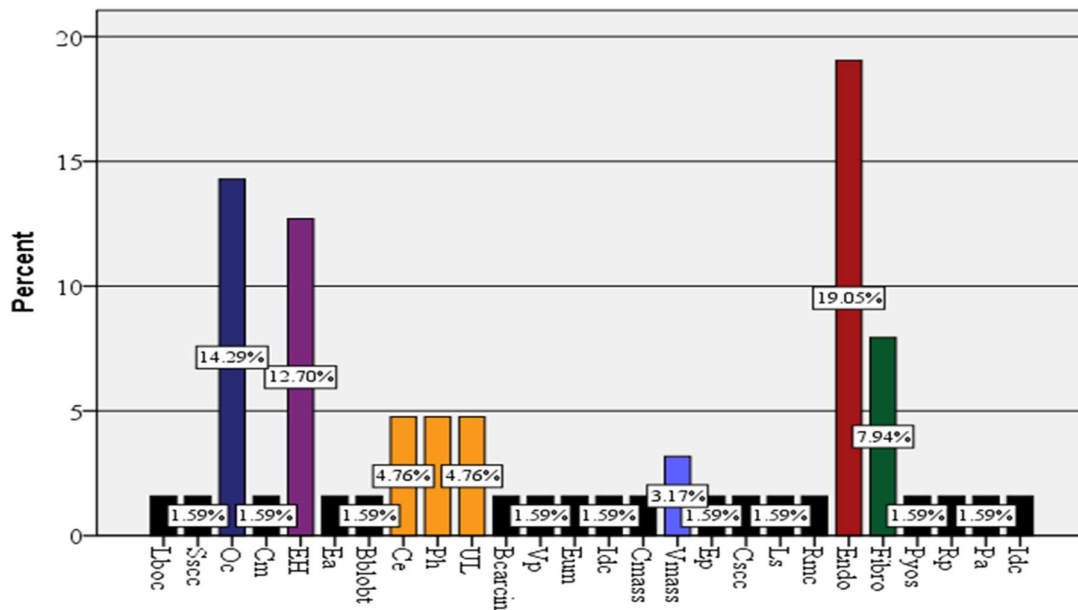


Figure [2] showing the distribution of abnormalities

According to the above figure [2], endometritis accounted for (19.05%) of the abnormalities that affected the patients, followed by ovaries (14.29%), endometrial polyps (12.70%), Breast masses (7.94%), chronic endometritis, prostatic hyperplasia, and uterine leiomyoma (4.76%), vulvar masses (3.17%), and the rest of conditions including left benign ovarian cysts ,skin squamous cell carcinoma, vaginal polyp, eumycetoma, invasive ductal carcinoma, cervical tumor, endometrial adenocarcinoma, benign lesion of bone tissue, and breast cancer Reactive mesothelial cells, leg edema, cervical squamous cell cancer, cervical mass, and endometrial polyp Rectal polyp, invasive ductal cancer, prostatic adenocarcinoma, and pyrosalpingitis were accounted for (1.59%).

This data indicates that endometritis was the most common condition, followed by ovarian cysts, endometrial polyps, fibroadenoma, chronic endometritis, prostatic hyperplasia,

uterine leiomyoma, and vulvar masses. Skin squamous cell carcinoma, cervical mass, endometrial adenocarcinoma, benign bone tissue lesions, breast cancer, vaginal polyp, Eumycetoma, Invasive Ductal Carcinoma, cervical mass, endometrial polyp, cervical squamous cell carcinoma, leg swelling, and reactive mesothelial cells were the least common infectious cancers among patients. Rectal polyp, invasive ductal cancer, prostatic adenocarcinoma, and pyrosalpingitis.

