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* The findings and conclusions in this publication are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
FOREWORDS

Over the last several decades, the world has seen incredible progress in the fight against cancer. Thanks to advances in cancer prevention, early detection, treatment, and support for those facing the disease, more people than ever before have reason to hope. For example, the cancer mortality rate in the United States has declined 27% since 1991, averting more than 2.6 million cancer deaths.

Despite extraordinary advances in what we know about cancer, not everyone has benefited from this progress equally. Cancer is a growing burden among people living in low- and middle-income countries, and many people living in these areas cannot access the information or interventions that could save their lives. By 2040, considering only population growth and aging, the global cancer burden is expected to grow to 27.5 million new cancer cases per year, up from 17 million new cases in 2018. When we consider lifestyle factors such as smoking, unhealthy diet, and physical inactivity, the number of new cancer cases will likely be considerably larger.

This much is clear: we simply must do better to ensure everyone can benefit from advances in the fight against cancer. As you will see in the pages of this Cancer Atlas, Third Edition, progress is not only possible, but also achievable. For example, cervical cancer death rates have declined by 70% or more in many high-income countries that began prioritizing cervical cancer screening in the 1970s. This type of dramatic progress should not be limited to women living in high-income nations. Interventions such as HPV vaccination and cervical cancer screening can be implemented even in low-resource settings, where nearly nine out of 10 deaths from cervical cancer occur. Public and private sector leaders must work to ensure that women have access to screening and girls and boys have access to HPV vaccination. Tobacco control is another area of tremendous potential. Tobacco use remains the leading preventable cause of cancer deaths worldwide, and tobacco control remains vitally important to preventing cancer. We have the tools—tobacco-free environments, restrictions on product marketing, graphic warning labels on packaging, and more—that are proven to reduce tobacco use and save millions of lives. But they can only work if leaders around the world prioritize, embrace, and implement them.

The American Cancer Society is proud to work with partners in the United States and around the globe to save lives, celebrate lives, and lead the fight for a world without cancer. Together with our 1.5 million volunteers, we convene partners to create awareness and impact; fund cancer research breakthroughs; build communities to support people facing cancer; and provide direction by empowering people with the information they need. In the USA, the American Cancer Society Cancer Action Network, our nonprofit, nonpartisan advocacy affiliate, works at the state and federal levels of government to ensure patients can obtain and maintain quality, affordable, and comprehensive health insurance that enables access to cancer care—from prevention through treatment. Globally, we collaborate with our partners to increase access to information that is relevant and culturally appropriate, as well as to increase access to prevention, early detection, treatment, and palliative care that is affordable and universally available. For example, the American Cancer Society collaborates with public and private sector partners to expand access to essential cancer treatment medications across sub-Saharan Africa to make high-quality treatment more affordable and accessible. Only by increasing access to care can we truly realize progress against cancer for all.

While we face great challenges in this work, we also have the proven interventions, dedicated global partners, and momentum we need to truly address the global cancer burden. This Cancer Atlas, Third Edition is an important source of information to help the global cancer community achieve our shared goal of a world without cancer.

Working together with leaders around the world, we can ensure that recent progress does not stop, but instead accelerates and benefits everyone.

— Gary Reedy

Gary Reedy
Chief Executive Officer, American Cancer Society

This much is clear: we simply must do better to ensure everyone can benefit from advances in the fight against cancer. As you will see in the pages of this Cancer Atlas, Third Edition, progress is not only possible, but also achievable.
The last time I wrote a foreword for The Cancer Atlas was in 2014. I started by referencing the landmark High-Level Meeting (HLM) on Non-Communicable Diseases (NCDs), which took place in September 2011 in New York. Since that first meeting, which confirmed the importance of cancer and other NCDs in the global health agenda, there have been new milestones. NCDs have been debated at two further HLMS (2014 and 2018) and, through the concerted advocacy efforts of the cancer and NCD communities, a target to reduce premature deaths caused by NCDs was included in the Sustainable Development Goals (SDGs) adopted in September 2015. The International Agency for Research on Cancer (IARC) forecasts an increasing cancer burden, primarily due to the aging and growing world population, and that this burden will fall on parts of the world least able to cope with the increase. We will ensure that governments take tobacco control seriously, encourage healthy behaviors, implement vaccination and screening programs, improve cancer registries, and invest in the infrastructure required to treat the most common cancers.

The Cancer Atlas has proved to be an outstanding publication in the past, helping the cancer community communicate the progress we have or have not made, the challenges we face and the areas of focus for future years. Its beautifully crafted presentations of fact and evidence help us construct compelling messages to better articulate the problem and present solutions. The next edition will once again be circulated widely and accessible, easily manageable, and comprehensive. The Atlas systematically presents data, analysis, and policy recommendations that can be used to inform the planning of cancer control strategies, to inspire those of us who want to see change happen. We all know that there is much to do. The next decade will test the tenacity of the cancer community in cancer prevention research for the public good, to promote leadership on interdisciplinary cancer prevention and control that have been proven to work, to address social and economic inequities, to contribute to the capacity-building of the international scientific community in cancer prevention research, to the ultimate goal of tackling the global cancer burden. Through a closely interwoven network of collaborations, IARC plays its part in cancer prevention and control as we press for change, helping governments fulfil the promise of their global commitments to cancer control. The Cancer Atlas is a key resource for researchers, advocates, patients and cancer planners. My thanks to ACS, IARC and the many others who have contributed to such a wonderful resource for our community.

CANCERATLAS.CANCER.ORG

The next decade will test the tenacity of the cancer community as we press for change, helping governments fulfill the promise of their global commitments to cancer control. The Cancer Atlas is a key resource for researchers, advocates, patients and cancer planners.
Ms. Torre is an epidemiologist in the Surveillance and Health Services Research Group at the American Cancer Society. She concentrates on global cancer surveillance and has authored over 20 peer-reviewed publications, including book chapters in American Cancer Society service publications. She is the lead author of Global Cancer Facts & Figures, 6th and 7th editions, an editor of the Cancer Atlas, Second and Third Edition, and a contributor to the annual American Cancer Society Facts & Figures publication. She also conducts and collaborates on research focused on global cancer control, with particular emphasis on risk factors, disparities, and cancer survival. Ms. Torre received a BSc in International Political Economy from Georgetown University and an MPH in Global Epidemiology from the Rollins School of Public Health, Emory University.

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The editors of The Cancer Atlas, Third Edition would like to thank the American Cancer Society and the International Agency for Research on Cancer for their support of this edition. We would also like to thank the Union for International Cancer Control for its generous support of the dissemination of this edition. Many individuals have donated their time and expertise in the preparation of the Atlas. In particular, we would like to thank Rabia Khan at the American Cancer Society for invaluable logistical and editorial support, and Mathieu Laversanne at the International Agency for Research on Cancer for supplying data and analytical support. For their individual contributions to the Atlas, we would like to thank: Shazia Woodhouse, Vanja Jordan, Kimberly D. Miller, Ann Goding Sauer, Kit Kit Lia, Laura Sabat, Katina Leit, Qhina Dave, Blake Sanders, Kenny Osinyo, Loreen McCormay, Luke Nildháoishte, Kathy Poumehr, and Derek Rizard at the American Cancer Society.

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The Cancer Atlas aims to open readers’ eyes to the facts and figures of cancer: the scale and magnitude globally, the major causes, and the different ways the disease can be prevented and treated. It is a comprehensive global overview that equally highlights the distinct patterns and inequities in the present cancer burden, the associated risk factors, and the prospects for cancer prevention and control.

This third edition unites these topics under the theme of “Access Creates Progress,” drawing attention not only to the problem at hand, but also the means of tackling the cancer burden through access to information and services—addressing not only the immediate causes of cancer but also the underlying drivers of disease and disparities. This third edition of The Cancer Atlas maintains the structure of the previous editions, with chapters grouped into three sections: Risk Factors, The Burden, and Taking Action.

The first section, Risk Factors, highlights regional and international variations in many of the major risk factors for cancer, including tobacco use, infections, excess body weight, and ultraviolet radiation. Tobacco smoking continues to be the predominant cause of cancer in most high-income countries, while infections still play a major role in many sub-Saharan African and Asian countries. The importance of excess body weight as a major risk factor for cancer continues to escalate in many economically transitioning countries.

The second section, The Burden, describes the geographic diversity in cancer occurrence worldwide and, in separate chapters, for each of the major world regions. This burden is also described in terms of the national Human Development Index, the primary measure of a country’s societal and economic development used in this book. Profiles of cancer survival and cancer survivorship are expanded in this book. Chapters throughout the book highlight “Access Creates Progress” text boxes in chapters throughout the book highlight successful strategies to address the cancer burden.

In summary, The Cancer Atlas is intended to deliver a rapid but comprehensive grasp of the global essentials of cancer. This book and its accompanying website (canceratlas.cancer.org) were carefully designed to ensure user-friendly, accessible, and downloadable descriptions and graphics can be easily used by cancer control advocates, government and private public health agencies, and policymakers, as well as patients, survivors and the general public. The Cancer Atlas is an illustrative guide to cancer’s diversity and disparities, but also a positive vehicle for the promotion and delivery of cancer prevention and cancer control worldwide.
There are still 1.1 billion smokers worldwide and tobacco causes more preventable cancer deaths than any other risk factor.

Progress in tobacco control legislation over the last decade means 1.5 billion people in 55 countries are now protected by smoke-free legislation.
**OVERVIEW OF RISK FACTORS**

Many of the known risk factors for cancer can be prevented.

Tobacco use, infectious agents, unhealthy diet, excess body weight, physical inactivity, and alcohol consumption account for the majority of cancer deaths caused by known risk factors. Smoking causes multiple cancer types (see Table 2.1), and smoking-related tobacco causes cancers of the oral cavity, esophagus, and pancreas. In 2017, smoking was responsible for an estimated 1.7 million cancer deaths globally (34% of all cancer deaths), with an additional 120,000 cancer deaths due to smoldering tobacco and secondhand smoke.

Infectious agents can cause a wide range of cancer types. Figure 2.1. However, there is large variation across countries in the proportion of cancers caused by infectious agents, ranging from around 4% in many very high-income countries to more than 30% in several sub-Saharan African countries. As such, many low-income countries infection-related cancers are a leading cause of cancer deaths (see Figure 2.2).

Unhealthy diet, excess body weight, and physical inactivity cause multiple types of cancer (see 2.5, Diet and Nutrition), and are emerging risk factors for cancer worldwide. The cancer burden associated with these risk factors is expected to grow in most parts of the world, particularly in parts of the Middle East and several other low- and middle-income countries in parts of Asia and Oceania because of the obesity epidemic. Further, alcohol drinking is responsible for 4% of all cancer deaths globally, with marked variation across countries.

Environmental and occupational factors other than tobacco use worldwide.

**FIGURE 3. Types of cancer caused by infectious agents.**

**INFECTION AGENT**

- Helicobacter pylori
- Human papillomavirus (HPV)
- Hepatitis B virus (HBV)
- Hepatitis C virus (HCV)
- Epstein-Barr virus (EBV)
- Kaposi sarcoma herpes virus (KSHV)
- Human T-cell lymphotropic virus, type 1 (HTLV-1)
- Human immunodeficiency virus (HIV)

**CANCER TYPE**

- Stomach
dental tissues (cervix, vulva, vagina, conjunctiva of the eye)
- Hepatocellular carcinoma (liver)
- Nasopharynx, some types of lymphoma
- Biliary tract
cranial nerve fibers (cerebellum, eye)
- Kaposi sarcoma, primary effusion lymphoma
- Skin of the head
- Cervical/cervix
- Soft tissue

In 2017, 41% of lung cancer deaths were caused by smoking. Tobacco use also causes cancer in the oral cavity, esophagus, and pancreas. In 2017, smoking was responsible for an estimated 1.7 million cancer deaths globally (34% of all cancer deaths), with an additional 120,000 cancer deaths due to smoldering tobacco and secondhand smoke.

Infectious agents such as H. pylori, HPV, and hepatitis B and C viruses are responsible for a substantial proportion of cases for some cancer sites.

**FIGURE 2.2. Prevalence (%) of human papillomavirus (HPV) infection (all ages) and HPV vaccination (ages 10–20 years) among females by continent.**

<table>
<thead>
<tr>
<th>Continent</th>
<th>HPV Infection Prevalence</th>
<th>HPV Vaccination Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>1% vs. 21%</td>
<td>10%</td>
</tr>
<tr>
<td>Asia</td>
<td>4% vs. 11%</td>
<td>20%</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>15% vs. 40%</td>
<td>3%</td>
</tr>
<tr>
<td>Europe</td>
<td>7% vs. 15%</td>
<td>5%</td>
</tr>
<tr>
<td>Northern America</td>
<td>9% vs. 16%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Infectious cancers are a major public health threat in regions that infect insects, plants, and crops that have been stressed, stressed crops.

**FIGURE 2.3. Distribution (%) of global aflatoxin-related liver cancer by WHO region.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Proportion (%) of liver cancer deaths caused by aflatoxin</th>
<th>Proportion (%) of liver cancer deaths caused by aflatoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Africa</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Northern America</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Americas</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Europe</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

**FIGURE 2.4. Comparison (%) of lung cancers caused by select environmental and occupational factors other than tobacco use worldwide.**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Western Europe</th>
<th>North America</th>
<th>Pacifics</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fragile fuels</td>
<td>20%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Air pollution</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Radon</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Household air pollution</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

**FIGURE 2.5. Other important cancers and their sources.**

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer</td>
<td>Secondhand tobacco smoke, radon, aerosolized tobacco smoke, asbestos</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>Smoking, estrogen levels, hormonal factors</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>Dietary factors, physical activity</td>
</tr>
<tr>
<td>Liver cancer</td>
<td>Hepatitis B and C viruses, aflatoxin</td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>Uranium, beryllium, hair dyes, aromatic amines</td>
</tr>
<tr>
<td>Kidney cancer</td>
<td>Lead, cadmium, arsenic, tobacco use</td>
</tr>
</tbody>
</table>

**FIGURE 2.6. Cancer risk reduction interventions.**

1. For women: If you can, breastfeed your baby. (11)
2. Consider using hormone replacement therapy. (12)
3. Take part in organized cancer screening programs for cancers of the breast, female breast, and cervix. (13)

**THE EUROPEAN CODE AGAINST CANCER**

**ECAC is an initiative of the European Commission, developed by the World Health Organization’s International Agency for Research on Cancer (IARC).**

**Ways To Reduce Your Cancer Risk**

1. Do not smoke or use any form of tobacco.
2. Make your home smoke free. Support smoke-free policies in your workplace.
3. Take action to be a healthy body weight.
4. Be physically active. Limit the time you spend sitting.
5. Eat a healthy diet. Enjoy plenty of whole grains, vegetables, fruits, and fish.
6. Limit alcohol consumption. Not drinking is better for cancer prevention.
8. In the workplace, follow health and safety instructions to protect yourself from harmful substances.
9. Know if you are exposed to radiation from naturally high radon levels in your home. Take action to reduce high radon levels.
10. For women: If you can, breastfeed your baby. (11)
11. Consider using hormone replacement therapy. (12)
12. Take part in organized cancer screening programs for cancers of the breast, female breast, and cervix. (13)
RISKS OF TOBACCO

Tobacco use is the leading preventable cause of cancer worldwide. Fortunately, reductions in smoking yield large reductions in cancer incidence and mortality.

As estimated 1 billion people use tobacco products worldwide. The majority (about 1.1 billion) use smoked tobacco products, chiefly as manufactured or hand-rolled cigarettes. Other smoked products include pipes, cigars, bat, hookah, and/or kreteks. Smoked products include snuff, chewing tobacco, and betel. Novel tobacco products, especially recently redesigned e-cigarettes, increasingly dominate tobacco use among youth in some high-income countries (HIC).

Eighty percent of the world’s smokers live in low and middle income countries (LMIC). The enormous global health and economic burden from tobacco use is increasingly borne by LMIC, due to population aging and the massive numbers of people who continue to smoke. Although smoking prevalence and per-capita consumption are decreasing worldwide, the rate of decrease is slower in LMIC than in HIC, and among women than men in HIC.

All smoked and traditional smoked tobacco products cause cancer. Although lung cancer is the most common cancer caused by cigarette smoking, at least 60% of other cancers sites or subsites are designated as causally related to smoking.

Even that list may be incomplete, as it does not include breast cancer or advanced prostate cancer, two sites for which the evidence has been labeled suggestive but not conclusive. Cigar and pipe smoking cause cancers of the lung and upper aerodigestive tract, including the oral cavity, esophagus, hypopharynx, larynx, and esophagus; secondhand smoke causes lung cancer. Smoked tobacco products cause even more deaths from vascular and respiratory conditions than from cancer. Cessation of smoking dramatically reduces risk compared to continued smoking.

Access to smoking cessation aides such as counseling, telephone quit lines, and pharmacotherapy can help people quit smoking. Even brief counseling encounters have been shown to increase quit rates, and a combination of counseling and pharmacotherapy can further increase success.
Infections are an important cause of many cancers worldwide, especially in economically transitioning countries.

