



Cancer prevention 4

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The world population is ageing and increasing in size. As a result, the numbers of people diagnosed with and dying of cancer are increasing. Cancer is also a growing problem in developing countries. Government, be it local, state, provincial, national, or even a union of nations, has clear roles in the control of cancer. It is widely appreciated that much of the research that has defined the causes and treatment of cancer was, and is, government funded. Less appreciated, the body of work about how to control cancer shows the importance of an environment that encourages individuals to adopt healthy behaviours, and government has a vitally important role. Through regulation, education, and support programmes, governments can create an environment in which tobacco use is reduced and citizens maintain good levels of physical activity, healthy bodyweight, and good nutrition. Cancer prevention and the creation of a culture of health is an essential mission of government, beyond that of the traditional health-focused departments such as health ministries; it is in the domain of governmental agencies involved in environmental protection, occupational safety, and transportation. Cancer prevention and health promotion are also in the realm of the zoning board, the board of education, and the board of health.

Introduction

"Prevention is so much better than healing because it saves the labour of being sick."

Thomas Adams, 1618

Cancer is a group of diseases with a major societal impact, and it is the leading cause of death in most countries. Worldwide, cancer accounts for one in seven deaths. It is estimated that in 2012, more than 14 million people were diagnosed with cancer and 8·2 million died from cancer.¹ The projected ageing and increasing size of the world's population in the next few decades portends an increase in the absolute number of cancers and cancer deaths.²

Governments have clear roles in cancer control. These roles include sponsoring research to identify the causes of cancer; sponsoring research on screening, diagnosis, and treatment of cancer; and the provision of proven, effective preventive and treatment interventions. Research, much of it conducted or funded by governments, has helped identify the causes of several types of cancers³ and has led to increased understanding of the potential for cancer prevention and has helped to define interventions that can prevent cancer. More than half of cancers diagnosed in the USA and western Europe are associated with identifiable risk factors.⁴ An estimated third of all cancer deaths in the USA, Canada, and the European Union (EU) are caused by tobacco use.⁵ The combination of excess bodyweight, physical inactivity, and poor nutrition (ie, too many calories) is the cause of 20–30% of cancers in high-income countries.^{6,7}

Governments at all levels—federal, state or provincial, and local (city or county)—have a role in encouraging cancer prevention. Although cancer prevention has become an essential mission of public health agencies, WHO has emphasised that disease prevention is really in

the domain of all agencies of government, not just health agencies. Laws and regulations can restrict access to carcinogens or facilitate and motivate healthy behaviours. Cancer prevention is as much in the domain of environmental protection agencies, occupational safety agencies, zoning boards, and boards of education, as well as of boards of health.

Government and other social institutions can contribute to the control of cancer by creating an environment and culture that is supportive of cancer prevention. An environment that encourages healthy behaviours involving diet, exercise, and abstinence from tobacco use reduces the risk of cancer and several other chronic diseases, such as diabetes and cardiovascular disease. Other government-sponsored cancer prevention interventions include vaccination against human papillomavirus (HPV) and hepatitis B virus, as well as treatment of infections such as hepatitis C and *Helicobacter pylori*.⁸ Additionally, screening programmes sponsored or encouraged by governments can prevent colorectal and cervical cancer through detection and removal of precancerous lesions.

The social environment in its broadest sense influences healthy choices. Examples include making it difficult to buy and consume tobacco, making neighbourhoods safe from crime, making exercise convenient, and making healthy foods affordable and available. The US Centers for Disease Control and Prevention (CDC) has published the health impact pyramid to explain this concept (figure). In addition to a direct appeal for individual behaviour change through education, multilevel initiatives addressing socio-economic and physical environments where people live, work, go to school, and play, have the greatest potential to affect health behaviour on a large scale. Thus, the anticancer effort is most effective if health promotion is encouraged throughout government, not

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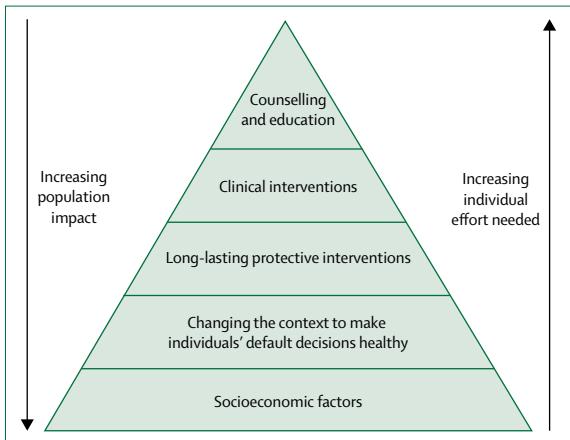


Figure: The US Centers for Disease Control and Prevention's health impact pyramid

Interventions to promote healthy behaviours change the conduct of populations, whereas other interventions focus on smaller groups. Reproduced with the permission of US Centers for Disease Control.

just in the health ministry. Indeed, WHO has stressed that health promotion and disease prevention should be considered in all policies of government. City planning can have a downstream effect on promotion of physical activity, as can governmental agencies concerned with transportation. Agricultural ministries are important to assure the ready availability and affordability of healthy foods. Effective education ministries are also important because highly educated populations are more likely to do physical exercise and have healthy eating habits.