5. DISCUSSION

This study, which is retrospective and hospital-based, showed that cancer and other significant public health issues in East Darfur is rising. The causes of the rise in cancer cases and infection are most likely a reflection of the increase in the state's population and public knowledge of obtaining medical attention. Nevertheless, the number of cancer cases in East Darfur is not accurately reflected by this increase, as individuals may not seek treatment due to various factors such as poverty, congested public transportation, high medical expenses, and medication costs in addition to alternative care before receiving medical attention at appropriate Oncology Institutions. With the construction of multiple regional hospitals and cancer centers, the nation has made notable progress toward decentralizing services. Wad Medani and Merowe, two provincial centers, offered radiation therapy, albeit to a far lesser extent than Khartoum. Chemotherapy and a limited range of cancer operations and diagnostics are offered by additional centers, including those in Shendi, El Obeid, El-Gadarif, Nyala, and El-Fasher. The most prevalent malignancies in both sexes, according to Globocan estimates, are esophageal, colorectal, non-Hodgkin lymphoma, breast, and leukemia. This picture is, to some extent, similar to the pattern of cancer incidence in the developed rather than the developing countries. According to the current findings the number of female's patients were significantly elevated compared to males and the age range of 33-50 years old saw the highest incidence of abnormal cases among both male and female patients, this resulted from the increasing medical education and awareness among middle aged population. Under-registration of clinically diagnosed cases is a possibility, and this findings are similar to the most recent statistical data from NCI's Surveillance, Epidemiology, and End Results Program, the median age of a cancer diagnosis is 66 years meaning that half of cancer cases occur in people below this age and half in people above this age. In RICK and NCI-UG centers, breast cancer was the most frequently diagnosed cancer, accounting for one-fifth of all cancer cases recorded in both males and females. This is consistent with data from Sudan previously published. Breast cancer ranked highest 30.81% of all cancer cases in females treated for cancer

at these centers on a regular basis. Nearly one-third of cancer cases in women. Other states in Sudan have also reported an increase in breast cancer cases, namely in Khartoum and Gezira. Prior to this, breast cancer ranked second among cancer-related deaths among women in Sub-Saharan Africa in 2008. It was recently observed that the most frequent cancer in women diagnosed in a number of Sub-Saharan African countries. Many risk factors associated with urbanization and economic development were cited to contribute to this increase in breast cancer and these include early menarche, late childbearing, having fewer children, obesity, and increased awareness and detection. Approximately 80% of occurrences of cervical cancer (CC), one of the most prevalent malignancies affecting the female genital tract globally, are reported from poor nations. According to reports, between 1954 and 1961, CC was the second most frequent malignancy in women in Sudan. Access to cancer diagnoses is also highly challenging, and in certain cases it is currently nonexistent. For instance, immunohistochemistry testing for breast cancer are only available in Khartoum, which is currently destroyed by the ongoing armed conflict, although histopathology services are mostly available in Khartoum, Wad Medani, and Alqadarif (in the eastern portion of Sudan. This study focused on the patterns of tumor in East Darfur Stat and involved 63 cases clinically suspected or diagnosed and treated in El-Daein Teaching Hospital.

6. CONCLUSION

The data on the present status of the most common benign and malignant tumors in Sudan and the neighboring areas is scarce. There is a complex interaction between the impact of infectious agents, genetics and environmental risk factors on the risk of development of most of these tumors. The population distribution of these risk factors is likely to be different. It is hoped that this attempt of bringing together some of the more recent studies on tumors in Sudan will initiate further interest and reaction with the aim to be followed by more in-depth investigations and regular monitoring of tumor changes. Even if the results of this research are comparable, further research on the tumor pattern in the East Darfur region is advised.

7. REFERENCES

- Advancements in Life Sciences. (2023). Characteristics of patients with breast cancer attending the Breast Cancer Center. *Submission*. (n.d.). Sudan.
- Ahmed Eltayeb, M., Faggad, A., Sharafeldin Abbadi, O., & Mohammed Ali Elhassan, M. (2020). Characteristics of breast cancer at first presentation in Sudanese patients