Infectious agents are responsible for an estimated 15% of all new cancer cases annually worldwide, of which two-thirds occur in less developed countries (where they account for up to one quarter of all cancers). The four most important cancer-causing infections worldwide are Helicobacter pylori (170,000 cases globally in 2012), human papillomavirus (HPV) (640,000), hepatitis B virus (HBV) (770,000 cases globally in 2012), human T-cell lymphotropic virus, liver flukes, and schistosomiasis. Human immunodeficiency virus (HIV) infection also indirectly causes infection-related cancers through immunosuppression. In the US, for instance, the proportion of infection-associated cancer in people with HIV (4%) is 10 times larger than in the general US population (0.4%).

Powerful prevention tools exist for infection-related cancer, including HPV and HBV vaccines, screening for HIV-associated cervical precancer, and drugs to treat HBV, HIV, Helicobacter pylori, and HPV infections.
Excess body weight, alcohol consumption, unhealthy diet and physical inactivity are important modifiable cancer risk factors.

Excess body weight (i.e., overweight and obesity) increases risk of 13 types of cancer, and in 2012 accounted for 5.6% of all new cancer cases among adults worldwide. The global prevalence of excess body weight has increased in recent years, with an estimated 34% of men and 40% of women aged 60 years and older, and 37% of boys and 46% of girls aged 10-18 years, were obese.\(^\text{FIG. 2}\) High amounts of sugar-sweetened beverages, and sedentary behaviors, including screen-time, increase risk of excess body weight, whereas aerobic physical activity, including walking, reduces risk.\(^\text{FIG. 3}\)

Alcohol consumption is known to cause cancers of the oral cavity, pharynx, larynx, esophagus, liver, colon, rectum, and female breast. Worldwide, in 2016, 4.4% of cancer deaths were attributed to alcohol consumption.\(^\text{FIG. 4}\)

Independent of effects on body weight, a healthy dietary pattern rich in plant foods, including fruits, non-starchy vegetables, whole grains, and legumes (e.g., beans), and low in red and processed meats, reduces risk of certain cancers, particularly colorectal cancer. Independent of effects on body weight, physical activity reduces risk of some types of cancer, specifically colon, and among women, breast and endometrial cancer. Globally, 9% of adults did not meet World Health Organization physical activity guidelines in 2010, and more than 80% of adolescents were insufficiently physically active.

Reversing the obesity epidemic, limiting alcohol consumption (among those who drink), and increasing the prevalence of healthy eating and active living hold considerable potential for reducing cancer incidence and mortality, which will require a comprehensive approach involving actions by institutions and individuals at all levels from national to local communities.

The International Agency for Research on Cancer has concluded that alcoholic beverage consumption causes at least seven types of cancer.
Skin cancers are caused by ultraviolet radiation and can be prevented by sun protection and banning sunbeds.

A majority of skin cancer are caused by ultraviolet (UV) radiation. Keratinocyte skin cancers (basal cell and cutaneous squamous cell carcinomas) are the most common human cancers with over 23 million cases estimated each year worldwide. While rarely fatal, keratinocyte cancers cause substantial burdens of morbidity and cosmetic concern (most occur on the face). Melanoma is a more lethal form of skin cancer with about 69,000 deaths and 350,000 cases annually worldwide. In many countries skin cancers pose a significant economic burden due to their sheer numbers and the high cost of treatment for metastatic melanoma. 

UV radiation comes from the sun, filtered by stratospheric ozone. The UV Index measures the intensity of sunburn-causing UV reaching the Earth’s surface on a scale of 1 (low) to 11+ (extreme) and varies with latitude, altitude, time of day and year, cloud cover, and air pollution. In summer, the UV Index averages around 12 in Bangkok, Thailand (14°N); 5 in Sydney, Australia (34°S); 8 in New York, USA (41°N); 7 in Berlin, Germany (52°N) and 5 in St Petersburg, Russia (66° N). Cosmetic tanning devices also emit UV radiation, often stronger than summer sun, and are classified as human carcinogens; however, their use remains high, particularly in Europe and North America. 

Banishing these devices brings potentially high savings of lives and costs.

Indirect risk factors for skin cancer, such as light skin and red hair, and having follicles and moles, influence the effects of ambient UV and occupational and recreational sun exposure. Skin cancer is rare in people with innately dark skin. Risk is higher with high UV exposure in childhood.

When the UV Index is >3, skin can be protected by avoiding outdoor activities in the middle of the day, providing effective shade outdoors; wearing hats, clothing cover and sunglasses; and applying sunscreen of Sun Protection Factor 30+ or higher. In contrast to many European countries, Australia began implementing UV protection campaigns in the 1980s, and rates of melanoma are now decreasing in younger generations. 

The skin cancer prevention campaign of 2005 was a global health success. It was seen as a model for successful health communication and as a factor in the decrease in melanoma rates in many countries.

The World Health Organization has called for a global treaty to ban cosmetic tanning devices. The treaty could bring substantial economic benefits to many countries while saving many lives and costs.

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Reproductive patterns and exposure to reproductive hormones play a role in the development of some cancers in women. Economic, political, and societal shifts in the last century have been marked by profound changes in sexual maturation and reproductive patterns. These changes have led to increased lifetime number of monthly menstrual cycles, which is associated with higher risk of breast, endometrial, and ovarian cancers. Although not fully understood, one mechanism that could underlie these relationships is increased exposure to endogenous estrogen and progesterone levels. Other aspects of menopause may play a role in the development of some types of ovarian cancers. Longer term breastfeeding decreases risk of most types of breast cancer likely through cessation of the menstrual cycle, changes to the hormonal milieu, and profound cellular changes to the breast tissue. While shifting patterns of reproductive factors, such as decreasing age at menarche, increasing age at first birth, and fewer births per woman, continue in many developing countries—and may have contributed to increases in incidence rates for hormone-related cancers—these trends have plateaued in many developed countries. While breastfeeding up to and beyond 12 months is common in many low- and middle-income countries, fewer children in high-income countries are exposed to sustained use of exogenous hormones for contraception, reproductive assistance, and menopausal symptoms. Hormonal contraceptive users have a slight, transient increase in the risk of breast cancer, but a moderate and long-term reduction in the risk of some types of ovarian cancer and endometrial cancer. Although use of fertility drugs is a relatively recent exposure, early studies indicate that use of these powerful hormones does not increase cancer risk. Menopausal hormone therapy increases risk of breast and endometrial cancer dependent on formulation, timing of use, and body size, but may be associated with a decreased risk of colorectal cancer.

Increasing breastfeeding duration from present levels to 12 months per child in high-income countries and at least 2 years per child in low- and middle-income countries could avert 22,000 breast cancer deaths per year.

The number of births per woman has decreased to 2 or fewer in most higher-HDI countries.
ENVIRONMENTAL & OCCUPATIONAL EXPOSURES

Limiting carcinogenic exposures in the environment and in the workplace provides an opportunity to reduce the cancer burden, particularly for workers with unacceptable high exposures.

ENVIRONMENTAL POLLUTANTS

Outdoor air pollution causes between 6 and 8 million premature deaths from lung cancer and other diseases each year. The International Agency for Research on Cancer (IARC) has classified outdoor air pollution and the particulate matter in outdoor air pollution as known human carcinogens. Outdoor pollution levels are particularly high in rapidly growing cities in low- and middle-income countries. Diesel exhaust, also classified as a lung carcinogen by IARC, contributes to outdoor air pollution and is also an occupational lung carcinogen.

Indoor air pollution from use of solid fuel (e.g., wood, other biomass, and coal) is estimated to cause about 3.8 million deaths, including about 120,000 lung cancer deaths, each year in low- and middle-income countries. Globally, the number of people cooking with solid fuels has declined, but populations in less-developed countries continue to be exposed to high levels of household air pollution. In rural settings, indoor smoke emissions from coal or a known human carcinogen, and from other types of solid fuels are probable carcinogens.

Exposure to radon is probably the second-leading cause of lung cancer in the United States and Europe. Radon gas from the radioactive decay of uranium, found at differing concentrations in soil and rock throughout the world. While the general population is exposed primarily from radon gas entering homes from the soil, exposure to high levels of radon can also occur when the gas is trapped in underground mines.

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OCURRENCE OF CANCER IN THE WORLD

The air we breathe has become polluted with a mixture of cancer-causing substances. We now know that outdoor air pollution is not only a major risk to health in general, but also a leading environmental cause of cancer deaths.

— Ole Knud Strøm, Former Head of the IARC Monograph Section
**HUMAN CARCINOGENS**

Identified by the IARC Monographs Program

The International Agency for Research on Cancer (IARC) Monographs Program systematically identifies environmental and occupational causes of human cancer. Sometimes called the WHO “Encyclopedia of Carcinogens,” the IARC Monographs are critical reviews and evaluations of the weight of the evidence that an agent may cause an increased risk of cancer in humans. Since the program’s inception in 1976, over 100 agents have been evaluated, including individual chemicals, complex mixtures, physical agents, biological agents, personal habits, and occupational exposures.

The agents are classified as “cancerogenic to humans” (Group 1), “probably carcinogenic to humans” (Group 2A), “possibly carcinogenic to humans” (Group 1B), “not classifiable as to carcinogenicity to humans” (Group 2B), or “probably not carcinogenic to humans” (Group 3). This classification, based on all published scientific literature, reflects the strength of the evidence derived from epidemiological studies in humans, cancer biologies in experimental animals, and in vitro and in situ studies on the mechanisms of carcinogenicity. Evidence from studies in humans and animals is considered to be sufficient, limited, inadequate, or suggesting lack of carcinogenicity.

Data from mechanistic studies are considered as providing strong, moderate, or weak evidence for a given mechanism. To date, 120 agents have been evaluated, including individual chemicals, complex mixtures, occupational exposures, and personal habits. Some important risk factors known to cause cancer in humans have however not been covered in the IARC Monographs.

To date, IARC has classified 120 agents as carcinogenic to humans.

**Reproductive System**

- **Nasal Cavity and Paranasal Sinus**
  - Nickel compounds
  - Rubber production industry
  - Phenytoin (anticonvulsant)
- **Skin**
  - Benzene
- **Larynx**
  - Tobacco smoke
  - Phenacetin, analgesic mixtures

**Respiratory System**

- **Liver**
  - Polychlorinated biphenyls
  - Radon gas
- **Eye**
  - Benzene
  - Cigarette smoke
  - Tetrachlor ethylene (solvent)

**Urinary System**

- **Bladder**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Hematopoietic System**

- **Skin**
  - Mercury and inorganic mercury compounds
  - Cadmium
- **Lungs**
  - Radon gas
  - Tobacco smoke
  - Benzene

**Digestive System**

- **Esophagus**
  - Tobacco smoke
  - phenacetin
  - Phenytoin (anticonvulsant)
- **Colon and Rectum**
  - Tobacco smoke
  - Phenacetin

**Central System**

- **Pituitary**
  - Tobacco smoke
  - Phenacetin

**Hazardous Risk**

The classification indicates the strength of the evidence that a substance or agent causes cancer in humans. The classification is based on factors such as exposure levels and duration, the frequency of cancers observed, the anatomical site of the cancer, and the strength of the evidence of the effect of the agent.

**Human Immunodeficiency Virus**

- **Uterine Cervix**
  - Human papillomavirus type 16
- **Kidney**
  - Radium-228 and its decay products
  - Soot
- **Larynx**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Oral Cavity and Pharynx**

- **Tongue**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)
- **Spleen**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Genital System**

- **Uterus**
  - Tobacco smoke
  - Phenacetin

**Hematopoietic System**

- **Skin**
  - Mercury and inorganic mercury compounds
  - Cadmium
- **Liver**
  - Phenacetin, analgesic mixtures
  - Phenytoin (anticonvulsant)

**IARC Monographs Program**

- **Liver**
  - Benzo[a]pyrene
  - Nickel compounds
- **Lungs**
  - Radon gas
  - Tobacco smoke
  - Benzene

**Uterine Cervix**

- **Melanoma**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Kidney**

- **Liver**
  - Benzo[a]pyrene
  - Nickel compounds
- **Lungs**
  - Radon gas
  - Tobacco smoke
  - Benzene

**Central System**

- **Pituitary**
  - Tobacco smoke
  - Phenacetin

**Hematopoietic System**

- **Skin**
  - Mercury and inorganic mercury compounds
  - Cadmium
- **Liver**
  - Phenacetin, analgesic mixtures
  - Phenytoin (anticonvulsant)

**Respiratory System**

- **Liver**
  - Benzo[a]pyrene
  - Nickel compounds
- **Lungs**
  - Radon gas
  - Tobacco smoke
  - Benzene

**Urinary System**

- **Bladder**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Larynx**

- **Eye**
  - Benzo[a]pyrene
  - Nickel compounds
- **Nervous System**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Genital System**

- **Uterus**
  - Tobacco smoke
  - Phenacetin

**Hematopoietic System**

- **Skin**
  - Mercury and inorganic mercury compounds
  - Cadmium
- **Liver**
  - Phenacetin, analgesic mixtures
  - Phenytoin (anticonvulsant)

**Respiratory System**

- **Liver**
  - Benzo[a]pyrene
  - Nickel compounds
- **Lungs**
  - Radon gas
  - Tobacco smoke
  - Benzene

**Urinary System**

- **Bladder**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)

**Larynx**

- **Eye**
  - Benzo[a]pyrene
  - Nickel compounds
- **Nervous System**
  - Tobacco smoke
  - Phenacetin
  - Phenytoin (anticonvulsant)
Each year, about 270,000 cancer cases are diagnosed in children. Today, five-year survival from childhood cancer in high income countries is greater than 80%, but it can be as low as 20% in lower-income countries.

With interventions to improve early diagnosis and adherence to appropriate treatment, childhood cancer survival can be increased to 60% in lower-income countries, saving almost 1 million children’s lives over a decade.
Cancer is a major public health and economic issue and its burden is set to spiral. With over 18 million cases in 2018, we can expect 29 million cases by 2040 due to the aging and growth of the population. Worldwide, there were an estimated 18.1 million cases and 9.6 million cancer deaths in 2018 (including non-melanoma skin cancers), with one in four men and one in five women developing the disease, and one in eight men and one in eleven women dying from it. In addition, there were 43.8 million people living with cancer in 2018 who were diagnosed within the last 5 years. Half of the new cancer cases and cancer deaths in the world occur in Asia. China, with the largest population size in the region and worldwide, 4.9 billion inhabitants, representing 19% of the global population in 2018—has the greatest global proportion of new cases (4.5 million cases, 24% of the total) and deaths (0.9 million deaths, 30%). Northern America is second in terms of new cases (2.4 million, 14%), and fourth for cancer deaths (0.7 million, 7%). Close to one fourth of all new cases globally (4.2 million) and one fifth of deaths (1.0 million) occur in Europe, despite the region representing less than one tenth of the global population. For both sexes combined worldwide, lung cancer continues to be the most commonly diagnosed cancer (4.1 million, 22% of the total), followed by colorectal cancer (2.1 million, 12% of the total). Lung cancer continues to be the most commonly diagnosed cancer globally, but second only to lung cancer in terms of mortality (5.8 million cases and 1.2 million deaths). Prostate cancer is the fourth most frequently diagnosed cancer, while stomach and liver cancer remain major causes of cancer death in 2018. Based on projected population aging and growth, the global burden of cancer is set to increase by more than ten-fold by 2040, from 18.1 million new cases in 2018 to a predicted 45.5 million cases in the year 2040. More broadly, cancer has become a leading cause of death over the last few decades. In terms of premature mortality (defined as death in ages 30–69 years), in the year 2018, cancer was the leading cause of death in 65 (largely high-income) countries, but second (mainly to cardiovascular disease) in an additional 79 countries. With rates of cardiovascular mortality in decline in many countries due to highly successful prevention and treatment, cancer is set to become the leading barrier to increasing life expectancy in this century. Cancer ranks as the first or second leading cause of premature death (among those 30–69 years of age) in 134 countries of the world. Lung cancer is the most commonly diagnosed cancer and the leading cause of cancer death worldwide.
LUNG CANCER

Lung cancer remains the most commonly diagnosed cancer and the leading cause of cancer death worldwide because of inadequate tobacco control policies. Globally, there were an estimated 1.8 million lung cancer cases and 1.7 million deaths in 2018. Incidence and mortality rates vary 60-fold between regions. Other established risk factors include secondhand smoke, air pollution, radon, and several occupational agents (seeolf, Environmental Pollutant and Occupational Exposure). However, reducing tobacco smoking alone could prevent the majority of lung cancers. Screening for detection of the disease at an earlier stage for long-term heavy current and former smokers is available, but wide dissemination of the procedure is unlikely in the short term, even in high-income countries, because of the need for a more advanced and coordinated healthcare system.

FIGURE 11.1 Lung cancer incidence and mortality rates, 2018

The tobacco epidemic is characterized by an increase in uptake of smoking followed by an increase in lung cancer mortality rates a few decades later.