Tobacco control

Decreasing tobacco use is one of the oldest cancer control goals. Early efforts stem from the British and American studies of the 1950s, the results of which showed that cigarette smoking is associated with lung cancer.^{9,10} Although cigarette smoking is the most common use of tobacco, other harmful ways of consuming tobacco include cigars, cigarillos (small cigars), smokeless (chewed or inhaled) tobacco,¹¹ and hookah.^{12,13} A study¹⁴ has shown that tobacco use can cause at least 17 cancers, as diverse as lung, oesophageal, and head and neck cancers, as well as cancers of the kidney, bladder, and even some leukaemias. Tobacco use affects virtually every organ system and has been linked to such varied diseases as glaucoma, periodontal disease, and cardiovascular disease.¹⁵

Governments and regulatory agencies have numerous responsibilities in the monitoring and control of tobacco. They routinely assess tobacco use to measure the magnitude of the tobacco problem in their populations.^{11,16} They also conduct and fund research about smoking and smoking cessation and have developed the evidence base to support tobacco control efforts. Results from numerous studies have shown

that the most successful approach to reducing tobacco use involves the use of three policies: make tobacco products difficult to obtain;¹⁷ make it difficult for tobacco consumers to use tobacco;¹⁸ and help those who are addicted to tobacco to quit.¹⁹

Making tobacco use difficult

Surveys consistently show that very few smokers started smoking after the age of 18 years;²⁰ most start smoking at age 14–15 years. Raising the price of tobacco products with high excise taxes is one of the best strategies for preventing children and teenagers from using tobacco products, and it also reduces adult use.²¹ The tax revenue is often used to fund governmental tobacco prevention and control programmes.

Another way to make tobacco difficult for children and teenagers to obtain is to set a minimum age for purchase.²² In many areas of the USA and Europe, the minimum age to purchase tobacco is 18 years. Some governments are increasing the minimum age for purchase to 21 years. The introduction and amendment of age laws requires interventions to educate retailers and community law enforcement.

Limited availability of tobacco leads to reduced consumption. Agricultural ministries have lowered tobacco availability with programmes designed to encourage tobacco farmers to grow alternative crops.¹⁸ Many governments have also limited the number and type of retail outlets where tobacco can be sold and purchased. The EU, for example, has barred pharmacies from selling tobacco. Some countries limit public access to tobacco by requiring that retailers keep tobacco behind a staffed counter.

Tobacco consumption is reduced in populations where there are restrictions on its public use.²³ Smoke-free and tobacco-free policies have health benefits for more than just the smoker. Environmental tobacco smoke, also known as second-hand tobacco smoke, causes cancer,²⁴ as well as other health problems such as cardiovascular disease, stroke, respiratory infections, and asthma. In an effort to protect non-smokers, numerous state and local governments in the USA, Canada, and Europe have enacted laws requiring workplaces, restaurants, bars, and other public places to remain smoke free.²⁵

Because of tobacco control efforts, tobacco use is on the decline in most high-income countries. The tobacco industry is still trying to circumvent the effect of risk-reducing policies in the USA and Europe by using social media and advertising where allowed. Many countries have barred television, radio, and billboard advertising for cigarettes. At the same time, the tobacco industry is trying to create new markets, with focused efforts in low-income and middle-income countries in Africa and South America. The tobacco industry often threatens the ability of these countries to restrict tobacco importation by challenging any governmental measure to reduce tobacco importation as a violation of international trade agreements.²⁶

Tobacco prevention and cessation programmes

Results from studies^{27–29} have shown that governments that provide a wide range of cessation services (including counselling and medication) have greater declines in tobacco sales, smoking prevalence, and ultimately lung cancer incidence and mortality, compared with governments who do not implement such measures.

Telephone quitlines offer ongoing cessation counselling to smokers and former smokers. They have become an integral component of comprehensive tobacco control programmes in many countries spanning several different cultures. Increasingly, innovative internet and social marketing interventions are also being used effectively. Many of these efforts are state sponsored, often through contracts to private companies.³⁰

Most residents of the EU have access to tobacco cessation services. In the USA, the US Patient Protection and Affordable Care Act (ACA), a piece of federal legislation implemented in 2011, mandates that US health insurance pays for smoking and tobacco cessation services.³¹ Unfortunately some individuals, especially low-income Americans, do not have access to insurance under the ACA and therefore do not have affordable access to tobacco cessation therapies. The future of the ACA is under threat because there have been attempts to repeal it, and it is unknown whether its tobacco control benefits will remain in force.

Public health education programmes

Marketing and social science are important for tobacco control.³² Strategic and culturally appropriate messages about the effects of tobacco use can be very effective. These messages are designed to encourage young people to not start smoking and encourage cessation for those who use tobacco.