- attending the National Cancer Institute–University of Gezira (NCI–UG). *Archives of Breast Cancer*, 7(3), 104–110. <https://doi.org/10.32768/abc.202073104-110>
- Ahmed, H. G., Ali, A. S., & Almobarak, A. O. (2010). Frequency of breast cancer among Sudanese patients with breast palpable lumps. *Indian Journal of Cancer*, 47(1), 23–26. <https://doi.org/10.4103/0019-509X.58854>
- Ahram, M., Abdelgawad, F., ElHafeez, S. A., Abdelhafiz, A. S., Ibrahim, M. E., Elgamri, A., & Silverman, H. (2022). Perceptions, attitudes, and willingness of the public in low- and middle-income countries of the Arab region to participate in biobank research. *BMC Medical Ethics*, 23(1). <https://doi.org/10.1186/s12910-022-00855-z>
- Al-Riyami, A. Z., Burnouf, T., Wood, E. M., Devine, D. V., Oreh, A., Apelseh, T. O., & the ISBT COVID-19 Convalescent Plasma Working Group. (2022). International Society of Blood Transfusion survey of experiences of blood banks and transfusion services during the COVID-19 pandemic. *Vox Sanguinis*, 117(6), 822–830. <https://doi.org/10.1111/vox.13256>
- Altirifi, H. I., Elsanousi, O. M., & Bedri, S. (2022). Very poor practices regarding breast cancer screening among Sudanese female workers at a secondary-level hospital: A cross-sectional study. *The Pan African Medical Journal*, 41, 43. <https://doi.org/10.11604/pamj.2022.41.43.30179>
- Awadelkarim, K. D., Arizzi, C., Elamin, E. O. M., Hamad, H. M. A., De Blasio, P., Mekki, S. O., & Barberis, M. C. (2008). Pathological, clinical, and prognostic characteristics of breast cancer in Central Sudan versus Northern Italy: Implications for breast cancer in Africa. *Histopathology*, 52(4), 445–456. <https://doi.org/10.1111/j.1365-2559.2008.02966.x>
- Awadelkarim, K. D., Mariani-Costantini, R., & Elwali, N. E. (2012). Cancer in the Sudan: An overview of the current status of knowledge on tumor patterns and risk factors. *The Science of the Total Environment*, 423, 214–228. <https://doi.org/10.1016/j.scitotenv.2010.09.010>
- Bray, F., Parkin, F., & Gnanon, G. (n.d.). Cancer in sub-Saharan Africa in 2020: A review of current estimates of the national burden, data gaps. *The Lancet*.
- Chen, K.-H., Lin, C.-Y., Su, S.-B., & Chen, K.-T. (2022). Leprosy: A review of epidemiology, clinical diagnosis, and management. *Journal of Tropical Medicine*, 2022, 1–13. <https://doi.org/10.1155/2022/8652062>
- Elamin, A., Ibrahim, M. E., Abuidris, D., Mohamed, K. E. H., & Mohammed, S. I. (2015). Part I: Cancer in Sudan—Burden, distribution, and trends of breast, gynecological, and prostate cancers. *Cancer Medicine*, 4(3), 447–456. <https://doi.org/10.1002/cam4.378>
- Ferlay, J., Shin, H.-R., Bray, F., Forman, D., Mathers, C., & Parkin, D. M. (2010). Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. *International Journal of Cancer*, 127(12), 2893–2917. <https://doi.org/10.1002/ijc.25516>
- Gafer, N., Walker, E., Allah, M. K., & Elbaghir, A. (2016). Cancer care in Sudan: Current situation and challenges. In *Cancer Care in Countries and Societies in Transition* (pp. 209–217). Cham: Springer International Publishing.