FIGURE 11.2 Converging lung cancer mortality rates among men and women, select countries, 1952–2012, age-standardized rate (world) per 100,000, all ages

FIGURE 11.3 Lung cancer related to tobacco smoking and air pollution in China and France

Although tobacco remains the most important risk factor for lung cancer, other factors such as air pollution are significant in some countries.
Breast cancer is the leading cancer type in females in most countries in the world. In 2018, 12.2 million new cases of breast cancer were diagnosed, with an estimated 2.0 million deaths. This translates to one in twenty females being diagnosed with breast cancer over the course of their lifetime. About one in twenty females will be diagnosed with breast cancer over the course of their lifetime, although this number varies significantly by country. There are large variations in estimated incidence rates worldwide, with an almost fourfold difference between the highest- and lowest-ranked regions. Incidence rates are elevated in Australia/New Zealand, Europe and North America, notably in Belgium (1.3 cases per 100,000 female population) and Luxembourg (1.9 in Europe, and in Australia (4)). In contrast, incidence rates in sub-Saharan African regions, particularly in Eastern (0.9 cases per 100,000 female population) and Middle Africa (4), as well as South Central Asia (1%), were considerably lower. Geographic variation is less pronounced for mortality rates, with the highest rates seen in Malawi (15 deaths per 100,000 female population) and Polyneisa (2), as well as in Northern and Western Africa (4). Notably, some countries in Europe, North America, and Oceania have among the lowest mortality rates despite their high incidence rates.

The variations observed in breast cancer incidence across countries can likely be at least partly attributed to differences in the prevalence and distribution of the major risk factors (e.g. reproductive factors, obesity) and partly to the degree of early detection and screening activities in operation. Breast cancer screening detects breast cancer at earlier stages, but also captures cases that would have never been diagnosed otherwise. As such, incidence rates are often higher in countries that implement breast cancer screening programs. In countries where the incidence of breast cancer is high, there has been a decline or stabilization of rates, while in countries where rates have historically been low, rates have been markedly increasing, probably related to improved diagnosis (i.e., detection of asymptomatic cancers) in combination with socio-cultural changes linked to an increase in westernized lifestyle. Declines in breast cancer mortality rates have been reported in many high-income countries, with large decreases in European and North American countries and in Australia and New Zealand, whereas countries in transition continue to show a slow increase in mortality from breast cancer, though this appears to be slowing. The favorable trends in mortality may stem from the combined effects of earlier detection (screening and increased breast cancer awareness) and a range of improvements in treatment.

In lower-resource settings, breast and cervical cancer disproportionately affect women in the prime of life, resulting in significant economic and social impact. A woman’s country of residence should not be allowed to influence the likelihood of dying from these cancers.

— Dr. Ophira Ginsburg, medical oncologist

Breast cancer is the most common cancer in women in almost all countries worldwide.

Although female breast cancer incidence rates are lowest in less developed regions, mortality rates in these areas are comparable to most of the more developed regions due to lack of access to early detection and treatment.
CANCER IN CHILDREN

The childhood cancer burden is strongly related to level of development, with high incidence in high-income countries but higher mortality in low-income countries.

Cancers occurring in childhood and adolescence differ markedly from cancers in adults in their incidence and tumor characteristics. Worldwide, the average annual incidence in children aged less than 15 years is 1.40 new cases per million children, although there are threshold variations between world regions and ethnic groups. FIGURE 13.1

The low rates recorded by population-based cancer registries in some low-income countries are thought to result from under-diagnosis. FIGURE 13.2

The most common cancers in children are leukemia and lymphoma, while the major cancers among adults, such as carcinoma of the lung, breast or colon, are rare in children. The incidence of carcinoma increases progressively with age, and together with lymphomas or germ cell tumors they become the most common cancers in adolescents aged 15-19 years, with the overall incidence rate rising to 6.79 per million. In contrast, the incidence of embryonal tumors, such as neuroblastoma, retinoblastoma, and nephroblastoma is very low in adolescents. FIGURE 13.2

More than half of long-term survivors of childhood cancer experience chronic health conditions.

The incidence of cancer in children and adolescents has been increasing by 0.3 to 0.4 percent per year in the high-income countries with established cancer registries over the past few decades. Although the increase may in part reflect more frequent diagnosis facilitated by advanced imaging techniques, other factors may also have contributed. Exposure to high doses of ionizing radiation, high birth weight and certain genetic syndromes have been consistently associated with increased risk of cancer in children. The role of other risk factors, such as air pollutants, tobacco or pesticide use, older parental age, or fewer children per family is debated. Potentially protective effects of breastfeeding and folic acid supplementations are being investigated.

Five-year-age-standardized net survival (%), observed in the available cohorts of cases diagnosed with lymphoid leukemia FIGURE 13.3

Survival from childhood cancer patients in high-income countries survives 5 years after their diagnosis. In many low-income countries, in contrast, the outlook is much less favorable because of suboptimal access to care, late diagnosis, treatment abandonment, inadequacy of therapy, and the financial burden. Survival of childhood cancer patients has been assessed in only a few low-income countries. FIGURE 13.4

As survival of cancer patients improves over time, FIGURE 13.4, many survivors experience chronic health conditions later in life as a consequence of their cancer or the anti-cancer therapy.

The true burden of cancer in children is unknown in most low-income countries.

The distribution of cancer in children differs from that of children and adults.

Occurrence of childhood cancer varies by region, with the highest incidence in more developed regions.

Burkitt lymphoma is the most common pediatric cancer in many parts of sub-Saharan Africa, while about 10% of children with Burkitt lymphoma in high-income countries can be cured with therapy including high-intensity chemotherapy and supportive care infrastructure; about 50% of children with the disease in resource-constrained settings where such treatment is not feasible can be cured with a simplified protocol.
It is the leading cause of premature death.

Unintentional injuries

2018 and the projected increase by 2040 by four-tier HDI

Females

VERY HIGH

Low HDI

Estimated number of new cancer cases in

Figure 2

Very High HDI

2040

Figure 1

5th–10th

Cardiovascular diseases

-  

Males

l

2nd

Malignant neoplasms

3

0

12M

6M

2M

10M

Very High HDI

14

44

India and China*

causes of cancer death (%) by four-tier HDI plus

INDEX

Understanding the

transition from

infection-related cancers to lifestyle-

related cancers in

many low- and middle-

income countries is vital for planning
tailored cancer control programs to reduce
the future deaths and suffering from the
disease.

FIGURE 14.2

Leading causes of premature mortality (%) (ages <70 years) in South Africa and Japan

While infectious causes of death dominate in South Africa, cancer is the most common cause of death in Japan.

By 2040, the cancer burden will double in low-HDI countries, which are least equipped to deal with the pending cancer epidemic.

FIGURE 14.4

Estimated millions of new cancer cases in 2018 and the projected increase by 2040 by four-tier HDI level, assuming only a demographic effect

Cancer is a leading cause of death in North and South America, Europe, Australia, North Africa, and parts of Asia.
There are more than 70 million Indigenous people spanning at least 70 countries worldwide. Indigenous peoples generally face disadvantage and have worse health than non-Indigenous people. Data related to cancer in these populations tend to be absent or of poor quality making many Indigenous peoples statistically invisible, with the majority of data that exist coming from a few high-income countries. There is under-reporting of cancer incidence and mortality in many jurisdictions. Indigenous peoples often have higher incidence and mortality rates of cancers related to exposure to tobacco, alcohol, poor diet, physical inactivity, high BMI, and diabetes mellitus than non-Indigenous people living in the same countries, although cancer patterns vary from country to country.

There are more than 370 million Indigenous peoples in the world, spanning at least 70 countries. Indigenous peoples generally face disadvantage and have worse health than non-Indigenous people. Data related to cancer in these populations tend to be absent or of poor quality making many Indigenous peoples statistically invisible, with the majority of data that exist coming from a few high-income countries. There is under-reporting of cancer incidence and mortality in many jurisdictions. Indigenous peoples often have higher incidence and mortality rates of cancers related to exposure to tobacco, alcohol, poor diet, physical inactivity, high BMI, and diabetes mellitus than non-Indigenous people living in the same countries, although cancer patterns vary from country to country.

Cancer control planning is needed to improve cancer outcomes for Indigenous peoples. Cancer control planning should be led by Indigenous women and form part of the draft global cervical cancer elimination strategy tabled at the 2020 World Health Assembly.

The World Health Organization has called for the elimination of cervical cancer. While disease burden is highest in low- and middle-income countries, significant disparities exist in high-income countries. In Australia, cervical cancer incidence in Indigenous women is double that of non-Indigenous women, with mortality rates over three times higher. Strategies are being needed to accelerate cervical cancer elimination for Indigenous women globally must be led by Indigenous women and form part of the draft global strategy tabled at the 2020 World Health Assembly.

New Zealand is the only country in the world that routinely records and reports national-level cancer statistics for its Indigenous population.

Indigenous peoples in many countries have a high prevalence of H. pylori, an infection which causes stomach cancer.
There are striking geographic differences in the incidence and mortality of different cancer types in different world regions. This global diversity reflects both the presence of local risk factors for specific cancers, and the extent to which effective cancer control measures have been implemented. Much of the observed variation in recorded incidence rates of different cancer types in different registry populations can be attributed to lifestyle and environmental factors. \textit{Geogr.} Such marked international variability supports the critical role of cancer prevention as a means to reduce the future cancer burden. Although specific causes remain unknown for many cancers, where measured, about two-thirds of cancers diagnosed today are potentially avoidable. Prevention measures include eliminating exposure to known lifestyle and environmental risk factors, including tobacco and alcohol, dietary factors, ozone body weight, and UV radiation, and increasing resistance to infection by vaccination. However, the proportion of cancer cases avoidable—overall and for specific risk factors—substantially varies by region. For example, infection accounts for 30–50% of all cases in sub-Saharan Africa, whereas this proportion is only 5% in Europe and North America.

The most frequently diagnosed cancers and leading cause of cancer death at the national level reflect the major risk factors in the population and the average prognosis of the major cancers observed. \textit{WHRCLL.} Certain cancers dominate the global landscape, particularly in women: breast cancer is the most frequent cancer in four-fifths of the world’s nations, with cervical cancer ranking most frequent in the majority of remaining countries, particularly in sub-Saharan Africa. The mortality profile among women is slightly more heterogeneous, with lung cancer also a leading cause of death.

Among men, there is considerable international diversity in the leading cancer types, with around 10 different cancers as the most commonly diagnosed cancer or leading cause of cancer death. Prostate, lung, and liver cancer are major cancers in men, although other cancers dominate in some regions (lip and oral cavity in South Asia and Kaposi sarcoma in Eastern Africa). Nevertheless, lung cancer is the leading cause of cancer death among men in over half of the world’s countries.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig1}
\caption{Relative and absolute global variations in incidence rates of registry populations included in ICD Volume XII (IRCA 2008–12), rates shown are those within the 10th and 90th percentiles in males.}
\end{figure}

\begin{table}
\centering
\begin{tabular}{|l|l|l|l|l|l|l|l|l|}
\hline
\textbf{Region} & \textbf{Country} & \textbf{Cancer Type} & \textbf{AGE-SPECIFIC MORTALITY RATES PER 100,000} & \textbf{M} & \textbf{F} & \textbf{10-90th PCT} & \textbf{P} & \textbf{Q}\0.001
\hline
Europe & Eastern Europe & Breast & 3.9 & 2.6 & 1.5 & 4.5 & 3.0 & 2.1
\hline
Asia & Indonesia & Lung & 6.1 & 3.9 & 2.0 & 7.1 & 4.3 & 3.3
\hline
Africa & South Africa & Skin & 6.1 & 3.9 & 2.0 & 7.1 & 4.3 & 3.3
\hline
Oceania & Australia & Lung & 6.1 & 3.9 & 2.0 & 7.1 & 4.3 & 3.3
\hline
\end{tabular}
\caption{Relative and absolute global variations in incidence rates of registry populations included in ICD Volume XII (IRCA 2008–12), rates shown are those within the 10th and 90th percentiles in males.}
\end{table}

\textbf{Cancer varies between different populations, and every type is rarer in some part of the world.}

Many specific causes are now known (to explain these differences), but a large proportion of global variation for common cancers remains unexplained.

— Prof. Juan Perez, Faculty 2001

\textbf{Considerating both sexes together, either female breast, prostate, or cervical cancer is the most commonly diagnosed cancer in over 70% of countries.}

\textbf{Site-specific incidence rates vary up to 50-fold between geographic areas.}

While prostate cancer is the most commonly diagnosed cancer among men in 100 countries worldwide, lung cancer dominates as the leading cause of cancer death in 93 countries.
Regional Diversity

SUB-SAHARAN AFRICA

Up to 50% of the cancers diagnosed in some countries in Eastern Africa are still related to infection, and these are largely preventable.

An estimated 752,000 new cancer cases (4% of the global total) and 566,000 cancer deaths occurred in sub-Saharan Africa in 2018. Although the overall cancer burden in the region is dominated by breast, cervical, and prostate cancers, the cancer profile in sub-Saharan Africa is quite diverse. MAP 17.1

The most common cancers in men are prostate (99,000 cases, or 33% of all cancers) and liver cancers (24,000 cases, or 8% of all cancers) as well as Kaposi sarcoma (20,000 cases, 6%). Breast (155,000 cases, 25% of all cancers) and cervical cancers (112,000 cases, 34%) are the most frequently diagnosed cancers in women. FIGURE 17.2

Incidence rates have been increasing for several major cancer sites. For example, cervical cancer rates increased by 86% in Zimbabwe and 94% in South Africa, although they have risen and declined recently in Uganda. FIGURE 17.3 Major increases have been seen for breast as well as for prostate cancers where they have been measured, doubling in Zimbabwe (breast) and South Africa (both cancers) over the last 15 years. While the causes of elevated rates for certain cancers such as esophagus is still largely unknown, a westernization of lifestyle (e.g. dietary habits, fertility, excess body weight, and physical inactivity) has been related to observed increases in breast cancer, and is expected to give rise to increases in rates of other cancers such as colorectum. An improved awareness and increased capacity to perform prostatectomies on older men has been suggested to be linked to the increase in prostate cancer rates. There is a large opportunity for cancer prevention and control programs to improve health outcomes in the region. Comparing incidence and mortality rates of all cancers combined across countries, large disparities in terms of incidence-to-mortality ratios are apparent. FIGURE 17.4 Large differences between incidence and mortality suggest poor outcome and substantial case-fatality from cancers. Yet primary prevention remains key in sub-Saharan Africa, where there is a need to prioritize the most cost-effective means of reducing the cancer burden. Improved access to diagnosis and treatment, including palliative care, is also essential to improve survival and limit suffering from the disease in the region.

The most common cancer cases and deaths in sub-Saharan Africa, both sexes combined, 2018

Over one-third of all cervical cancer deaths globally occur in sub-Saharan Africa, though the region represents only 14% of the world female population.

FIGURE 17.2 Incidence and mortality rates of the most common cancers in sub-Saharan Africa in males and females, 2018


FIGURE 17.4 Incidence and mortality rates in selected countries in sub-Saharan Africa, 2018

A relatively low incidence to mortality ratio can indicate poorer cancer outcomes. While the ratio between cancer incidence and mortality is 2.2 in Mauritius, one of the wealthiest countries in the region, it is 1.4 in Uganda.

FIGURE 17.5 Estimated number of new cancer cases vs. deaths and distribution (%) by type, both sexes, 2018

Sub-Saharan Africa has a unique mix of common cancers including several infection-related cancers.

FIGURE 17.6

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Sub-Saharan Africa has a unique mix of common cancers including several infection-related cancers.

FIGURE 17.6
Invasion and mortality rates for all cancers combined (except non-melanoma skin) reveal the extent of variation between countries, with incidence rates varying (in both sexes) from 265 (per 100,000) in Uruguay to 105 in Guyana, and mortality from 130 in Uruguay to 8 in Mexico.

FIGURE 18.2 Incidence rates vary more than twofold between countries of this region.

In some countries with longstanding cancer registries, there is evidence of modest increases in all-cancer incidence rates; this is mainly due to an upward trend in incidence rates of the most common cancer types, including female breast, colorectal and prostate cancer—coinciding with marked declines in stomach and cervical cancer.

In contrast, overall cancer mortality rates are stabilising or in decline in most countries during the more recent decades, driven by favourable mortality trends for major cancers in the region, except colorectal cancer, for which rates are rising in many countries. While lung cancer mortality rates in men are decreasing in many countries, they are still increasing in women. Bolivia and Chile exhibit the highest incidence rates of gallbladder cancer worldwide (44 and 18 per 100,000, respectively), possibly related to specific types of indigenous ancestry.

FIGURE 18.3 Bolivia and Chile have the highest gallbladder cancer rates in the world.

Gallbladder is the leading cause of cancer death in Bolivia.

Incidence rates of prostate and breast cancer are increasing, while rates of stomach and cervical cancer, both related to infection, are decreasing.

FIGURE 18.3 Incidence trends in selected countries in Latin America, prostate and breast cancer, all ages, 1982-2012

FIGURE 18.4 Incidence trends in selected countries in Latin America, stomach and cervical cancer, all ages, 1982-2012

Regional Diversity
LATIN AMERICA & THE CARIBBEAN

Prostate, breast and colorectal cancer are the main cancers in the region.

About 1.3 million new cancer cases and 866,000 cancer deaths were estimated to have occurred in 2018 in Latin America and the Caribbean. The five most common cancers in 2018 were female breast (200,000 new cases, 46% of all cancer cases), prostate (190,000, 42%), colorectal (180,000, 4%), lung (130,000, 7%) and stomach (85,000, 5%). Lung cancer is the leading cause of death (81,000, 12%), followed by colorectal (65,000, 10%), breast (51,000, 8%). Lung cancer is the leading cause of death, accounting for 26% (1 in 4 persons) in women.

Stomach, cervix and liver cancer are the leading causes of death in Latin America and the Caribbean, both sexes, all ages.