US federal efforts to reduce tobacco use began in 1964, when the US Surgeon General issued a statement that tobacco use causes lung and throat cancer.³³ This was followed with the Federal Cigarette Labeling and Advertising Act of 1965, which required a health warning to be placed on all cigarette packets sold in the USA.³⁴ It was followed with the 1970 Public Health Cigarette Smoking Act, which banned cigarette advertisements on US radio or television, and required an updated warning on cigarette packets. The label read: "Warning: the Surgeon General has determined that cigarette smoking is dangerous to your health."

Several European, Asian, and South American countries enacted similar advertising and warning label laws in the late 1960s and early 1970s. In the 1960s, several governments owned or had partial interest in tobacco companies. With increasing realisation of the harms associated with tobacco, most of these governments have divested or dissolved their tobacco interests. Ironically, privatisation of state-owned tobacco companies has been associated with weakened tobacco control laws and lower cigarette taxes. Today, 14 countries

in the Middle East, Africa, and Asia-Pacific regions have state-owned tobacco companies, and these countries account for 40% of the world's cigarette consumption.³⁵ China is by far the largest market with a state-owned tobacco company, known as the China National Tobacco Corporation.³⁶

In 1998, 46 state governments in the USA entered into the Tobacco Master Settlement Agreement with what were then the four largest US tobacco companies (Philip Morris, R J Reynolds, Brown & Williamson, and Lorillard).³⁷ The agreement settled a series of lawsuits that American state governments had filed against the tobacco companies. As part of the settlement, these companies agreed to curtail specific marketing practices, and to make annual payments to these states as compensation for some of the state-paid costs for the medical care of people with smoking-related illnesses.

Through the settlement, these tobacco companies also fund an anti-smoking advocacy group called the Truth Initiative (formerly known as the American Legacy Foundation). The Truth Initiative is aimed at developing anti-tobacco campaigns such as the series of hard-hitting advertisements called the Truth campaign.³⁸ These television and radio advertisements highlight the deadly effects of tobacco and the deceptive practices of the tobacco industry. Similar advertisements to the Truth campaign are now used in the EU and in other countries worldwide.

Several governments sponsor anti-tobacco advertising. Research has shown that graphic advertisements cut through smokers' defences and help convince them about the true dangers of tobacco use.²⁹ These messages also translate easily and transcend cultures. The Sponge campaign is the collaboration of the World Lung Foundation charity and several governments who buy or mandate television and radio time to air the campaign advertisements. The campaign is a mass-media promotion that graphically depicts the amount of tar that collects inside an average smoker's lungs. Advertisements have aired in Australia, Bangladesh, China, India, Mauritius, Senegal, Ukraine, and several other countries. When aired on Senegalese television in April and May, 2013, the Sponge campaign resulted in a nearly 600% increase in calls to the Senegal National Quitline.³⁹ This is an example of programmes that were developed in high-income countries being successfully adopted in low-income and middle-income countries.

The Framework Convention on Tobacco Control (FCTC) is a UN treaty that was adopted by the governing body of WHO in May, 2003, and came into force in February, 2005.⁴⁰ The FCTC was signed and ratified by 180 of the 192 WHO member states, for whom it is a multilateral and binding legal agreement. Nine WHO member states—Andorra, Dominican Republic, Eritrea, Indonesia, Liechtenstein, Malawi, Monaco, Somalia, and South Sudan—are not party to the treaty. The USA is one of seven countries (including Argentina, Cuba, Haiti, Morocco, Mozambique, and Switzerland) that has signed

For more on the **Truth campaign** see <https://www.thetruth.com>

For more on the **Sponge campaign** see <https://www.cancerinstitute.org.au/how-we-help/cancer-prevention/stopping-smoking/campaigns/Sponge>

	Measure	Articles
Lobbying	Call for a limitation in the interactions between lawmakers and the tobacco industry	Article 5.3
Reduction of demand	Tax and other measures to reduce tobacco demand	Articles 6 and 7
Passive smoking	Obligation to protect all people from exposure to tobacco smoke in indoor workplaces, public transport, and indoor public places	Article 8
Regulation	The contents and emissions of tobacco products are to be regulated and ingredients are to be disclosed	Article 10
Packaging and labelling	Large health warning (at least 30% of the packet cover, 50% or more recommended); deceptive labels (eg, mild, light) are prohibited	Articles 9 and 11
Awareness	Public awareness for the consequences of smoking	Article 12
Tobacco advertising	Comprehensive ban, unless the national constitution forbids it	Article 13
Addiction	Addiction and cessation programmes	Article 14
Smuggling	Elimination of illicit trade of tobacco products	Article 15
Minors	Restricted sales to minors	Article 16
Research	Tobacco-related research and information sharing among research parties	Articles 20, 21, and 22

Table 1: WHO Framework Convention on Tobacco Control

the treaty but not ratified it.⁴¹ The FCTC established a set of universal standards for tobacco control, including rules that govern the production, sale, distribution, advertisement, and taxation of tobacco (table 1). FCTC standards are minimal compared with more stringent standards in some countries but the treaty has had substantial influence in many countries; signatories are encouraged to enact even more stringent laws and regulations, such as the EU Tobacco Products Directive, which was passed in 2016.⁴² This regulation requires that cigarette boxes be plain and uniform in shape and size, and that packaging should have graphic health warnings with pictures. From 2020 onwards, there will be a ban on flavourings, such as menthol and vanilla, in cigarettes. Tar, nicotine, and carbon monoxide labelling will be replaced with the statement: "Tobacco smoke contains over 70 substances known to cause cancer." The EU also regulates electronic cigarettes and other nicotine delivery systems.