- Gebisa, T., Bala, E. T., & Deriba, B. S. (2022). Knowledge, attitude, and practice toward cervical cancer screening among women attending health facilities in central Ethiopia. *Cancer Control: Journal of the Moffitt Cancer Center*, 29, 10732748221076680. <https://doi.org/10.1177/10732748221076680>
- Hamad, H. M. A. (2006). Cancer initiatives in Sudan. *Annals of Oncology*, 17, viii32–viii36. <https://doi.org/10.1093/annonc/mdl985>
- HPV Centre. (n.d.). Retrieved July 29, 2024, from <https://hpvcentre.net/statistics/reports/XWX.pdf>
- IHSN. (n.d.-f). Retrieved June 24, 2024, from <https://catalog.ihsn.org/index.php/catalog/4216/download/55706>
- Jatsho, J., Nishizawa, Y., Pelzom, D., & Sharma, R. (2020). Clinical and bacteriological profile of neonatal sepsis: A prospective hospital-based study. *International Journal of Pediatrics*, 2020, 1–9. <https://doi.org/10.1155/2020/1835945>
- Jemal, A., Bray, F., Forman, D., O'Brien, M., Ferlay, J., Center, M., & Parkin, D. M. (2012). Cancer burden in Africa and opportunities for prevention: Cancer in Africa. *Cancer*, 118(18), 4372–4384. <https://doi.org/10.1002/cncr.27410>
- Khanna, D., Khargekar, N., & Budukh, A. (2019). Knowledge, attitude, and practice about cervical cancer and its screening among community healthcare workers of Varanasi district, Uttar Pradesh, India. *Journal of Family Medicine and Primary Care*, 8(5), 1715–1719. https://doi.org/10.4103/jfmpe.jfmpe_143_19
- Lupo, P. J., & Spector, L. G. (2020). Cancer progress and priorities: Childhood cancer. *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, 29(6), 1081–1094. <https://doi.org/10.1158/1055-9965.epi-19-0941>
- Mahjoub Taha, S., Weng, H.-Y., El Imam Mohammed, M., Osman, Y. M., N'dri, N., Mohammed, S. I., & Omer Abuidris, D. (2020). Prostate cancer clinical characteristics and outcomes in Central Sudan. *Ecancermedicalscience*, 14. <https://doi.org/10.3332/ecancer.2020.1116>
- Muddather, H. F., Elhassan, M. M. A., & Faggad, A. (2021). Survival outcomes of breast cancer in Sudanese women: A hospital-based study. *JCO Global Oncology*, (7), 324–332. <https://doi.org/10.1200/go.20.00538>
- National Cancer Institute. (2015, April 29). Risk factors: Age. Retrieved August 6, 2024, from <https://www.cancer.gov/about-cancer/causes-prevention/risk/age>
- NHS. (n.d.). *Cancer*. Retrieved August 4, 2024, from <https://www.nhs.uk/conditions/cancer/>
- OAPEN. (n.d.-c). Retrieved August 4, 2024, from <https://library.oapen.org/handle/20.500.12657/54044>
- Parkin, D. M., Whelan, S. L., Ferlay, J., Teppo, L., & Thomas, B. D. (n.d.). *Cancer incidence in five continents VIII*. Lyon, France: IARC Scientific Publication.

- Reed, F. W. (2021). *Human ecology, desertification, nationalism, and population growth in the Sahara*. In *International Dimensions of the Environmental Crisis*.
- ResearchGate. (n.d.-d). Retrieved August 7, 2024, from [https://www.researchgate.net/publication/353581155 Colorectal Cancer in Sudan Clinicopathology and Surgical Outcomes A Single Centre S](https://www.researchgate.net/publication/353581155_Colorectal_Cancer_in_Sudan_Clinicopathology_and_Surgical_Outcomes_A_Single_Centre_S)
- Saeed, M. E. M., Cao, J., Fadul, B., Kadioglu, O., Khalid, H. E., Yassin, Z., & Efferth, T. (2016). A five-year survey of cancer prevalence in Sudan. *Anticancer Research*, 36(1), 279–286.
- Safaeian, F., Ghaemimood, S., El-Khatib, Z., Enayati, S., Mirkazemi, R., & Reeder, B. (2021). Burden of cervical cancer in the Eastern Mediterranean Region during the years 2000 and 2017: Retrospective data analysis of the Global Burden of Disease study. *JMIR Public Health and Surveillance*, 7(5), e22160. <https://doi.org/10.2196/22160>
- Salma, A., Esraa, A., & Ali, E. (n.d.). Five months into conflict: Near total collapse of cancer services in Sudan. *ecancer*.
- Sharma, R. (2021). Global, regional, national burden of breast cancer in 185 countries: Evidence from GLOBOCAN 2018. *Breast Cancer Research and Treatment*, 187(2), 557–567. <https://doi.org/10.1007/s10549-020-06083-6>
- White, M. C., Holman, D. M., Boehm, J. E., Peipins, L. A., Grossman, M., & Jane Henley, S. (2014). Age and cancer risk. *American Journal of Preventive Medicine*, 46(3), S7–S15. <https://doi.org/10.1016/j.amepre.2013.10.029>
- World Health Organization. (2004). *The global burden of disease: 2004 update*. Retrieved July 28, 2024, from <https://www.who.int/publications/i/item/9789241563710>
- World Health Organization. (n.d.-b). Retrieved July 29, 2024, from <https://rho.emro.who.int/ar/per-country-sud>
- World Health Organization. (n.d.-e). Retrieved August 4, 2024, from <https://gco.iarc.who.int/media/globocan/factsheets/populations/729-sudan-fact-sheet.pdf>