Estimated incidence and mortality rates in 2018, ASR (World) per 100,000

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Gallbladder is the leading cause of cancer death in Bolivia.

Incidence rates of prostate and breast cancer are increasing, while rates of stomach and cervical cancer, both related to infection, are decreasing.
Lung cancer remains the leading cause of cancer death in Northern America, despite decades of declines in smoking prevalence.

Cancer is the leading cause of death in Canada and the second-leading cause, after heart disease, in the USA. About 1.4 million new cancer cases and 693,000 cancer deaths were estimated to have occurred in Northern America in 2018. The most commonly diagnosed cancers are prostate in males and breast in females, while lung cancer remains the most common cause of cancer death in both sexes. [FIGURE 19.2]

The crisis is obesity. It’s the fastest-growing cause of disease and death in America. And it’s completely preventable. — Dr. Richard H. Carmona, US Surgeon General

While breast cancer is the most commonly diagnosed cancer in Northern America, lung cancer is by far the leading cause of cancer death.

While in Northern America, the increase in public awareness and government policy on tobacco control, the decrease in smoking rates has been observed, largely due to the introduction of smoking cessation programs. [FIGURE 19.4]

Three in five endometrial cancers in the USA are caused by excess body weight.

There are wide differences in progress against colorectal cancer incidence and mortality in Northern America. [FIGURE 19.5]
Regional Diversity

SOUTHERN, EASTERN & SOUTHEASTERN ASIA

Lung, breast, and colorectal cancers are common in this region, in addition to liver and stomach cancers, which are associated with infection.

Due to the high use of smokeless tobacco products, rates of lip and oral cavity cancers in some countries in this region are up to three times higher than the global average.
Incidence trends for all cancer sites combined have continued to rise in many countries, although at a slower pace in recent years. This slower increase partly results from a stabilization or decline in breast and prostate cancers, countered by an increase in colorectal cancer. The other hand, overall cancer death rates are steadily decreasing in Europe, mainly due to decreasing death rates from breast and prostate cancers as well as lung (male only, particularly in Northern and Western Europe). In Central and Eastern European men, lung cancer incidence and mortality rates are beginning to stabilize or decline. In women across Europe, who for the most part acquired the smoking habit several decades after men, lung cancer rates are still rising, though there are early signs of stabilization in recent years in some countries, notably in the highest risk countries of Northern Europe.

There were an estimated 3.9 million new cancer cases and 1.4 million cancer deaths in Europe in 2018. Cancers of the female breast (535,000 new cases, 15% of all cancer cases), colorectum (502,000, 15%), lung (470,000, 12%), and prostate (462,000, 12%) were the most common cancers on the continent, and combined they represented almost half of the overall cancer burden. For men, prostate cancer was the most commonly diagnosed cancer in almost all northern and western European countries, and lung cancer was the most commonly diagnosed in most Eastern European countries. For women, breast cancer is the most commonly diagnosed cancer in all European countries. These cancers were also the leading causes of cancer death in Europe: lung (589,000 deaths, 20%), colorectum (242,000, 15%), female breast (138,000, 7%), and pancreas (128,000, 7%).

Substantial variation in incidence and mortality rates are observed at the national level, where cancer incidence rates in males vary from 450 per 100,000 in Ireland to 153 in Montenegro. The lifetime risk of a cancer diagnosis ranges from 5% in Ireland—indicating that in 5 persons in Ireland will be diagnosed with cancer over the course of their lifetime—to 36% in 21 people, in Montenegro. Similarly, a twofold difference in rates is seen for mortality, with the highest and lowest mortality rates observed in Hungary and Sweden, respectively. The risk of dying from cancer in men varies from 21% in the Republic of Moldova to 40% in Iceland, and in women from 13% in Hungary to 7% in Spain.

In many European countries, one in three people will be diagnosed with cancer by the age of 75. Europeans represent about one-tenth of the global population, yet one in four of all cancer diagnoses occur in this region.
Northern Africa and Central and Western Asia is a large and diverse region, characterized by low but increasing cancer incidence rates. The overall number of cases estimated for 2018 in the region was around 285,000, with this number predicted to increase to 4.4 million cases annually by 2040. However, each of the three sub-regions have distinct cancer profiles. **Map 22.1**

**NORTHERN AFRICA**
In Northern Africa, cancer incidence rates are typically about one-third to half of the corresponding rates in Western countries, with incidence rates for all cancer sites combined ranging from less than 100 cases per 100,000 population in Sudan to more than 190 in Egypt in men, and less than 100 in Libya and Sudan to more than 140 in Algeria and Morocco in women. **Figure 2** Liver cancer is the second most common cancer in both sexes combined, with incidence rates in Egypt estimated to be the second highest worldwide on both men and women. **Figure 2.2**

**WESTERN ASIA**
Western Asia is a large region, with close to 400,000 estimated cancer cases annually, but high-quality cancer registry data are available for only few countries, partly due to large numbers of displaced persons and ongoing conflicts. Some of the countries in the region have very high bladder cancer incidence rates; Lebanon notably has the highest estimated incidence rate in the world (40 cases per 100,000 in men), while rates in Iran, Syria, and Turkey also exceed 20 per 100,000 in men. Western Asia also includes the Gulf countries, with specific cancer profiles corresponding to their high national levels of HDI, high prevalence of obesity, and varying levels of smoking uptake, but low-alcohol consumption. **Map 22.2**

**CENTRAL ASIA**
Cancer incidence rates in Central Asia are relatively low but increasing. Cancer profiles are consistent with low-to-medium-HDI countries, with a high incidence of infection-related cancers such as stomach (18% of all cancer cases) and cervical cancer (8% of all cancer cases). The region forms part of the so-called esophageal cancer belt, which includes Turkmenistan, Tajikistan, Uzbekistan, Kazakhstan, Afghanistan and the eastern part of Turkey, with some of the highest incidence rates worldwide, particularly in men.

**Figure 2.1**

**In this diverse region with countries at different stages of the cancer transition, cancers associated with infection, smoking, and excess body weight are all common.**

### Regional Diversity

**NORTHERN AFRICA, WEST & CENTRAL ASIA**

Several countries in the region, particularly in Western Asia, have a high proportion of cancer cases attributable to excess body weight. We need to ask ourselves: What legacy will we leave our generation to be known for? The one that watched the NCD epidemic destroy the lives of our children and our children’s children, or the generation that said ‘enough is enough’ and took action?

—Michel Sidibe, Executive Director, UNAIDS
4% of all cancers), prostate (25,900, 15%), and colorectum (16,900, 14%) are also commonly diagnosed in the region. Lung cancer accounts for the greatest number of cancer deaths (10,300, 17%), followed by colorectum (9,100, 12%) and female breast cancer (8,100, 9%). Skin cancers (melanoma and non-melanoma) are the most common cancers and represent a significant public health issue, particularly in Australia and New Zealand.

Given the relatively large proportion of Australia & New Zealand, the vast majority of the region’s cancer cases and deaths (99% and 89%, respectively) occur in these two countries. Papua New Guinea is unique among the other nations in terms of its relatively large population and burden (10.4 million, 11,200 new cases, 7,700 deaths). Most of the Pacific Island countries and territories feature small populations that are often spread across many remote islands.

Cancer profiles vary considerably across subregions. In Australasia and Polynesia, the cancers with the highest incidence rates include female breast, prostate, lung, and colorectum. In Central America, cervical cancer incidence rates are almost half those of the above regions, and cervical cancer is the second-leading cancer, with rates two to three times higher than the average rate in the region.

An estimated 54,000 new cancer diagnoses and 69,000 cancer deaths occurred in 2018 in the subregions of Oceania, namely Australia, Melanesia, Micronesia, and Polynesia. Cancers of the female breast (24,600 new cases, 23.1%) were the most commonly diagnosed cancer in the region, commonly diagnosed cancer in the region, followed by colorectum (8,100, 12%) and female breast cancer (8,100, 9%). Skin cancers (melanoma and non-melanoma) are the most common cancers and represent a significant public health issue, particularly in Australia and New Zealand.

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Australasia and New Zealand have the highest skin melanoma incidence rates in the world.
Access to effective early detection and cancer treatment can substantially improve survival for cancer patients and reduce the survival gap worldwide.

Overall improvements in early detection and treatments have greatly improved average survival of cancer patients worldwide over the past several decades, yet prognosis still varies markedly depending on where a patient lives. Figure 24.4. Survival differences are also marked within regions. Within sub-Saharan Africa for example, overall (observed) survival of women diagnosed with breast cancer is about 30% higher in patients residing in high Human Development Index (HDI) countries than in those residing in low HDI countries. Figure 24.4. This is in part because breast cancer patients in the low-HDI countries are more likely to be diagnosed at a later stage and less likely to receive the appropriate treatment. In addition to variation between countries, within-country differences have also been reported. For example, in the United States, black cancer patients have lower survival than non-Hispanic white patients. Figure 24.4. In order to close this survival gap, improved population awareness about cancer symptoms, better access to diagnostic services, and adequate care are key. Universal Health Coverage is one strategy to achieving this. (see 40, Universal Health Coverage). The implementation of universal health coverage in Thailand in 2002 may at least partly account for the increase in the 5-year breast cancer survival proportion, from 44% for patients diagnosed from 1993 to 1999 to 59% for those diagnosed from 2000 to 2014. Figure 24.4.

Cancer patient survival benchmarking is an important tool for advocacy to ensure equitable cancer care. Global initiatives assessing international cancer survival include EUROCARE, a cross-European project since 1990, the International Cancer Benchmarking Partnership, involving high-income countries with similar health systems, CONCORD, which collects and reports data from all countries worldwide, and SURVIVAL, which aims to improve data and capacity for survival estimation in Africa, Asia, and South America, including an initiative with the African Cancer Registry Network to expand population-based survival estimates in sub-Saharan Africa. Unfortunately, high-quality data remains scarce. Figure 24.4. Improving the quality and availability of population-based survival data is essential to ensuring effective monitoring of progress in cancer control.

The number of population-based cancer registries that are able to provide high-quality survival statistics is lacking but has grown over the last decades, providing national and global evidence to improve effectiveness of health care systems.
The growing population of cancer survivors represents a global challenge for survivors and their families, employers, healthcare systems and governments.

The number of cancer survivors is rising worldwide, propelled by advances in early detection and treatment and the aging of the world’s population. In 2018, there were approximately 43.8 million cancer survivors diagnosed within the previous 5 years. The increasing visibility makes it increasingly clear that while some cancer survivors thrive, for many life after cancer presents lasting challenges. Fear of recurrence, depression, pain, memory problems, sexual dysfunction, relationship issues and school/work are common. Late effects (occurring months or years after treatment ends) may include cardiac problems, lymphedema, impaired functional status, and second cancers.

Combined, long-term and late-effects of cancer may disable survivors; risk of poor mental and physical health-related quality of life.

Working-age cancer survivors often face challenges in maintaining employment. They increasingly experience medical financial hardship; including problems paying medical bills, financial distress, and delaying or forgoing care because of cost. In the US, as many as 66% of working-age cancer survivors report at least one type of financial hardship.

Among older adults, most of these diagnosed with cancer present with one or more co-morbid health conditions. As the proportion of survivors who are older increases, rates of cancer-related morbidity can be expected to rise as well. To reduce the human cost of cancer, finding ways to screen those at risk for and mitigating adverse effects of treatment will be increasingly important, as well tailored follow-up care.

National guidelines for coordinated survivorship care are in place in some high-income countries, such as Australia, Canada, and the UK. In the US, guidelines are not always consistent. Survivorship care guidelines are less common in low- and middle-income countries. Developing and delivering care that addresses the long-term and late occurring effects of cancer and its treatment represent key challenges of survivorship worldwide.

**Figure 1**

Prevalence (%) of poor health-related quality of life among cancer survivors and adults without cancer, US, 2010

<table>
<thead>
<tr>
<th>Adults without cancer</th>
<th>Cancer survivors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor physical health</td>
<td>25</td>
</tr>
<tr>
<td>Poor mental health</td>
<td>15</td>
</tr>
<tr>
<td>Poor physical and mental health</td>
<td>10</td>
</tr>
</tbody>
</table>

Compared with those who have not had cancer, cancer survivors are more likely to experience poor physical and/or mental health.

**Figure 2**

Proportion (%) of poor health-related quality of life among cancer survivors and adults without cancer, US, 2010

**Cancer survivors face late and lasting medical, emotional, and social challenges resulting in 7.8 million years lived with disability globally in 2017.**

**Figure 3**

Estimated number of cancer survivors diagnosed within the past five years per 100,000 population, both sexes, 2018

<table>
<thead>
<tr>
<th>Race/region</th>
<th>2018 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>255 – 330</td>
</tr>
<tr>
<td>Black</td>
<td>448 – 502</td>
</tr>
<tr>
<td>Asian</td>
<td>98.3 – 1,011</td>
</tr>
<tr>
<td>2 or more</td>
<td>1,032 or more</td>
</tr>
</tbody>
</table>

**Figure 4**

Yrs lived with disability due to cancer, both sexes, all ages, 2017

<table>
<thead>
<tr>
<th>Race/region</th>
<th>2018 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>46,094 or fewer</td>
</tr>
<tr>
<td>Black</td>
<td>46,094 – 132,058</td>
</tr>
<tr>
<td>Asian</td>
<td>132,065 – 403,105</td>
</tr>
<tr>
<td>2 or more</td>
<td>483,708 – 989,521</td>
</tr>
<tr>
<td>986,322 or more</td>
<td>No data</td>
</tr>
</tbody>
</table>

Cancer survivors tend to be concentrated in higher-income countries where screening, diagnosis, and effective treatment are more accessible.
Over the next half century, an estimated 44 million cervical cancer cases will occur if current trends continue worldwide.

Effective delivery of combined high coverage screening and vaccination could avert over 13 million cervical cancer cases by 2069, and eventually lead to cervical cancer being eliminated as a major public health problem.
Evidence-based, resource-appropriate interventions for cancer prevention and control exist across the cancer continuum in each country, from prevention of risk factors to early detection, treatment, survivorship, and end-of-life care. FIGURE 26.1 Tobacco use, the cause of the largest number of preventable cancers worldwide, can be substantially reduced through raising excise tax on tobacco products, smoke-free air laws, health warnings on tobacco packaging, and restrictions on promotion and advertising of tobacco products. FACTS (see eG, Tobacco-Control). unhealthy diet and physical inactivity can be reduced through increased public awareness about their health hazards and through public policies (e.g., excise tax on sweetened beverages) and structural and environmental interventions (e.g., pedestrian and bike lanes) (see 27, Health Protection). The hepatitis B virus (HBV) and human papillomavirus (HPV), infections that cause liver cancer (HBV) and cervical and other uterine and oropharyngeal cancers (HPV), can be prevented through vaccination (see 29, Vaccination). Indoor and outdoor air pollution can be reduced through use of clean stoves, cleaner fuels, and proper ventilation, and air quality guidelines and policies. Protection from harmful sun exposure could reduce the risk of skin cancer. Cancer-causing occupational exposures could be prevented through improved workplace safety. Addressing cancer risk factors can also have a shared impact on other non-communicable diseases.

Regular screening for cervical, colorectal, breast, and lung cancers allows detection of these diseases at an early stage, when treatments are more successful for survival and cure is high. FIGURE 26.2 Screening for colorectal and cervical cancers also prevents cancer by detecting precursor lesions for removal by surgery or other forms of treatment. A heightened awareness of warning signs for cancer of the oral cavity, skin, and some other cancers may also lead to detection of cancers at early stage (see 30, Early Detection). Effective treatment modes (surgery, radiation, chemotherapy, hormonal therapy, immunotherapy) have been developed for several cancers, including for cancers of the breast, colon and rectum, and tests and for many childhood cancers. FIGURE 26.3 (see 31, Management and Treatment). For certain cancers such as testis, treatment could lead to cure, even for advanced-stage disease. Awareness and availability of services to meet the needs of cancer survivors are increasing worldwide (FIGURE 26.4), and pain associated with cancer can be managed through administration of analgesic drugs (see 32, Pain-Control). Resource-appropriate application of known interventions in each country could prevent a substantial proportion of cancers. However, such broad interventions have not materialized in many parts of the world largely because of lack of political commitment.

FIGURE 26.4: Cumulative probability (%) of death from lung cancer by attained age and smoking status.

If 70% of all eligible girls were vaccinated, an estimated 178,000 cervical cancer deaths could be avoided annually worldwide.

The scale of the global cancer burden and its associated economic costs indicate that adoption of healthy behaviors to reduce the risk of cancer is critical. However, behavior change continues directed at individuals are not likely to be successful without addressing the many external factors that influence behavior. In addition to educating and building skills that encourage healthier behaviors, health promotion must also include efforts to address the environmental, economic, and social factors that influence an individual’s ability to engage in these behaviors. For instance, the availability of sidewalks and biking infrastructure affects the degree of physical activity on a community, and the availability of affordable fresh fruits and vegetables affects healthy eating habits. This is especially important in the context of health equity, as vulnerable populations are most affected by environments that are not conducive to healthy behaviors.

A comprehensive policy framework to create environments that support following cancer prevention recommendations includes actions at the environmental, system, and individual levels. While that framework was developed to address diet, physical activity, breastfeeding, and alcohol consumption (all factors associated with cancer risk and/or body weight), the broad policy levers are applicable to other health behaviors, such as tobacco use and vaccination. Examples of initiatives include taxation, information and community mobilization, and counseling in healthcare.