Although the USA has not ratified the FCTC, it has enacted harmonious legislation, such as the Family Smoking Prevention and Tobacco Control Act, which was signed into law in 2009.⁴³ This bill gives the US Food and Drug Administration (FDA) the authority to regulate tobacco products. Much of the legislation is targeted at cigarettes and smokeless tobacco products, but it also includes electronic cigarettes. The act gives the FDA the power to require tobacco companies to: submit a list of product ingredients to the FDA; to make public the nicotine content of their products, and to reduce or eliminate other harmful substances; to enlarge warnings on tobacco packaging so that they take up 50% of the front and back of the package; and to restrict the use of terms, such as mild and light, and set standards regarding these terms.

Lowering alcohol consumption

Alcohol consumption, especially in excess, is linked to numerous cancers.⁴⁴ One study⁴⁵ of a European cohort estimated that alcohol is associated with 10% of all cancers in men and 3% of all cancers in women, including cancers of the head and neck, oesophagus, liver, breast, and colon. The combination of alcohol and tobacco use is an especially potent cause of cancers of the aerodigestive tract (cancers of the mouth, throat, and oesophagus).⁴⁶ Results from a European cohort study⁴⁵ suggest that alcohol and tobacco use were associated with nearly 45% of head and neck cancers in men, and 25% of these cancers in women.

As is the case with tobacco use, alcohol consumption is an unnecessary habit. Although there is no safe level of alcohol use, several developed governments have published guidelines with recommended upper levels of alcohol consumption in an educational effort that aims to encourage moderation.

There is no agreement about what constitutes harmful or excessive alcohol consumption across the world. As of January, 2016, the UK Government recommends that men and women consume no more than 14 units of alcohol per week.⁴⁷ A unit in the UK is equivalent to 8 g of alcohol. The 14-unit recommendation equates to no more than five pints of beer with 5% alcohol by volume per week. Compared with the British definition of unit and recommended consumption per week, the US Government recommends that men consume no more than 25 units; Ireland, 21·2 units; Denmark, 21 units; New Zealand, 19 units; and Spain, 35 units.⁴⁸ The 14-unit limit for women in the UK is similar to the recommended 12·3 units in the USA and 10·5 units in Denmark, and is on a par with Ireland.⁴⁸

In virtually every society, the affordability, availability, and promotion of alcohol are controlled, to varying degrees, by laws and regulation. Some governments attempt absolute prohibition because of cultural or religious reasons. Most of these countries have a black market for illegal alcohol. Other countries implement regulations, largely intended to prevent intoxication and promote traffic safety. The prevention of chronic disease is secondary and the prevention of cancer is clearly not the primary purpose of most alcohol control efforts in these countries.

Programmes promoting moderate and responsible alcohol consumption might involve laws, but more commonly involve public service announcements and education through television, radio, and print advertisements.⁴⁹ Educational efforts sometimes focus on the drinker, but often also on the drinker's friends and associates in an effort to create social pressure supportive of moderation or abstinence.

The CDC Community Preventive Services Task Force has suggested strategies that state and local governments can use to create social and physical environments that reduce excess alcohol use.⁴⁷ These strategies are garnered from systematic reviews of the scientific literature, and are

similar to those of tobacco control.⁵⁰ Strategies include introducing labelling regarding the harms associated with alcohol consumption, taxing alcohol (the more expensive alcohol is, the less excessive the use and related harms), regulating the density of retailers, limiting the days and hours that alcohol can be sold, enforcing laws that prohibit sales to minors, and enacting laws that hold retailers liable or at fault for harm caused by illegal sales to intoxicated or under-aged customers.⁴⁷

Regulation is disadvantageous to the alcohol industry. Alcohol manufacturers have tried to counter the threat of regulation by contesting the association between advertising and the levels of consumption; by supporting voluntary, industry-controlled educational initiatives; and by focusing on individual rather than corporate responsibility.⁵¹

Reducing exposure to carcinogens

Many factors, such as chemicals or physical exposures, affect the risk or chance of an exposed individual getting cancer. These factors are referred to as carcinogens, and include the carcinogen itself; the amount, duration, and method of exposure to the carcinogen; and the individual's genetic susceptibility. The proportions of cancers caused by environmental exposure to carcinogens are unknown; estimates range from 4% to 19% in the USA and Europe.⁵²

Some governments maintain lists of known carcinogens, including the National Toxicology Program (NTP), a collaboration of several US Government agencies.⁵² US Congress has mandated that the NTP publish the *Report on Carcinogens* every few years. This report is a list of chemicals, occupational exposures, and physical and biological agents that are categorised as "known to be a human carcinogen" or as "reasonably anticipated to be a human carcinogen". The NTP has a well defined process for nomination and evaluation of substances. The report currently lists 56 substances known to be a human carcinogen, and 187 substances that are reasonably anticipated to be a human carcinogen.

The International Agency for Research on Cancer (IARC) is an agency of WHO that publishes a list of chemical, physical, and lifestyle factors that are or could be carcinogenic. The IARC reviews all available scientific literature—including epidemiological studies in human beings and laboratory studies in animals—about whether a specific agent increases the risk of cancer in human beings, and assesses the strength of the evidence (panel).

Since 1971, IARC has evaluated more than 900 compounds and exposures for carcinogenicity.⁵³ So far, 119 have been classified as group 1 (carcinogenic), including tobacco and alcohol. More than 40 agents cause cancer in more than one organ site; for example, tobacco smoke causes cancer in 17 sites, including cancers of the lung, larynx, mouth, oesophagus, throat, bladder, kidney, liver, stomach, pancreas, colon, rectum, and cervix, as well as acute myeloid leukaemia; alcohol

Panel: International Agency for Cancer Research carcinogenicity groups

- Group 1 (carcinogenic to humans): 119 agents
- Group 2A (probably carcinogenic to humans): 81 agents
- Group 2B (possibly carcinogenic to humans): 299 agents
- Group 3 (not classifiable as to its carcinogenicity to humans): 505 agents
- Group 4 (probably not carcinogenic to humans): 1 agent

Reproduced from International Agency for Research on Cancer monographs.⁵²

has been associated with cancers of the mouth, oesophagus, larynx, pharynx, colon, liver, and breast; and radiation has been associated with cancers of the thyroid, breast, lung, skin, and several leukaemias, among others.

Most known carcinogens are used in agriculture or industry. Some examples of group 1 carcinogens include ethylene oxide, which is found in pesticides and cleansers and is a carcinogen linked to haematological malignancies; the metal strontium, which is used as a red colour in fireworks and to coat cathode ray tubes, and is also linked to haematological cancers; asbestos, which is used in insulation and is linked to mesothelioma and lung cancer; and wood dust, which causes nasopharyngeal cancer. These carcinogens are problematic for people working in industry, but some household products are also carcinogenic. Glyphosate, a component of common household weed control compounds, has been labelled as a probable carcinogen (group 2A). Pickled vegetables have also been categorised as a possible carcinogen (group 2B).

Indoor air pollution from solid fuels burned for heating and cooking is estimated to cause about 4 million deaths every year worldwide, mainly in low-income countries.⁵⁴ IARC has categorised indoor smoke emissions from coal as a known carcinogen (group 1) and emissions from other types of solid fuel as probable carcinogens (group 2A). The air in large cities often contains fine particulate matter that is classified by IARC as carcinogenic (group 1), along with exhaust from diesel and other fossil fuels. Governmental efforts to mandate exhaust venting or to encourage the use of alternative fuels are ongoing.

Many countries have agencies charged with enforcing environmental laws and regulations. The Environmental Protection Agency does this in the USA and the European Environment Agency in the EU. The European Environment Agency is a leader in the harmonisation of classification and labelling of substances. The appropriate approach to many carcinogens is one of managing exposure, rather than preventing all exposure. Governmental bodies, especially occupational health agencies, often regulate the use of known carcinogens. It is rare that governments ban the use of a compound.

For more on the NTP report see
[https://ntp.niehs.nih.gov/
 pubhealth/roc/index-1.html](https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html)

Healthy eating and active living

The triad of obesity, consumption of too many calories, and physical inactivity constitutes the second leading cause of cancer in the USA and Europe.⁷ Given the decline in tobacco use in these two regions, this triad will become the leading cause of cancer within the next decade.⁵⁵ With the increasing influence of high-income countries in Africa and South America, the triad is now becoming an increasingly common cause of cancer in many low-income and middle-income countries.

Factors that contribute to the problem include the low cost of food, particularly energy-dense carbohydrates; real income growth, which leads to increased consumption of carbohydrates, meat products, and saturated fat; and the global marketing of processed foods, prepared meals, and snack foods. Competition within the food industry has led to larger portion sizes. Marketing has created demand for sweet, fatty, salty, energy-dense foods.