The WCRF/AICR has introduced a new policy framework to address diet, physical activity, breastfeeding, and alcohol consumption. FIGURE 27.2

HEALTH PROMOTION
A Population and Systems Approach

Health promotion must address the environmental, economic, and social factors that influence health behaviors.

The city of Philadelphia implemented a 6% decline in purchases of sugar-sweetened beverages and a 4% increase on sugar-sweetened beverages (US $0.015 per ounce) on January 1, 2014. Two months after the tax went into effect, Philadelphians were 58 – 40 percent less likely to drink sugary sodas and 60 percent less likely to drink sugary drinks with <5g/100ml; and no tax for drinks with 5–8g/100ml; a moderate tax for drinks with 8g of sugar per 100ml; and a high tax for drinks with >8g of sugar per 100ml. The Healthy Caribbean Coalition’s “I Need a Healthy Diet” campaign educates citizens about the harmful effects of poor diet and lack of physical activity and asks them to call on their governments to enact policies and legislation that effectively combat childhood overweight and obesity.

A Green Prescription (GRx) is the written advice a health-care provider is eligible for ongoing support, delivered as monthly telephone calls, face to face meetings, in group support in a community setting. The patient’s progress is reported back to the referring health professional.

A retrospective study of individuals who had participated in the GRx program two to three years earlier found that those who had completed the program reported an additional 64 min of total physical activity per week and were less likely to be sedentary and more likely to meet the current physical activity guidelines of at least 150 min of physical activity per week.

In the Netherlands, substantial investments have been made in cycling-promoting infrastructure and policies, resulting in 27% of trips being made by bicycle. This physical activity is estimated to save 6,500 deaths annually and contribute an additional half-year in life expectancy of Dutch people.

A handful of communities worldwide, including Mexico, the United Kingdom, and various cities in the US, have begun implementing excise taxes on sugar-sweetened beverages and evaluating the impact on consumption and/or product formulation. A 2017 modeling study examining the potential impact of product reformulation estimated, with reduced sugar content by 15–30%, the number of adults and children with diabetes would fall by 144,000, and there would be 19,000 fewer cases of diabetes per year in the UK.
Tobacco use is the largest preventable cancer risk factor. While global cigarette consumption and overall prevalence have been declining recently, success has been uneven. In countries with vigorous tobacco control policies, tobacco use has typically declined more.

VACCINES

Highly effective and safe vaccines are available to prevent HBV and HPV infections and associated cancers.

An estimated 257 million people are living with hepatitis B virus (HBV) infection globally. HBV is responsible for nearly 900,000 deaths annually, including more than 300,000 deaths from hepatocellular carcinoma (HCC). HCC results from chronic HBV infection, and the risk of chronic infection is greatest if transmission occurs during birth or early childhood. The vaccines for HBV infection are highly effective and safe, and target HBV types e and a (which cause over 70% of all cervical cancers) and most other cancers that are caused by HBV. The nonavalent vaccine targets HBV types e and a as well as five additional cancer-causing HBV types; these seven types cause over 90% of cervical cancers. In most countries, the target group for HPV vaccination is young adolescent girls; some countries also recommend vaccination for boys.

Several vaccines have been available since 1982 as a three-dose or a two-dose series, are highly effective and safe, and target HPV types 16 and 18 (which cause over 70% of all cervical cancers) and most other cancers that are caused by HBV. The nonavalent vaccine targets HBV types e and a as well as five additional cancer-causing HBV types; these seven types cause over 90% of cervical cancers. In most countries, the target group for HPV vaccination is young adolescent girls; some countries also recommend vaccination for boys.

The first countries to introduce HPV vaccine were high-income countries, due to the cost of vaccines. Middle- and low-income countries started to introduce vaccines three to six years later. Many countries have achieved high coverage of childhood hepatitis B vaccine since its introduction in 1982. Although the HPV vaccine has been introduced into some lower-HDI countries, most with the highest burden of cervical cancer have not yet included the HPV vaccine in their national programs.

The first countries to introduce HPV vaccine were high-income countries, due to the cost of vaccines. Middle- and low-income countries started to introduce vaccines three to six years later. Many countries have achieved high coverage of childhood hepatitis B vaccine since its introduction in 1982. Although the HPV vaccine has been introduced into some lower-HDI countries, most with the highest burden of cervical cancer have not yet included the HPV vaccine in their national programs.

HPV is responsible for nearly all cervical cancers and a substantial proportion of other anogenital and oropharyngeal cancers.

Through a scale-up of HPV vaccination and screening, millions of cervical cancer cases could be avoided in the coming decades, particularly in lower-HDI countries.

Following infant hepatitis B vaccinations in 1984, primary liver cancer among children decreased by up to 75% in Taiwan, China.
Early detection allows more effective treatment when the cancer is at an earlier, much more curable stage.

Detection of some cancers at an early stage combined with prompt treatment permits less aggressive treatment, leading to a better quality of life of the patient, and is associated with significantly reduced mortality. There are two distinct approaches to early detection—screening and early diagnosis.

Screening involves systematic examination of an apparently healthy and asymptomatic population at risk with a test to detect the disease at an early stage. However, implementation is quite complex and resource-intensive. Screening may be population-based (inviting the entire target population at the appropriate intervals) or opportunistic (at the initiation of the patient or upon invitation at an unrelated clinical encounter). To date, screening of the general population is recommended only for cervical, colorectal, and female breast cancer, depending on resources of the country. FIGURE 30.1

Recommended activities for early detection of selected cancers

| Year of diagnosis | Program* | Earliest possible stage, usually through patient awareness of the early symptoms of common cancers, and training of healthcare workers to recognize and appropriately refer patients with probable early cancer symptoms. FIGURE 30.1 Early diagnosis is detection of a cancer at the earliest possible stage, usually through patient awareness of the early symptoms of common cancers, and training of healthcare workers to recognize and appropriately refer patients with probable early cancer symptoms. FIGURE 30.1

Cervical cancer incidence rates decreased by 50% or more in many high-income countries following the introduction of screening with the Pap test in the 1960s.

Detected in countries where mammography screening is not feasible have resulted in more breast cancers being diagnosed at an early stage. Prevention of death is often more effective if the cancer is at an early stage. However, implementation is quite complex and resource-intensive. Screening may be population-based (inviting the entire target population at the appropriate intervals) or opportunistic (at the initiation of the patient or upon invitation at an unrelated clinical encounter). To date, screening of the general population is recommended only for cervical, colorectal, and female breast cancer, depending on resources of the country. FIGURE 30.1

Cervical cancer screening in the EU, 2016

Breast cancer screening in the European Union (EU), 2016

Colorectal cancer screening in the EU, 2016

DNA testing offers many advantages for countries with limited healthcare infrastructure. More lower-resource countries are adopting this method of cervical cancer screening.

A majority of EU Member States have implemented population-based breast cancer screening programs. National population-based colorectal cancer screening is not yet widespread in Europe.

Programs to raise awareness of breast cancer and promote clinical breast examination in countries where mammography screening is not feasible have resulted in more breast cancers being diagnosed at an early stage.
Existing cost-effective interventions such as surgery, radiotherapy, and access to essential oncologic drugs can greatly improve cancer survival worldwide.

Cancer management starts with obtaining a valid diagnosis. However, lack of diagnostic imaging and pathologists are major barriers to receipt of high-quality oncologic care in many parts of the world.

Surgery is needed for 80% of early-stage cancer patients, and as a palliative measure for a substantial proportion of late-stage cancer patients. However, surgery is only delivered to one in four eligible patients globally due to infrastructure and workforce limitations, as well as lack of affordability, particularly in LMICs. Furthermore, although specialized surgery performed by an oncologic surgeon is crucial to patient outcomes, due to shortages of these specialists, cancer patients in LMICs usually receive surgery from a general surgeon. As a key contributor to improving the survival of cancer patients, the inequities in LMICs must be tackled.

Radiotherapy is indicated for about 60% of cancer patients. Radiotherapy coverage is less than 50% in many LMICs, including many due to cancer care and control. Radiotherapy services vary in access and are typically underutilized in low-resource settings. For example, within 5 years after a diagnosis of cervical cancer, radiotherapy prevents recurrence in 1 in 3 patients and death in 1 in 5 patients. Coverage for radiotherapy, as well as radiation machines, is zero in one-third in Africa, about two-thirds in Asia Pacific, and around 50% in Europe and Latin America WebFig 31.2. In Ethiopia, for example, a population of nearly 100 million is served by a single radiotherapy center. Newly implementing radiotherapy (mostly in Africa) and scaling up coverage (on South East Asia) will require financial and human resources as well as continuous technical support.

Radiotherapy has changed over time, from administration of chemotherapy to all patients to personalized approaches considering receptor status, RNA expression, underlying DNA mutations, tumor environment and immunologic responses. Meanwhile, the cost of cancer drugs continues to rise, with over US$100,000 per treatment in many high-income countries. Still there are many low-cost and effective cancer drugs for broad and equitable application in LMICs, which are on the WHO essential drug list.

Radiotherapy can prevent one out of five deaths among cervical cancer patients. Certain cancer therapeutics have greatly improved cancer outcomes. For example, tamoxifen endocrine therapy for hormone receptor-positive breast cancer patients substantially reduces local recurrence and disease-specific mortality.

31. TAKING ACTION

MANAGEMENT AND TREATMENT

A substantial proportion of countries do not include major cancer therapies on their national essential medicines list. Radiotherapy for advanced cancers is a key contributor in improving cancer survival, worldwide. It provides a periodic review of the most

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Percent of 135 Countries</th>
</tr>
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<tbody>
<tr>
<td>Methotrexate</td>
<td>95%</td>
</tr>
<tr>
<td>Cyclophosphamide</td>
<td>89%</td>
</tr>
<tr>
<td>Tamoxifen</td>
<td>83%</td>
</tr>
<tr>
<td>Vincristine</td>
<td>82%</td>
</tr>
<tr>
<td>Daunorubicin</td>
<td>81%</td>
</tr>
<tr>
<td>Anadrol</td>
<td>79%</td>
</tr>
<tr>
<td>Chlorambucil</td>
<td>72%</td>
</tr>
<tr>
<td>Mitomycin</td>
<td>70%</td>
</tr>
<tr>
<td>Procarbazine</td>
<td>68%</td>
</tr>
<tr>
<td>Methotamine</td>
<td>64%</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>64%</td>
</tr>
<tr>
<td>Chlorambucil</td>
<td>64%</td>
</tr>
<tr>
<td>Cisplatin</td>
<td>64%</td>
</tr>
</tbody>
</table>

**Figure 31.5** Cancer therapy included on the World Health Organization essential medicines list, and the proportion of countries that include the medication on their national essential medicines list. Used for the following cancers:

- Breast, bladder, leukemia, sarcoma, melanoma.
- Breast.
- Lymphoma, acute leukemia, sarcoma.
- Lymphoma, acute leukemia, melanoma.
- Breast, gastrointestinal.
- Breast, lymphoma, sarcoma, bladder.
- Lymphoma, acute leukemia, sarcoma.
- Lymphoma, acute leukemia, melanoma.
- Breast, lymphoma, leukemia.
- Breast, leukemia.
- Breast, colon.
- Breast, leukemia.
- Breast, colon.
- Breast, leukemia.

**Figure 31.6** Figure 1: Acute lymphocytic leukemia. Acute leukemia: Chronic lymphocytic leukemia. Lymphoma, acute leukemia, sarcoma.

**Figure 31.7** The chance for a cure, the chance to live, should no longer remain an accident of geography. Radiotherapy.

**Figure 31.8** Some countries have no radiotherapy machines, making basic life-saving treatment for many cancer patients a prohibitively costly endeavor.

**Figure 31.9** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.10** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.11** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.12** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.13** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.14** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.15** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.16** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.17** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.18** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.19** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.20** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.21** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.22** Chart showing the number of radiotherapy machines per 100,000 cancer patients.

**Figure 31.23** Chart showing the number of radiotherapy machines per 100,000 cancer patients.
Millions of cancer patients, almost entirely in low- and middle-income countries, lack access to essential pain medicines.

The greatest numbers of untreated deaths in pain are in East Asia and the Pacific, South Asia, and sub-Saharan Africa.

Essential medicine lists of the World Health Organization and many countries include opioid analogues, such as morphine. The moderate or severe pain experienced by approximately 80% of people with advanced cancer cannot be relieved without them.

But access to opioid analogues is limited in low- and middle-income countries, where 80% of the world’s population consumes 42% of the medicinal opioids. FIGURE 32.1 Legal and regulatory restrictions, cultural misperceptions about pain, inadequate training of healthcare providers, poorly functioning markets, weak health systems, and concern about addiction and non-medical use all contribute to limited access, even though morphine, the most effective treatment for severe pain, is safe, effective, inexpensive, and easy to use.

Meanwhile, some high-income countries are dealing with a very different challenge related to pain relief, as rates of addiction continue to rise due to harmful and non-medical use of opioids.

Worldwide, the number of cancer patients in need of pain relief is projected to increase 48% from 2012 to 2035, but this increase is likely to be considerably higher in the regions with more rapidly increasing cancer rates and with the lowest access to pain relief, including South-Eastern Asia (projected 54% increase in cancer cases) and Africa (74% increase), where consumption of pain relief is insufficient to cover less than 12% of deaths in pain.

FIGURE 32.2 A balanced approach to access to opioids with sufficient measures to prevent harmful and non-medical use has been achieved by many Western European countries and in some low- and middle-income countries.

86% of untreated deaths in pain are in middle-income countries.

Three quarters of untreated deaths in pain occur in just ten countries.

Almost all untreated deaths in pain due to cancer and HIV are in low- and middle-income countries.

FIGURE 32.3 Unmet needs in cancer care and pain in patients undergoing treatment, resulted in a tripling of the use of essential pain medications and a 25% decrease in average pain scores in the oncology unit after being implemented at Kenyatta National Hospital in Nairobi, Kenya.

ACCESS CREATES PROGRESS

The Pain-Free Hospital Initiative, a one-year hospital-based health worker training initiative designed to improve the quality of pain assessment and treatment, resulted in a tripling of the use of essential pain medications and a 25% decrease in average pain scores in the oncology unit after being implemented at Kenyatta National Hospital in Nairobi, Kenya.

FIGURE 32.4 More than 99% of patients with advanced cancer in United States hospices mentioned opioid analgesics, such as morphine. The moderate or severe cancer pain suffered by over 80% of cancer patients in terminal phase.

—World Health Organization
In the early 1960s, there were only 31 high quality population-based cancer registries in 28 countries. This number has increased to 343 registries in 68 countries in 2008–2012, providing essential data for health planning and prioritization.

![Cancer Surveillance Map](http://ci5.iarc.fr)

**CANCER INCIDENCE IN FIVE CONTINENTS**

Population-based cancer registries are the backbone of national cancer control programs. Over time, quality cancer data drives change in health services that ultimately improve patient outcomes.

— Dr. Tamayo Miranda, Chief, PanAmerican Cancer Registry Section, National Cancer Center, Japan; President International Association of Cancer Registries

Reliable cancer data are essential for planning and monitoring the effectiveness of cancer control programs, for examining cancer care delivery patterns, and other types of research. Population-based cancer registries (PBCRs) fulfill this requirement by systematically collecting cancer incidence data for defined populations. This includes information on patient and tumor characteristics at diagnosis, as well as additional information including receipt of treatment and vital status where resources permit.

Cancer registries are primarily used to describe the scale and profile of the cancer burden and changes in cancer patterns across time and geographic areas. A PBCR may cover an entire country, but most cover smaller regions within a country, particularly in large or resource-constrained countries. Registry quality varies widely by geographic region.

Although there are significant disparities in the stature, population coverage, and quality of cancer registries worldwide, the number of high-quality cancer registries is increasing.

**MAP 33.2**

Quality of mortality registration worldwide, 2007–2016

**ACCESS GREAT PROGRESS**

The Global Initiative for Cancer Registry Development (GICR) is the first strategy to support cancer surveillance worldwide. Together with its partners, the GICR aims to provide measurable improvements in the quality, availability, and use of cancer registry data.

**MAP 33.1**

Availability of population-based cancer registry data, 2015

**TAKING ACTION**

Reliable cancer incidence and mortality data are essential to cancer control. To better equip countries, a global strategy is underway to strengthen capacity in cancer surveillance, prioritizing support in low- and middle-income countries.

**FIGURE 33.1**

Coverage (%) of high-quality population-based cancer registries per world region, as published in Cancer Incidence in Five Continents

**FIGURE 33.2**

While population coverage of high-quality cancer registries has increased in North America, Oceania, and Europe, it remains low in South America, Asia, and Africa.

**FACTS & FIGURES**

- In 1966 that establishes standards and provides opportunities for cancer registry professionals to meet, exchange information, and receive training.

Cancer mortality data, predominantly collected through vital registration systems, are also important for planning and monitoring cancer control programs as well as for research. As with cancer registry data, the availability and quality of death certificate information varies widely, with many low- and middle-income countries having either poor quality data or a complete absence of vital registration.

In many countries, mortality data compliments the cancer registry database as a means to estimate a patient’s status (alive or dead) to estimate cancer survival. Survival studies remain sparse in many transitioning countries, in part due to the absence of or low quality of national mortality information systems. Cancer survival is nevertheless a key indicator of the effectiveness of cancer services in a country or region, and a positive measure of progress that can reflect the prospects of clinical care.
Each country and locality needs cancer research tailored to local disease burdens and knowledge gaps to improve population health.

For national or regional cancer control programs, research is an essential component of planning, implementation, and monitoring the program’s effectiveness. In addition, research improves patient outcomes and creates national wealth through innovation. However, bibliometrics reveal a large disparity in research activities across countries. FIGURE 34.3, The United States and a few wealthy European countries account for the majority of publications. Barriers to development of strong, sustainable cancer research output in low-income countries include lack of funds, competing disease priorities, weak infrastructure, and work load and protected time to do research. For example, expenditure on science and technology research represents less than 1% of gross domestic product in many low-income countries, compared to over a 5% in several high-income countries. FIGURE 34.4. However, there is renewed commitment from private and public institutions in high-income countries to help build sustainable research capacity in low-income countries through north-south partnerships. In addition to regional variation in publication output, there is a mismatch between cancer research output/funding and societal cancer burden. Some common cancer sites, such as pancreas and lung in the United States and Europe, are under-funded and under-studied compared to less common cancers. FIGURE 34.4 Further, in many countries the bulk of research funding is allotted to basic science, with very little to cancer prevention and control research. Increased cancer research tailored to local disease burdens and knowledge gaps is needed for continuous improvement of population health in each country and locality. In low- and middle-income countries, research should focus on identifying local, common risk factors (for example, local alcoholic brews), evaluating preventive interventions, and conducting implementations and operational research. Research in high-income countries should also focus on implementation research as well as biomedical markers and precision medicine.

**FIGURE 34.3**
Cancer publications (2002–2013) compared with gross domestic product (GDP) for 31 European countries

**FIGURE 34.4**
Research priorities by cancer site in number of publications, proportion of US National Cancer Institute (NCI) funding* (2012), and disability-adjusted life years (DALYs, 2011)

*Total NCI budget in 2012 is $5.07 billion

**FIGURE 34.5**
A greater percentage of GDP is spent on research in higher-HDI countries.

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**Africa accounts for less than 1% of worldwide research publications, but nearly 15% of the world’s population.**

**FIGURE 34.6**
Cancer publications increase with a country’s gross domestic product.

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Between 2010 and 2017, cancer publication output in China more than tripled.
Cancer results in economic burden for patients, healthcare systems, and countries due to healthcare spending, and productivity losses from morbidity and premature mortality. Economic analyses can inform resource allocation decisions and investments in cancer control programs, including prevention, early detection, treatment, survivorship, and end-of-life care.

The global economic burden of cancer is unknown, although data are available in some countries. In the US in 2017, estimated cancer healthcare spending was US$365 billion, productivity loss from morbidity, US$95 billion, and premature mortality, US$190 billion. The economic burden of cancer in the US is approximately 8% of gross domestic product (GDP). In the European Union, healthcare spending was €141.8 billion, 1.07% of GDP.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Costs of Cancer in Billions of Euros</th>
<th>Productivity Losses due to Premature Death from Cancer in Billions of Euros</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>€39.5B</td>
<td>€3.6B</td>
</tr>
<tr>
<td>Germany</td>
<td>€6.9B</td>
<td>€0.1B</td>
</tr>
<tr>
<td>Spain</td>
<td>€10.8B</td>
<td>€0.1B</td>
</tr>
<tr>
<td>Italy</td>
<td>€18.6B</td>
<td>€0.1B</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>€16.2B</td>
<td>€0.1B</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>€7.1B</td>
<td>€0.1B</td>
</tr>
</tbody>
</table>

The cost of cancer varies widely in European Union countries, reflecting differences in population size, age distribution, healthcare delivery systems, employment patterns and wages, and cancer incidence and mortality rates.

Productivity losses due to premature deaths vary in transitioning countries. Cancer treatment costs are increasing worldwide, making prevention and screening efforts more cost-effective and sometimes cost-saving. For example, when more expensive chemotherapies were considered in comparisons of colorectal cancer screening to no screening, treatment savings from preventing advanced cancer and death more than doubled in the US. Vaccination against human papillomavirus infection, which is responsible for most cervical cancers, in 73 countries supported by Gavi, the Vaccine Alliance, could avert nearly US$5.6 billion in treatment costs and productivity losses between 2011–2020. Smoking is a strong risk factor for lung and other cancers. The cost of smoking globally is nearly US$2.05 trillion annually, almost 2% of the world’s economic output. Most of this cost is productivity losses from premature death.

Productivity losses due to cancer represent a large economic burden in transitioning economies. Variation reflects population size, employment patterns, wages, and cancer mortality rates.

The economic burden of cancer is substantial in all countries and reflects health care spending as well as lost productivity due to morbidity and premature death from cancer. As cancer treatment costs increase, prevention and early detection efforts become more cost-effective, and potentially cost-saving.

The economic burden of lost productivity due to morbidity and premature death from cancer is nearly 60% of the total economic burden associated with cancer in European Union countries.
In Rwanda, cervical cancer burden in low- and middle-income countries necessitates building on existing infrastructure. In Rwanda, cervical cancer control has been successfully integrated into women’s health services. In Kenya, leaders built on the existing HIV-treatment infrastructure to screen and treat women for cervical cancer. The American Society for Clinical Oncology’s cooperative care physicians in countries with limited oncology infrastructure to recognize the signs and symptoms of cancer, and to better integrate cancer services into existing resources. Partners who can help country planners see the whole health landscape, integrating cancer, are critical in supporting this integration at the country level. For example, the International Cancer Control Partnership was formed by the US National Cancer Institute and the Union for International Cancer Control to support country development of national cancer plans or to encourage countries to include cancer control activities within their NCD plan. The International Cancer Control Partnership portal (https://www.iccp-portal.org) contains resources for plan development, including examples of plans that integrate across the health system. Essentially, cancer cannot be addressed alone. It shares many common risk factors with other NCDs, and the health systems that work to prevent and treat NCDs as well as infectious diseases can be leveraged to effectively incorporate cancer control.

In 2011, the global community adopted the Global Action Plan (GAP) for the prevention and Control of Non-communicable Diseases (NCDs). The GAP urged countries to set national targets to address premature death from four major NCDs (cancer, cardiovascular disease, diabetes, and respiratory disease). Built into the GAP is the opportunity to address various risk factors across NCDs that contribute to premature mortality, known as “best buys.” In addition to focusing on these proven approaches, countries can turn to successful programs in maternal and child health and HIV prevention and control, among others, to reach the target population to promote cancer prevention.

A growing number of countries have national cancer control plans, noncommunicable disease plans, or both.

Addressing multiple risk factors can reduce the overall noncommunicable disease burden and premature mortality. “Best buys” are a set of affordable, feasible and cost-effective intervention strategies to achieve these goals.
Now is the time to drive national action to reduce cancer deaths. Governments are following up on major global commitments including the Sustainable Development Goals (SDGs), the United Nations (UN) Political Declaration on the Prevention and Control of non-communicable diseases (NCDCs), and the 2025 World Health Assembly cancer resolution, which outlines a clear roadmap to scale up action on cancer control irrespective of income level. Because cancer knows no borders, cooperation is necessary to reduce the burden of cancer nationally and internationally.

FIGURE 3.2 Working in partnership has benefits such as amplifying cancer control initiatives and bringing them to the attention of key decision-makers, expanding the reach and scale-up of interventions, stimulating new ideas and generating peer-to-peer support, and shaping cancer policies that can leave a long-lasting footprint around the world. The global cancer community— including the UN, WHO, Ministries of Health, national cancer institutes, cancer societies, research and treatment centers, academia, patient support groups, appropriate private sector, and survivors at the local, national and global levels— is collaborating on a broad spectrum of activities that support cancer surveillance, early detection, treatment and care, and the delivery of palliative care.

FIGURE 3.1 One of the key lessons from the recent World Cancer Leaders’ Summit was the importance of bringing together key stakeholders in cancer control, and identifying new and innovative solutions with thought leaders in the cancer field.

A cancer community united behind implementation of the commitments from the World Health Assembly 2017 cancer resolution will harness the political drive for real national impact.

SUMMARY OF ATTAINABLE GOALS Aiding the global cancer community— including the UN, WHO, Ministries of Health, national cancer institutes, cancer societies, research and treatment centers, academia, patient support groups, appropriate private sector, and survivors at the local, national and global levels— is collaborating on a broad spectrum of activities that support cancer surveillance, early detection, treatment and care, and the delivery of palliative care.

FIGURE 3.2 Working in partnership has benefits such as amplifying cancer control initiatives and bringing them to the attention of key decision-makers, expanding the reach and scale-up of interventions, stimulating new ideas and generating peer-to-peer support, and shaping cancer policies that can leave a long-lasting footprint around the world. The global cancer community— including the UN, WHO, Ministries of Health, national cancer institutes, cancer societies, research and treatment centers, academia, patient support groups, appropriate private sector, and survivors at the local, national and global levels— is collaborating on a broad spectrum of activities that support cancer surveillance, early detection, treatment and care, and the delivery of palliative care.

FIGURE 3.1 One of the key lessons from the recent World Cancer Leaders’ Summit was the importance of bringing together key stakeholders in cancer control, and identifying new and innovative solutions with thought leaders in the cancer field.

A cancer community united behind implementation of the commitments from the World Health Assembly 2017 cancer resolution will harness the political drive for real national impact.
GLOBAL RELAY FOR LIFE

Global Relay For Life celebrates survivors, remembers loved ones lost and mobilizes communities to take a stand against cancer.

When the Cancer Association of South Africa was given the “gift” of Relay For Life 13 years ago, the opportunity for our cancer organization to stand against a disease that is affecting more than 30 years ago to raise money and awareness has become a true global movement against cancer, uniting people in 29 countries to do what no one country or organization can do alone: build a world free from cancer. Across the globe, Relay For Life fosters hope, healing and inspiration in more than 5,000 communities.

The Cancer Association of South Africa (CANSA) and the American Cancer Society (ACS) launched the first Global Relay For Life program in 2005 as a platform to deliver on their mission. With the Danish Cancer Society, Relay extends their advocacy initiatives, engaging participants, survivors and volunteers in anti-tobacco and caregiver advocacy events. The Japan Cancer Society found Relay For Life has attracted more students to volunteer work and “their interests tend to shift to learning the value of life and having compassion for others and self.” The Cancer Society of New Zealand utilizes funds from the Relay For Life event to promote, deliver and facilitate more than 12,269 rides to treatment and nearly 62,000 nights of accommodation for patients.

This network of Relay For Life participants is bringing hope and help to millions across the globe. To learn more about the Relay For Life movement, please visit relayforlife.org/global or contact globalrelayforlife@cancer.org.

### MAP A FIGURE 38.1
Global Relay For Life sources and numbers within continents, 2017

#### REGION EUROPE

<table>
<thead>
<tr>
<th>Region</th>
<th>Participants</th>
<th>Survivors</th>
<th>Luminaria</th>
</tr>
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<tbody>
<tr>
<td>Europe</td>
<td>1,248</td>
<td>5,029</td>
<td>197,189</td>
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#### REGION THE AMERICAS

<table>
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<tr>
<th>Region</th>
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<th>Luminaria</th>
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<tr>
<td>Americas</td>
<td>272,893</td>
<td>3,093</td>
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<td>South America</td>
<td>5,446</td>
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#### REGION ASIA

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<th>Luminaria</th>
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<tbody>
<tr>
<td>Asia</td>
<td>203,029</td>
<td>12,289</td>
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#### REGION OCEANIA

<table>
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<tr>
<th>Region</th>
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<th>Luminaria</th>
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<tr>
<td>Australia</td>
<td>201,288</td>
<td>1,028,484</td>
<td>27,289</td>
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</table>

#### REGION AUSTRALASIA

<table>
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<tr>
<th>Region</th>
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<tbody>
<tr>
<td>Oceania</td>
<td>92,658</td>
<td>39,451</td>
<td>3,933</td>
</tr>
</tbody>
</table>

#### REGION SOUTH AFRICA

In 2005 I founded my team, the “Ridgley Rascals” from my small community of Ridgley, Tasmania. In 2013 I was diagnosed with breast cancer, which gave me a whole different role for the Relay. This compassion, friendship, support and love I received from so many people at the Relay brought me to tears many times. I was experiencing the Relay through different eyes. I finally truly understood what it was all about, with all those survivors and their families felt about the Relay. I love it with a passion.

#### REGION AFRICA

In 2012 I was diagnosed with breast cancer, which gave me a whole different role for the Relay. This compassion, friendship, support and love I received from so many people at the Relay brought me to tears many times. I was experiencing the Relay through different eyes. I finally truly understood what it was all about, with all those survivors and their families felt about the Relay. I love it with a passion.

### MAJOR FACTS

- More than 1.2 million people from 50 countries have been touched by Relay For Life activities.
- Relay For Life has raised more than $8 billion since 1992.
- Relay For Life is bringing hope and help to millions across the globe.

### TOGETHER WE CAN!

Maria Scholtz, Head Sustainability, Cancer Association of South Africa

“...a true global movement against cancer...”

#### MALAYSIA

<table>
<thead>
<tr>
<th>Region</th>
<th>Participants</th>
<th>Survivors</th>
<th>Luminaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>3,033</td>
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<td>27,289</td>
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</table>

#### UNITED STATES OF AMERICA

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<tr>
<th>Region</th>
<th>Participants</th>
<th>Survivors</th>
<th>Luminaria</th>
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<tr>
<td>United States of America</td>
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<td>3,933</td>
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</table>

#### CANADA

<table>
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<th>Region</th>
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<th>Luminaria</th>
</tr>
</thead>
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<tr>
<td>Canada</td>
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</table>

#### HONDURAS

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<tr>
<td>Honduras</td>
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<td>3,933</td>
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</table>

#### ZAMBIA

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<th>Survivors</th>
<th>Luminaria</th>
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<tbody>
<tr>
<td>Zambia</td>
<td>203,029</td>
<td>12,289</td>
<td>1,248</td>
</tr>
</tbody>
</table>

#### PRINCIPAL SOURCES

- Relay for Life 2017 Global Report
- Relay for Life Report 2016
- Relay for Life Report 2015

### ACCESS CREATES PROGRESS

The world’s largest fundraiser, Relay For Life attracted nearly 1.3 million participants in 2017.
Policy and legislation are essential to address the burden of cancer globally and locally. The effective use of law to achieve population health goals requires collaboration across sectors.

In 2011, a landmark high-level meeting of the United Nations General Assembly resulted in a commitment to address non-communicable diseases (NCDs) as a major development challenge. In 2013, the World Health Assembly adopted the World Health Organization Global Action Plan on NCDs, emphasizing whole-of-society approaches to reduce the major drivers of preventable NCDs. The plan also endorsed a global monitoring framework including nine voluntary global targets. FIGURE 39.2. In 2014, 34% of NCDs by one child was included in the United Nations Sustainable Development Goals. FIGURE 39.3.

The effective use of law requires collaboration across sectors, governments, civil society, academia, health professionals, communities, people affected by cancer or NCDs, their families and caregivers, and, as appropriate, the private sector. Collaboration across different parts of government is also needed, as few problems can be addressed by health ministers acting alone. Addressing cancer and NCDs through law involves engaging with domestic, regional and international legal and governance frameworks, including those dealing with health, human rights, international trade, intellectual property and investment law, environment, and occupational health and safety. It also requires being able to defend against litigation, or threats of litigation, by corporate interests—such as the tobacco, alcohol and fast food industries—which is becoming increasingly common. FIGURE 39.1 Legal capacity in an essential component of the cancer/NCD workforce.

The Australian Government has successfully defended against three sets of legal challenges to its tobacco plain packaging laws: a constitutional challenge in its highest domestic court, an investment treaty claim, and a dispute in the World Trade Organization. These victories demonstrate the power governments have to legislate for public health.

In Australia, the Tobacco Plain Packaging Act 2012 imposed plain/standardized tobacco packaging and required tobacco companies to print a uniform look on all packs to make it more difficult for consumers to select specific brands. The plain packaging regulations were enforced in March 2012.

The government of Uruguay challenged Australia’s plain packaging laws under a bilateral investment treaty (BIT) between the two countries. The BIT sets out the rights and obligations of states in relation to foreign investment. In the BIT case, the government of Uruguay argued that the plain packaging legislation was inconsistent with Australia’s obligations under the BIT, including provisions related to the protection of intellectual property.

The BIT case was heard by an international investment tribunal, which applied the principles of international law to determine whether the plain packaging laws impaired the rights of the tobacco companies to enforce their intellectual property rights. The tribunal found that the plain packaging laws were a legitimate measure to protect public health and did not violate the rights of the tobacco companies under the BIT.

The decision in the BIT case was significant because it demonstrated that governments have the authority to regulate the tobacco industry using laws that are designed to protect public health, even if such laws may have negative implications for corporate interests. The case also highlighted the role of international investment law in shaping the relationship between states and foreign investors, and the importance of balancing the rights of investors with the rights of states to regulate in the public interest.

The BIT case was a groundbreaking decision that set a precedent for subsequent cases related to tobacco control laws around the world. The decision has been upheld in subsequent cases, including a challenge by the government of the United States against Belgium’s plain packaging laws, which was heard by an international investment tribunal in 2017.