Governments and regulatory agencies are involved in the promotion of healthy eating and active living.⁵⁶ The dietary goal is to reduce total calorie intake and the consumption of salt, sugar, and saturated fats at the population level. These efforts are more frequently thought of as efforts to reduce the incidence of diabetes and cardiovascular disease, but they should also be viewed as cancer-control efforts.⁵⁷

Evidence-based efforts focus on education in schools, public messaging (ie, public education, such as through advertising and public service announcements), improved availability of low-calorie nutritious foods, and encouraging an environment conducive to exercise. In the USA, the CDC has published a list of effective interventions that federal, state, and local governments can use.⁵⁸ The European Commission and the Canadian Health Ministry have also taken a similar approach.⁵⁹

The environment shapes an individual's knowledge, preferences, and behaviours related to food choices and eating habits.⁶⁰ Governments and non-governmental organisations of civil society try to inform consumers by disseminating understandable, evidence-based, truthful information regarding nutrition.⁶¹ This approach often requires nutrition labelling to aid healthy decision making. The European Commission, the FDA, and the US Department of Agriculture are exploring ways to make the labels more effective than they are currently.⁶² In 2016, EU regulations came into force that made standardised food labelling compulsory. These labels must indicate energy, fat, saturated fat, carbohydrate, sugar, protein, and salt content. Changes to US labels will be announced in 2017. Calories will be displayed more prominently and there will be information about added sugar and the link between the food's nutritional content and chronic diseases.⁶³ In addition to structured labels, there are regulations regarding truth in the health and nutrition claims made by the food industry; laws require truth but not full transparency.

Some countries have enacted restrictions on food advertising aimed at children.⁶⁴ Numerous governments, including Slovenia, Norway, Mexico, Chile, and Turkey, have regulations that do not allow advertising of unhealthy foods on radio and television during hours in which children account for a substantial component of the audience. Several countries go so far as to ban food advertising containing well known cartoon characters.⁶⁵

Financial incentives linked to health and wellness objectives for food are controversial.⁶⁶ The concept is to make unhealthy foods more expensive and less affordable than healthier foods. In January, 2014, the Mexican Government implemented an 8% tax on food with an energy content exceeding 275 kilocalories per 100 grams, and a 1 peso (around £0.05) per litre tax on all sugar-sweetened beverages.⁶⁷ The tax was accepted by the public, despite criticism from food manufacturers. Several other countries (among them Ireland, Denmark, Finland, France, and Hungary) have implemented taxes on unhealthy foods. These taxes are politically sensitive and have had mixed success in reducing consumption and changing behaviour. They have, however, caused some manufacturers to reformulate their products and make them healthier to reduce or eliminate the tax.

Healthy food choices are often not available, especially in socioeconomically underserved neighbourhoods.⁵⁶ Governments (usually through agricultural departments) can be instrumental in improving the availability of supermarkets to underserved population groups, and incentivising them to offer healthier food and beverage options. Efforts are also ongoing to incentivise production, distribution, and procurement of food from local farms. Programmes providing subsidies for food to low-income families sometimes restrict purchases of less healthy foods.⁶¹

Government agencies can increase the opportunity for physical activity and reduce sedentary activity by requiring physical education in schools, providing increased access to outdoor recreational facilities, supporting community infrastructure for walking and cycling, changing zoning ordinances to allow schools and places of employment to be within walking distance of residences, and increasing the availability and convenience of public transportation.⁶⁸

The CDC has funded the study of whether mixed-use developments, where shopping and recreational facilities are in the same buildings as, or near, residences, can affect physical activity.⁶³ Attention to traffic safety and crime prevention also encourages exercise and outside activity.⁶⁹

Breastfeeding reduces a child's risk of obesity and lowers the mother's long-term risk of breast cancer.⁷⁰ Some governments encourage breastfeeding by requiring specific areas reserved for breastfeeding mothers in places of employment and in public spaces such as shopping centres. Such provisions allow women the time and private space to express and store breastmilk for later use.

Another important aspect of healthy living is limiting sun exposure, especially sun tanning and sunburn, which causes skin cancer. State-sponsored health education advocates the wise use of sunscreen and minimising sun exposure. Several state and provincial governments in the USA, Canada, and Europe have implemented stringent regulation of indoor sun-tanning facilities. These regulations bar children from using them and require customers to be informed of the cancer risks. In some areas, use of sun beds or tanning salons is taxed in an effort to decrease use.

Clinical preventive interventions

Some clinical interventions to prevent cancer can be sponsored by or mandated by governments. Many infectious agents are carcinogens, including HPV, hepatitis B virus, hepatitis C virus, HIV, and *H pylori*. Infectious diseases are associated with up to 7% of all cancers in Europe, 4% of all cancers in the USA, and 33% of all cancers in sub-Saharan Africa.⁷¹

Effective vaccines to protect against infection with hepatitis B virus (HBV) and HPV are approved for use in the USA and EU, and they have also been adopted by several other countries (table 2).^{72,73} After the European Agency for the Evaluation of Medicinal Products approves a vaccine, the national immunisation programme of each EU country must adopt it for it to be distributed. In the USA, the FDA approves vaccines for safety and efficacy and the CDC Advisory Committee on Immunization Practices reviews the data and recommends the use of a vaccine and the population in which it should be used.

HBV is a major cause of hepatocellular carcinoma and is highly prevalent in southeast Asia. The HBV vaccine was introduced in the USA in 1981.⁷⁴ A few years later, the Taiwanese Government approved the use of the vaccine and launched an effective nationwide vaccination programme in 1984. This programme initially targeted neonates of HBV-infected mothers, but was expanded over 6 years to include the entire population including adults.⁷⁵ A decade after the programme began in children, the proportion of seropositivity for hepatitis B surface antigen in children was reduced from 10% to less than 1%, and this decline was correlated with a reduction in the incidence of childhood hepatocellular carcinoma.⁷⁶ The hepatitis B vaccine is very safe and effective, and there is a very high prevalence of vaccine use; most countries now require it be administered to infants (ie, before age 12 months).⁷⁷

The HPV vaccine has the potential to prevent cervical cancer and five other types of cancer, including cancers of the tonsil, oropharynx, anus, penis, and vulva.⁷⁸ The first HPV vaccine was developed through a collaboration with university researchers in Australia and the USA working with scientists employed by the US National Cancer Institute, a federal government agency. The FDA approved the first HPV vaccine in early 2006. Within a year, regulatory agencies of more than 80 countries

approved this vaccine. Today, several HPV vaccines are available and each new generation of vaccine protects against more types of the HPV virus.

Most European governments have introduced the HPV vaccine; some require it, others recommend it. Most governments pay for the vaccine when it is administered

	Year of introduction	Sex	Target age (years)	Financing by national health authorities	Policy
Austria	2006	M, F	10–12	100%	Vaccination through private sector only
Belgium	2007	F	10–13	75%	Vaccination through private sector only
Croatia	2016	M, F	12	100%	Voluntary immunisation for women who are not yet sexually active
Denmark	2009	F	12	100%	Part of the Danish Childhood Vaccination programme
France	2007	F	14–23	65%	Voluntary immunisation for women who are not yet sexually active; vaccination through private sector only
Germany	2007	F	12–14	100%	Vaccination through private sector only
Greece	2007	F	12–26	100%	Mandatory for all girls entering 7th grade (ie, aged 12–13); vaccination through private sector only
Hungary	2014	F	12–14	100%	..
Iceland	2011	F	12	100%	Vaccination through public health and school infrastructure
Ireland	2008	F	12–13	100%	..
Italy	2007	F	12		..
Latvia	2009	F	12	100%	..
Luxembourg	2008	F	12	100%	Vaccination through public health and school infrastructure
Macedonia	2009	F	12	100%	Mandatory; part of the national immunisation programme
Netherlands	2009	F	12–13	100%	..
Norway	2009	F	12–13	100%	Part of the national immunisation programme
Portugal	2007	F	13	100%	Vaccination through public health and school infrastructure
Romania	2008	F	10–11	100%	Vaccination through public health and school infrastructure
Slovenia	2009	F	11–12	100%	Vaccination through public health and school infrastructure
Spain	2007	F	11–14	100%	Vaccination through public health and school infrastructure
Sweden	2010	F	10–12	100%	Vaccination through public health and school infrastructure
Switzerland	2008	F	11–14	100%	Vaccination through public health and school infrastructure
UK	2008	M, F	9–15 (boys) 9–26 (girls and women)	100% for women and girls only	..

M=male (boys and men). F=female (girls and women). Data from the European Centre for Disease Prevention and Control (ECDC), 2012.⁷³

Table 2: Financing and policy of human papillomavirus vaccine programmes in Europe, by country

	Cancer registry	Vital registration
North America	95%	100%
Latin America	8%	28%
Europe	42%	18%
Africa	2%	0%
Asia	6%	3%
Oceania	78%	74%

Data from The Cancer Atlas.⁹⁰

Table 3: Proportion of population (%) covered by cancer registry and complete vital registration of death, by world region

to girls aged between 10 and 13 years. Governmental committees in the UK and Austria have recommended giving the HPV vaccine to boys and girls (table 2).

The CDC has recommended HPV vaccination for girls since 2006 and for boys since 2011, but in the USA, few states have adopted this recommendation for HPV as a required vaccination. Convincing parents to vaccinate their children has been difficult because of suspicions regarding vaccine safety and fear that vaccination is equivalent to giving permission to engage in sexual promiscuity. As of 2010, the ACA requires American insurance companies to reimburse HPV vaccination costs; cost is an issue for the uninsured.

Several African countries offer the HPV vaccine to citizens with support from the Global Alliance for Vaccines and Immunization (GAVI).⁷⁹ GAVI is a public-private partnership that works with governments to make vaccines available and affordable. Not all countries participate in GAVI programmes, and the vaccine is not available or is unaffordable in a number of low-income countries. In Japan, the HPV vaccine became available in 2010. It was fully financed by national health authorities. Unfortunately, use of the vaccine was suspended in 2013 because of fears of adverse reactions.⁸⁰

No vaccine yet exists to prevent hepatitis C infection, but the infection can be treated and in many instances cured with drug therapy.⁸¹ Cure of hepatitis C can prevent the development of hepatocellular cancer and some lymphomas. Some countries have implemented screening programmes to diagnose hepatitis C and begin early treatment.^{82,83} Other countries encourage people born between 1945 and 1965 to get screened for the virus.⁸⁴ Common features of many surveillance systems include passive case finding and the reporting of both acute and chronic HBV and hepatitis C virus infections. Many governments sponsor public health programmes to encourage behaviours that will prevent the spread of hepatitis C, including blood and body fluid protection regulations for health-care workers and public service announcements advocating responsible sex practices. These behaviours also prevent the spread of HBV and HIV. HIV has been linked to several cancers, particularly lymphoma and Kaposi's sarcoma.