The success of the plain packaging laws in Australia and Uruguay highlights the potential of law to advance public health goals in the context of the global health crisis. However, the effectiveness of legal interventions depends on a range of factors, including the quality of the legal framework, the capacity of governments and the regulatory apparatus, and the political will to enforce the law. In many countries, the implementation of plain packaging laws faces significant challenges, including legal challenges from the tobacco industry, opposition from tobacco companies, and resistance from the tobacco lobby.
Universal health coverage improves cancer outcomes equitably and promotes financial protection as well. Universal health coverage (UHC) means that all people have access to the healthcare services they need, and that the services are of high quality without resulting in financial hardship for patients and their families. UHC has become an important policy goal in many countries, and plays a key role in the health-related United Nations Sustainable Development Goals.

Countries should progress towards UHC through a process of progressive realization by moving sequentially along 5 dimensions: (a) increase the proportion of the population covered; (b) increase the proportion of prepaid funds and reduce out-of-pocket payments; and (c) expand the number of services available to the population.

BY ONE REGION

FIGURE 40.2

CANCER CARE

APPROACH TO CANCER CARE

In many countries, a substantial proportion of cancer patients face financial catastrophe due to the costs of cancer treatment. In many countries, substantial proportion of cancer patients face financial catastrophe due to the costs of cancer treatment.

Making basic services and financial protection available to all results in major improvements in outcomes.

Cancer patients in lower-income countries are the least likely to have access to cancer care services in the public sector.

BY WORLD BANK INCOME GROUP

FIGURE 40.3

CANCER CARE

APPROACH TO CANCER CARE

In many countries, a substantial proportion of cancer patients face financial catastrophe due to the costs of cancer treatment.

Making basic services and financial protection available to all results in major improvements in outcomes.

Cancer patients in lower-income countries are the least likely to have access to cancer care services in the public sector.

BY WORLD BANK INCOME GROUP

FIGURE 40.4

CANCER CARE

APPROACH TO CANCER CARE

In many countries, a substantial proportion of cancer patients face financial catastrophe due to the costs of cancer treatment.
**HISTORY OF CANCER**

**BCE–18th Century**

**70–80 million years ago**
Evidence of cancer cells in dinosaur fossils, found in 2005.

**4.2–3.8 million years ago**
The oldest known human malignant tumor was found in Homo erectus or Australopithecus by Louis Leakey in 1952.

**3000 BCE**
Evidence of carcinomas in mummies.

**1900–1800 BCE**
Cancer found in mummies of Bronze Age human female skull.

**1750 BCE**

**1800 BCE**
The Egyptians blamed cancer on the gods. Ancient Egyptian scrolls describe eight cases of breast tumors treated by cautery/autopsy. Stomach cancer treated with boiled barley mixed with dates; cancer of the uterus by a concoction of fresh dates mixed with pig’s brain introduced into the vagina.

**1100–400 BCE**
Physicians specializing in treating swellings and ulcers were referred to in The Rites of the Zhou Dynasty.

**500 BCE**
**INDIA**
Indian epic tale, the Ramayana described lesions suggestive of malignant melanoma.

**400 BCE**
**GREECE**
Greek physician Hippocrates (460–370 BCE), the “Father of Medicine,” believed illness was caused by imbalance of four bodily humors: yellow bile, black bile, blood, and phlegm. He was the first to recognize differences between benign and malignant tumors.

**Circa 250 BCE**
**CHINA**
The first clinical picture of breast cancer, including progressive metastasis, death, and prognosis approximately ten years after diagnosis, was described in The Nei Ching, or The Yellow Emperor’s Classic of Internal Medicine. It gave the first description of tumors and five forms of therapy: spiritual, pharmacological, diet, acupuncture, and treatment of respiratory diseases.

**50 AD**
**ITALY**
The Romans found some tumors could be removed by surgery and cauterized, but thought medicine did not work. They noted some tumors grew again.

**100 AD**
**ITALY**
Greek doctor Claudius Galen (129–216 AD) removed some tumors surgically, but he generally believed that cancer was left untreated. Galen believed melanoma was the chief factor in causing breast cancer, and recommended special diets, exercise, and topical applications.

**500–1500**
**EUROPE**
Surgery and cautery were used on smaller tumors. Cauteristic practices, usually containing arsenic, were used on more extensive cancers, as well as phlebotomy (blood-letting), diet, herbal medicines, powder of uric, and symbolic charms.

**1400–1500s**
**ITALY**
Leonardo da Vinci (1452–1519) dissected carvers for artistic and scientific purposes, adding to the knowledge of the human body.

**1500**
**EUROPE**
Autopsies were conducted more often and understanding of internal cancers grew.

**1595**
**NETHERLANDS**
Zacharias Janssen invented the compound microscope.

**17th century**
**GERMANY**
Cancer surgery techniques improved, but lack of anesthesia and antiseptic conditions made surgery a risky choice. German surgeon Wilhelm Fabriacus Hildanus (1560–1634) removed enlarged lymph nodes in breast cancer operations, while Johann Scultetus (1599–1645) performed total mastectomies.

**18th century**
**FRANCE**
Physician Claude Germain (1663–1750) concluded that cancer at least locally as a hard, growing mass, unattractive and without drugs, and that it must be removed with all its “filaments.”

**17th–18th centuries**
**NETHERLANDS**
Anthony van Leeuwenhoek (1632–1723) refined the single lens microscope and was the first to see blood cells and bacteria, aiding the better understanding of cells, blood, and lymphatic system—major steps in improving the understanding of cancer.

**1775**
**UNITED KINGDOM**
Dr. Percival Pott of St. Bartholomew’s Hospital in London described cancer in chimney sweeps caused by soot collecting under the scrotum, the first indication that exposure to chemicals in the environment could cause cancer. This research led to many additional studies that identified other occupational carcinogens and to public health measures to reduce cancer risk.

**1779**
**FRANCE**
First cancer hospital founded in Reims. It was forced to move from the city because people believed cancer was contagious.

**18th century**
**UNITED KINGDOM**
Scottish surgeon John Hunter (1728–93) stated that tumors originated in the lymph system and then seeded around the body. He suggested that some cancers might be cured by surgery, especially those that had not invaded nearby tissue.
19TH CENTURY

1951–1971 UNITED KINGDOM
Decennial censuses linked cancer death to occupation and social class.

1980 UNITED KINGDOM
Earlier invention of general anesthesia (chloroform, ether, nitrous oxide) became more widespread, making cancer surgery more acceptable.

1898 UNITED KINGDOM
Earlier invention of general anesthesia (chloroform, ether, nitrous oxide) became more widespread, making cancer surgery more acceptable.

1890s UNITED KINGDOM
Radiotherapy—the use of radiation to kill cancer cells or stop them dividing—was developed as a treatment.

1895 UNITED KINGDOM
Physician Wilhelm Konrad Röntgen (1845–1928) discovered x-rays, used in the diagnosis of cancer. Within a few years, this led to the use of radiation for cancer treatment.

1897 GERMANY
Dr. Thomas Beatson discovered that the breasts of rabbits stopped producing milk after he removed the ovaries. This control of one organ over another led Beatson to test what would happen if the ovaries were removed in patients suffering from advanced breast cancer, and he found that oophorectomy (removal of the ovaries) had a significant effect on the disease.

1905 UNITED KINGDOM
Physicians at the Royal Ophthalmology Hospital in London reported the first case of "hereditary" retinal glioma, which presented in the offspring of a parent cured of the disease.

1905 AUSTRIA
Austrian Cancer Society founded.

1907 FRANCE
The first use of radiation to kill cancer cells or stop them dividing was developed as a treatment.

1910 USA
First national cancer society founded: Austrian Cancer Society.

1911 FRANCE
Marie Curie was awarded a second Nobel Prize, this time in chemistry, in recognition of her work in radioactivity.

1911 USA
First national cancer society founded: Austrian Cancer Society.

1911 USA
Payton Rous (1879–1970) proved that viruses caused cancer in chickens, for which he was eventually awarded the Nobel Prize in 1966.

20TH CENTURY

1900–1950 USA
By 1900 hundreds of materials, both man-made and natural, were recognized as causes of cancer (carcinogens).

1902 USA
X-ray exposure led to skin cancer on the hand of a lab technician. Within a decade, many more physicians and scientists, unaware of the dangers of radiation, developed a variety of cancers.

1995 FRANCE
Radiotherapy—the use of radiation to kill cancer cells or stop them dividing—was developed as a treatment.

1990s UNITED KINGDOM
Radiotherapy—the use of radiation to kill cancer cells or stop them dividing—was developed as a treatment.

1909 USA
First practical cigarette-making machine patented by James Bonsack. It could produce 120,000 cigarettes a day, each machine doing the work of 48 people. Production costs plummeted, and—with the invention of the safety match—a few decades later—cigarette smoking began its explosive growth.

1902 GERMANY
First practical cigarette-making machine patented by James Bonsack. It could produce 120,000 cigarettes a day, each machine doing the work of 48 people. Production costs plummeted, and—with the invention of the safety match—a few decades later—cigarette smoking began its explosive growth.

1842 ITALY
Domenico Antonio Righini-Stern undertook the first major statistical analysis of cancer incidence and mortality using 1760–1839 data from Verona. This showed that more women than men died from cancer, that chronic inflammation—the site of a wound that never heals—was the cause of cancer.

1886 BRAZIL
Hereditary basis for cancer first suggested after Professor Hilario de Gouvea of the Medical School in Rio de Janeiro reported a family with increased susceptibility to retinoblastoma.

1882 GERMANY
Rudolph Virchow (1821–1902), later proposed that “glioma of the retina,” which typically appeared within the eyes of newborns and young children and was usually lethal, might be cured via early removal of affected organs.

1881 UNITED STATES
Pathologist Johann Müller demonstrated that cancer is caused by cancer cells, not by other tumors. He found cancer death rates for both sexes were rising, and concluded that the increased incidence of cancer increases with age, that cancer mortality using 1760–1839 data from Verona. This showed that more women than men died from cancer, that chronic inflammation—the site of a wound that never heals—was the cause of cancer.

1845 UNITED KINGDOM
John Hughes Bennett, the Edinburgh physician, was the first to describe leukemia as an excessive proliferation of blood cells.

1879 FRANCE
Gynecologist Joseph Recanzer described the invasion of the bloodstream by cancer cells, coining the term metastasis, which came to mean the distant spread of cancer from its primary site to other places in the body.

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1829 UNITED KINGDOM
In the early 1800s, Scottish physician John Wilsdorp proposed that “glioma of the retina,” which typically appeared within the eyes of newborns and young children and was usually lethal, might be cured via early removal of affected organs.

1828 UNITED KINGDOM
Pathologist Johann Müller demonstrated that cancer is caused by cancer cells, not by other tumors. He found cancer death rates for both sexes were rising, and concluded that the increased incidence of cancer increases with age, that cancer mortality using 1760–1839 data from Verona. This showed that more women than men died from cancer, that chronic inflammation—the site of a wound that never heals—was the cause of cancer.

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1823 UNITED KINGDOM
Pathologist Johann Müller demonstrated that cancer is caused by cancer cells, not by other tumors. He found cancer death rates for both sexes were rising, and concluded that the increased incidence of cancer increases with age, that cancer mortality using 1760–1839 data from Verona. This showed that more women than men died from cancer, that chronic inflammation—the site of a wound that never heals—was the cause of cancer.
1913
USA
The American Cancer Society was founded as the American Society for the Control of Cancer (ASCC) by 15 physicians and business leaders in New York City. In 1945, the ASCC was renamed the American Cancer Society. It remains the world’s largest voluntary health organization.

1915
JAPAN
Cancer was induced in laboratory animals for the first time by a chemical, coal tar, applied to rabbits’ skin at Tokyo University. Soon many other substances were observed to be carcinogenic, including benzene, hydrocarbons, aniline, asbestos, and tobacco.

1916
UNITED KINGDOM
Physician and epidemiologist Janet Lane-Claypon (1877–1967) published results from a study that demonstrated some of the major contemporary risk factors for breast cancer among women, including not breastfeeding, being childless, and older age at first pregnancy.

1928
GERMANY
Researchers in Cologne drew the first statistical connection between smoking and cancer.

1930
DENMARK, UNITED KINGDOM
First national cancer registries established.

1932
UNITED KINGDOM
First breast cancer mortality statistics published.

1933
UNITED KINGDOM
Dr. Norman Delarue compared 50 patients with prostate cancer who were smokers to 50 patients who did not smoke and found that over 90% of the first group—but only half of the second—were smokers, and confidently predicted that by 1950 no one would be smoking.

1934
UNITED KINGDOM
Drs. W. Burton Wood and S. R. Glynn reported the first two cases of lung cancer linked to asbestos.

1935
USA
Physician and epidemiologist Janet Lane-Claypon (1877–1967) published results from a study that demonstrated some of the major contemporary risk factors for breast cancer among women, including not breastfeeding, being childless, and older age at first pregnancy.

1936
JAPAN
Physician Irving J. Selikoff (1915–92) published the first report showing that black dye workers had an unusually high rate of lung cancer.

1937
UNITED KINGDOM
National Cancer Institute inaugurated.

1939
USA
Drs. Alton Ochsner and Michael Delaney first reported the association of smoking and lung cancer.

1939–1945
USA
During the Second World War, the US Army discovered that nitrogen mustard was effective in treating cancer of the lymph nodes (lymphoma). This was the birth of chemotherapy—the use of drugs to treat cancer.

1943–1945
DENMARK, UNITED KINGDOM
First national cancer registries established.

1947
CANADA
Dr. Norman DeLearé compared 50 patients with lung cancer with 50 patients hospitalized with other diseases. He discovered that over 90% of the first group—but only half of the second—were smokers, and confidently predicted that by 1950 no one would be smoking.

1947
USA
Sidney Farber (1903–79), one of the founders of the specialty of pediatric pathology, used a derivative of folic acid, methotrexate, to inhibit acute leukemia in children.

1948
UNITED KINGDOM
First kidney transplantation performed by Bernard Blackfan and J. Alan Barron. The recipient died 23 days later.

1949
UNITED KINGDOM
E. C. Ayer and Janet Clive launched the Hammond-Horn Study.

1949–1950
USA
Dr. Charles B. Huggins (1907–97) demonstrated some of the major contemporary risk factors for breast cancer among women, including not breastfeeding, being childless, and older age at first pregnancy.

1950
USA
Grodtho Ellon (1901-89) created a purine chemical, which she developed into 6-mercaptopurine, or 6-MP. It was rapidly approved for use in childhood leukemia. She received the Nobel Prize in 1988.

1950
USA
The link between smoking and lung cancer was confirmed. A landmark article from The Journal of the American Medical Association appeared on May 27th, 1950: “Tobacco smoking as a possible etiologic factor in bronchogenic carcinoma” by E.L. Wynder and Elvira Graham. The same issue featured a full-page ad for Chesterfield cigarettes. The American Cancer Society, which opposed the use of smokers, contacted the industry and received an assurance that no further ads would appear until at least 1953.

1951
UNITED KINGDOM
Dr. Richard Doll and Prof. Austin Bradford Hill published a study of smoking and lung cancer.

1951
UNITED STATES
Dr. Charles B. Huggins (1907–97) demonstrated some of the major contemporary risk factors for breast cancer among women, including not breastfeeding, being childless, and older age at first pregnancy.

1952
UNITED STATES
Epidemiologists at the American Cancer Society launched the Hammond-Horn Study, a long-term follow-up study of 188,000 men designed to examine the association between cigarette smoking and cancer.

1953
UNITED KINGDOM
First kidney transplantation performed by Bernard Blackfan and J. Alan Barron. The recipient died 23 days later.

1953–1954
UNITED STATES
Dr. Richard Doll and Prof. Austin Bradford Hill published a study of smoking and lung cancer.

1954
USA
First tobacco litigation against the cigarette companies, brought by a widow on behalf of her smoker husband, who died from cancer. The cigarette companies won.

1955
USA
Dr. Min Chiu Li (1919–85) first demonstrated clinically that chemotherapy could result in the cure of a widely metastatic malignant disease.

1960
JAPAN
Group cancer screening for stomach cancer began with a mobile clinic in Tohoku region.

1960
USA
Dr. Min Chiu Li published another important and original finding: the use of multiple-agent combination chemotherapy for the treatment of metastatic cancers of the testicles. Twenty years later, it was demonstrated that combination chemotherapy, combined with techniques for local control, had virtually eliminated deaths from testicular malignancy.

1963
USA
Cancer research programs were established by the Ministry of Health and Welfare and the Ministry of Education, Science, and Culture.

1964
UNITED KINGDOM
First US Surgeon General’s report on smoking and health.

1965
FRANCE
WHO established the International Agency for Research on Cancer (IARC), based in Lyon, France.

1966
UNITED STATES
American Association for Cancer Research (AACR) founded.

1960s–1970s
USA
Trials in several countries demonstrated the effectiveness of mammography screening for breast cancer.

1970s
USA, ITALY
Bernard Fisher in the USA and Umberto Veronesi in Italy both launched long-term studies as to whether tamoxifen followed by radiation therapy was an alternative to radical mastectomy in early breast cancer. These studies concluded that total mastectomy offered no advantage over either tamoxifen or tamoxifen plus radiation therapy.

1971
UNITED STATES
The National Cancer Act in President Nixon’s “War on Cancer” mandated financial support for cancer research, outlined intervention strategies, and, in 1973, established the Surveillance, Epidemiology, and End Results (SEER) program, a network of population-based cancer registries.

1973
USA
Bone marrow transplantation first performed successfully in a dog in Seattle by Dr. E. Donnall Thomas (1920–2020). This led to human bone marrow transplantation, resulting in cures for leukemias and lymphomas. In 1990, Dr. Thomas won a Nobel Prize for his work.
1970s
Childhood leukemia became one of the first cancers that could be cured by a combination of drugs.

1970s
Discovery of the first cancer gene (the oncogene, which in certain circumstances can transform a cell into a tumor cell).

1970s onwards
WHO, IARC, and others promoted national cancer planning for nations to prioritize and focus their cancer control actions.

1981
ITALY
Professor Takeshi Hirayama (1923–95) published the first report linking passive smoking and lung cancer in the non-smoking wives of men who smoked.

1981
ITALY
Dr. G. Bonnadona in Milan performed the first study of adjuvant chemotherapy for breast cancer using 5-fluorouracil, resulting in reduction of cancer relapse. Adjuvant chemotherapy is now standard treatment for lung, breast, colon, stomach, and ovary cancers.

1980s
Kaposi’s sarcoma and T-cell lymphoma linked to AIDS.

1980s
Discovery of BRCA1, the first known breast and ovarian cancer predisposing gene.

1980s
USA
Vincent DeVita developed a four-drug combination to significantly raise the cure rate of Hodgkin disease to 80%.

1980s
USA
Human Genome Project was initiated to pinpoint genes that make up the inherited set of “instructions” for functions and behavior of human beings.

1980s
WHO Program on Cancer Control established.

1988
First WHO World No Tobacco Day, subsequently an annual event.

1989
European Network of Cancer Registries (ENCR) established.

1989
USA
National Institutes of Health researchers performed the first approved gene therapy, inserting foreign genes to track tumor-killing cells in cancer patients. This project proved the safety of gene therapy.

1991
Evidence linking specific environmental carcinogens to telltale DNA damage emerged, e.g. sunscreen radiation was found to produce change in tumor suppressor genes in skin cells, aflatoxin (a fungus poison) or hepatitis B virus to cause mutations in the liver, and chemicals in cigarette smoke to switch on a gene that makes lung cells vulnerable to the chemicals’ cancer-causing properties.

1994
USA, CANADA, UNITED KINGDOM, FRANCE, JAPAN
Scientists collaborated and discovered BRCA1, the first known breast and ovarian cancer predisposing gene.

1994
USA
National Program of Cancer Registries (NPCR) established.

1995
Gene therapy, immune system modulation, and genetically engineered antibodies used to treat cancer.

1999
NETHERLANDS, USA
The Bill & Melinda Gates Foundation awarded a five-year, $50 million grant to the Alliance for Cervical Cancer Prevention (ACCP), a group of five international organizations with a shared goal of working to prevent cervical cancer in developing countries.

1999
USA
First annual event in 2002 was supported in 30 countries around the world and raised over $100,000 for parent organizations to help children in their own countries.

2000
SWITZERLAND
International Childhood Cancer Day was launched, its aim to raise awareness of the 250,000 children worldwide who get cancer every year. Some 80% of these children have little or no access to treatment. The first annual event in 2002 was supported in 30 countries around the world and raised over $100,000 for parent organizations to help children in their own countries.

2000
USA
The entire human genome is mapped.

2000
USA
Charter of Paris against Cancer is signed.

2001
LUCERNE
International Childhood Cancer Day was launched, its aim to raise awareness of the 250,000 children worldwide who get cancer every year. Some 80% of these children have little or no access to treatment. The first annual event in 2002 was supported in 30 countries around the world and raised over $100,000 for parent organizations to help children in their own countries.

2004
SWITZERLAND
WHO’s cancer prevention and control resolution approved by World Health Assembly.

2005
WHO Framework Convention on Tobacco Control came into force, using international laws to further public health and prevent cancer.

2006
USA
The US Food and Drug Administration (FDA) approved the first HPV vaccine to prevent infections that cause cervical cancer.

2010
USA
The US FDA approved sofosbuvir for use in combination with other agents for the treatment of chronic HCV infection in adults, reducing treatment time and toxicity compared with earlier treatments and increasing cure rates to more than 80%.

2015
A goal to reduce premature mortality from NCDs including cancer by one-third by 2030 was added to the United Nations Development Programme’s Sustainable Development Goals.

2017
WHO, UICC, and others promoted national cancer planning for nations to prioritize and focus their cancer control activities.

2018
The World Health Organization announces the Global Initiative for Childhood Cancer with the aim of reaching at least a 60% survival rate for children with cancer by 2030, representing a doubling of the global cure rate for children with cancer.

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2018
The World Health Organization announces the Global Initiative for Childhood Cancer with the aim of reaching at least a 60% survival rate for children with cancer by 2030, representing a doubling of the global cure rate for children with cancer.
Aflatoxin: A harmful, cancer-causing chemical made by certain types of fungi that may be found in stored grains and nuts. Consumption of foods contaminated with aflatoxin is an important risk factor for hepatocellular (liver) cancer.

Age-specific rate: A rate for a specific age group, in which the numerator and denominator refer to the same age group.

Age-standardization: A technique that allows comparison of incidence or mortality rates between populations, adjusting for any differences in their respective age distributions.

Asbestos: A natural material that is made of tiny fibers and used in insulation and as a fire retardant. Asbestos exposure is an important risk factor for cancer, especially mesothelioma (tumors of the chest, abdomen, and heart) and lung cancer.

Benign tumor: An abnormal growth that is not cancerous and does not spread to other areas of the body.

Body mass index (BMI): A measure of a person's weight in relation to his or her height, calculated as weight in kilograms divided by height in meters squared.

Cancer: A disease in which abnormal cells divide uncontrollably. Cancer cells can invade nearby tissues and spread through the bloodstream and lymphatic systems of the body.

Cancer registry: An institution that performs the systematic collection and maintenance of a file or register of all cancer cases occurring in a defined population. It is used to identify trends in disease, collect and maintain data on cancer incidence and mortality, and disseminate statistical information about cancer.

Carcinoma: A tumor that begins in the inner lining of the body (epithelial cells) in areas such as the lungs, skin, and breast.

Chemotherapy: Treatment with a drug or drugs to destroy cancer cells. Chemotherapy may be used, either alone or in combination with surgery or radiation treatment, to treat cancer when it is at an early stage, when the cancer has spread, when the cancer has come back (recurred), or when there is a strong chance that the cancer will recur.

Colonoscopy: Examination of the large bowel with a flexible, lighted tube called a colonoscope. The physician looks for polyps or early cancers during the exam, and removes them using a wire passed through the colonoscope.

Computerized tomography (CT): A series of detailed pictures of areas inside the body taken from different angles; the pictures are created by a computer linked to x-ray machines and called computerized axial tomography (CAT) scan. A special type of CT machine, the spiral CT, is more likely to be used for early lung cancer.

Diagnosis: The process of identifying a disease by its signs and symptoms, as well as medical tests and tissue sampling and examination as needed.

Direct costs: Expenditures for medical procedures and services associated with the treatment and care of people with cancer.

Disability-adjusted life year (DALY): A measurement of the years of healthy life lost due to disease in a population. DALYs are the sum of two components: the years of life lost due to premature death, and the years of life lost due to disability.

E-cigarette: A device that contains a solution of nicotine, flavoring, and other chemicals that turns into a mist that can be inhaled into the lungs. Also called electronic cigarettes.

Epidemic: Occurrence of a disease in an area that exceeds the established range of occurrence for that disease, or an occurrence that exceeds normal occurrence of the disease in the region.

Estradiol: A hormone produced by the ovaries and used with human menopausal gonadotropins to treat symptoms of hormone deficiency in menopausal women.

Etiology: The study of causes of disease or cancer.

Incidence: The number of new cases arising in a given period in a specified population. This information, collected routinely by cancer registries, can be expressed as an absolute number of cases per year or as a rate per 100,000 persons per year.

Malignant tumor: A type of cancer that is not controlled by the abnormal growth of blood vessels that develop into lesions on the skin, lymph nodes, lining of the mouth, nose, and throat, and other tissues of the body. It is caused by human papillomavirus (HPV) B. The risk of developing Kaposi sarcoma in a person who has HPV B increases significantly if the person is also infected with human immunodeficiency virus (HIV).

Morbidity: A measure of disease in a population. It can be expressed as an absolute number of cases per year or as a rate per 100,000 persons per year.

Neoplasm: A mass of cells that may invade surrounding tissues or spread (metastasize) to distant areas of the body. Sromas and basal cell cancers are unusual.

Neuroblastoma: Cancer of the blood or blood-forming organs.

Primary prevention: Efforts to prevent cancer before it starts or to stop a disease that has started from progressing.

Surgery: Removal of tissue and lymph nodes removed.

Surgical resection: Removal of the entire breast. There are different types of mastectomy that differ in the amount of tissue and lymph nodes removed.

Therapy: A form of treatment to destroy cancerous tissue and lymph nodes.

Urine: A natural liquid that is produced by the kidneys and is responsible for removing wastes and excess water from the body.

Vaccine: A substance given to induce immunity against a disease by stimulating the body to produce antibodies.

Vesicocentesis: The drainage of fluid from a body cavity or organ using a needle and a syringe.

Vital status: The state of being alive or dead. Age-specific mortality rates can be used to show the proportion of people who are alive or dead at different ages.

Vitamin B12: A vitamin that is needed by the body to make DNA, the genetic material in cells, and to help form red blood cells.
PARTICIPATE MATTER:
Microscopic solid or liquid particles associated with the atmosphere that can penetrate the lungs and cause damage that can lead to lung cancer. Participate matter can be naturally occurring (e.g., originating from volcanoes or dust storms) or synthetic (e.g., vehicle emissions). The smallest class of particulate matter (i.e., 2.5 micrometers diameter) is the deadliest.

PALLIATIVE CARE:
An approach that aims to improve the quality of life for patients and families facing the problems associated with life-threatening cancers. It provides for prevention and relief of suffering through treatment for pain and other symptoms as well as through spiritual and psychosocial support, at the time of cancer diagnosis, through the end of life, and during family bereavement.

PREVALENCE:
The number of persons in a defined population who have been diagnosed with a specific type of cancer and who are still alive at the end of a given year (the survivors). Five-year prevalence limits the number of patients to those diagnosed in the past 5 years. It is a splendidly useful measure of cancer burden because most cancers, patients who are still alive five years after diagnosis are usually considered cured. However, exceptions to this include breast cancer patients, who continue to die from the disease 5 years after diagnosis.

PROGNOSIS:
Prediction of the course of cancer, and the outlook for cure of the disease.

RADIOTHERAPY:
The use of radiation treatment to kill cancer cells or to stop them from dividing.

RADIATION:
A radioactive gas that is released by uranium—in a substance found in soil and rock—and is an important risk factor for lung cancer.

RATES:
The incidence or mortality rate is the number of new cases of cancer or deaths from cancer, respectively, in a specified population over a specified period (e.g., 1, 3, or 5 years) following a diagnosis.

SILICOGRAPHS:
A radiography is an examination to help find cancer or polyps within the rectum and distal part of the colon. A slender, hollow, lighted tube is placed into the rectum, allowing the physician to look for polyps or other abnormalities. The silicographoscope is shorter than the colonoscope.

SOLAR IRRADIATION:
See UV radiation.

SOLID FuELS:
Solid materials burned usually for heating purposes, including wood, peat, charcoal, coal, and grains. In certain conditions, excess exposure can be an important risk factor for lung cancer.

Survival/rate, estimate:
The proportion or percentage of persons with a given cancer who are still alive after a specified time period (e.g., 1, 3, or 5 years) following a diagnosis.

SYSTEMATIC THERAPY:
Treatment using substances that travel through the bloodstream, reaching and affecting cells all over the body.

Targeted therapy:
A cancer treatment that uses drugs or other substances to identify and attack cancer cells while avoiding harm to normal cells better than many other cancer treatments. Some targeted therapies block the mechanisms involved in the growth and spread of cancer cells. Other types of targeted therapies help the immune system kill cancer cells or deliver toxic substances directly to cancer cells.

ULTRAVIOLET (UV) RADIATION:
Invisible rays that are part of the energy that comes from the sun. UV radiation also comes from sun lamps and tanning beds. UV radiation can cause damage to the skin, lead to premature aging, and cause melanoma and other types of skin cancer.

VITAL REGISTRATION:
The continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital events (e.g., births and deaths) pertaining to the population, as provided through decree or regulation in accordance with the legal requirements of a country.

WISDOM TUMOR:
A type of kidney cancer that usually occurs in infants and young children.


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Figure 1: Gordon LG, Rowell D. Skin cancer costs of skin cancer and cost-effectiveness of skin cancer prevention and screening: a systematic review. Euro J Cancer Prev. 2015; 24:141-149.


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Maps 1–2, and Figure 1: State of Global Air 2019.


Figure 4: Woman's body with cancer stage classification.

Cancer in Women


Figure 5: Cancer incidence in five continents. Lyon, France: IARC; 2018. Available from: https://gco.iarc.fr/today.
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Figure 4: The estimates for regions were calculated as an average of 5-year age-standardized net survival ob- served in the most recent available period in all areas with at least 50 cases, weighted by the numbers of cases.


Figure 5: abbreviated词

Figure 6: International Human Development Index Transitions Cancer burden in 2014:


Most commonly diagnosed cancers:


Text:


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Figure 3 and 4: Rates and 5-year smoothed averages. WHO Cancer Mortality Databank: http://www.deap.iarc.fr/WHDwb/WHOdb.html

Northern America
Endemicole lines in the US:

Text:

Figure 4:

Map and Figure 1:
North American Association of Central Cancer Registries, Inc. Population and Figures 1–3:

Europe

Text:

Map and Figures 1–3:

Australia, New Zealand, and the Pacific
- Cancer Incidence, Mortality, Prevalence and Survival – Australia and New Zealand
http://www-dep.iarc.fr/WHOdb/WHOdb.htm

South-Eastern Asia
Cancer cases expected to double in this region
Figure 2:

Text:

Map and Figures 1–3:

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- Surveillance and cancer risk factors in the North: Figure 2:

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Cancer burden contribution of this region
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Text:

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Figure 3:
Rates have been smoothed using 5-year averages.

Text:


Map and Figures 1–3:

North-Eastern Europe
Cancer survival: a look at the distribution of modifiable risk factors and east–west gradient in colorectal cancer risk:

Text:

Map and Figures 1–3:


- World Health Organization Cancer Survival: Survival from childhood acute lymphoblastic leukemia

Appendix D: Cancer Incidence, Mortality, Prevalence and Survival – Europe

Text:

Map and Figures 1–3:


- World Health Organization Cancer Survival: Survival from childhood acute lymphoblastic leukemia

Appendix G: Cancer survival: a look at the distribution of modifiable risk factors and east–west gradient in colorectal cancer risk:
Tung J, Politis CE, Chadder J, et al. The north–south transition in
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Map: Data quality varies according to cancer site and is typically better for more common cancer sites. Data quality determination in the map is based on best estimates.


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Figure 1 and 4: Adapted from Di Carlo V, et al., for the CONCORD Working Group Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. Lancet 2018 Mar 17;391(10125):1023–1075. Licence CC BY 4.0.

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Cancer Survivorship


Figure 5: Map: Global Atlas of Palliative Care at the End of Life. Available from: https://www.evidenceoncology.com/communication/cancer-today/page-maps.php

Figure 3: WHO IARC. Cancer Mortality Database. https://gco.iarc.fr/en/whoiarc/whoiarc.php


Health Promotion: A Systems and Approaches Progress:


Figure 1: Retrieved from https://www.evidenceoncology.com/communication/cancer-today/page-maps.php

The Cancer Continuum: An Overview of Interventions and Potential for Impact

The annual number of worldwide deaths the HPV vaccination is estimated to prevent by 2020.


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While we face great challenges in this work, we also have the proven interventions, dedicated global partners, and momentum we need to truly address the global cancer burden. This Cancer Atlas, Third Edition is an important source of information to help the global cancer community achieve our shared goal of a world without cancer.

— Gary Reedy, CEO, American Cancer Society

The Cancer Atlas, Third Edition has brought together cancer control experts from around the world to present useful and comprehensible information to aid in the fight against cancer. This all-new edition is a comprehensive global overview that equally highlights the distinct patterns and inequities in the present cancer burden, the associated risk factors, and the prospects for cancer prevention and control. This edition unites these topics under the theme of “Access Creates Progress,” drawing attention not only to the problem at hand, but also the means of tackling the cancer burden through access to information and services. It provides basic information on the global burden of cancer in a user-friendly and accessible form for cancer control advocates, government and public health agencies, and policymakers as well as patients, survivors, and the general public.

Topics Include
- Risks of tobacco
- Body weight, physical activity, diet, and alcohol as cancer risk factors
- Infection-related cancers
- Childhood cancers
- Cancer in indigenous populations
- The burden of cancer by world region
- Cancer survival and survivorship issues
- Vaccines
- Early detection
- Pain control
- Universal health coverage