Gastric cancer is the third leading cause of cancer death worldwide. *H pylori* infection causes 80% of the 1 million cases of gastric cancer that occur every year worldwide, and it is an especially large problem in Asia. Treatment of this infection reduces the risk of gastric cancer. A few public health programmes exist in Asian countries with a very high prevalence of the disease that advocate screening for and treating *H pylori* infection.⁸⁵ More efficient food storage might decrease the prevalence of *H pylori* infection rates.

Cancer screening to prevent cervical and colon cancer

Colon and cervical cancers are preceded by precancerous lesions. Cancer can be prevented when these lesions are diagnosed and removed. Well designed trials have shown a benefit for colon screening of the normal risk adult population, beginning at age 50 years.⁸⁶ Effective screening most commonly consists of stool blood testing, sigmoidoscopy, or colonoscopy. Cervical screening is focused on women beginning in their late teens or early 20s.⁸⁷ For 60 years, effective cervical screening used the Pap smear. Over the past 15 years, testing for HPV infection and visual inspection of the cervix with acetic acid has also proven effective.

Organised screening programmes are resource intensive. Health services must be adequately developed to ensure that all individuals who have a positive result at screening can receive adequate diagnostic evaluation, treatment, and follow-up. Several governments, including Australia, Finland, and the UK, have implemented national screening programmes for cervical and colon cancers with systematic contact, follow-up, and recall of people in target populations. These programmes are more effective at reducing colon and cervical cancer burden compared with opportunistic screening.⁸⁸

The ACA provides health insurance to a large proportion of Americans. It mandates that health insurance companies must provide patients with specific screening tests without out-of-pocket costs (deductibles or copayments). This approach has resulted in an increased number of Americans receiving cervical and colon cancer screening.⁸⁹

Surveillance and monitoring of public health interventions

Reliable monitoring and surveillance of the cancer burden are essential for cancer control planning.¹ Population-based cancer registries generate data that are used to assess cancer incidence, mortality, survival rates, and trends in a defined area, which might be a province or an entire country. The registry needs a comprehensive and good census to define the underlying population. In some countries, the government runs these registries; in others, universities or hospitals run registries, often with government funding. An estimated 290 functioning cancer registries exist in 68 countries (table 3).⁹⁰

Search strategy and selection criteria

I searched PubMed, MEDLINE, and LexisNexis for articles published between Jan 1, 2005, and Aug 1, 2016, using the following words and phrases: "tobacco control" or "tobacco cessation" and "regulation" or "government"; "nutrition" or "food" and "community" or "environment" or "policy"; "obesity" or "overweight" and "government"; "physical activity" or "exercise" and "community" or "environment" or "policy" and "obesity" or "overweight" or "chronic disease" or "cancer" and "government"; "infection" or "vaccine" and "government"; "screening" or "cancer prevention" and "government". I also searched for reviews with the keywords "cancer prevention" or "cancer control" or "cancer prevention and control", published between Jan 1, 2011, and Aug 1, 2016. Papers describing programmes and interventions to reduce cancer incidence were assessed. Additionally, the reference lists of articles identified by this search strategy were reviewed, and relevant articles selected for reading. Although the published literature is very much centred on the USA and the European Union, the principles are widely applicable to many other countries.

Several governments sponsor questionnaires regarding health status and health habits. These surveys aim to assess a nationally representative sample of the population and they permit assessment of public health interventions and describe changes in health habits. The European Health Interview Survey was first done in EU states between 2006 and 2009, and there are plans for health ministries of each country to conduct the survey every 5 years. The survey asks members of randomly selected households a number of questions related to cancer risk, including height and weight (to calculate body-mass index), habits regarding physical activity, dietary habits such as the consumption of fruits and vegetables, and alcohol consumption and smoking behaviour. The US Government has a similar annual National Health Interview Survey that began in the late 1950s.

Registry work is complicated and difficult. It requires information to be gathered from several different sources, and the accuracy of published data varies. For a registry to function, laws and regulations must be in place to allow the collection of demographic and clinical data. Thus, quality of data varies among registries. Vital registration to determine death rates and the cause of death is also important. Cancer death rates are often extracted using death certificate data, when available. In some countries, especially those in South America and Africa, cancer incidence can only be estimated from an analysis of death rates.

Conclusion

The key to cancer prevention is for the individual to engage in and adopt healthy lifestyle habits. Behavioural activities, such as eating a proper diet, both in types and

amounts of food, engaging in appropriate exercise and physical activity, and receiving appropriate clinical interventions to prevent cancer, are important. Being healthy also involves avoiding known causes of cancer, including tobacco and alcohol, and careful management of exposure to other carcinogens. When discussing healthy habits, phrases such as individual choice or personal responsibility are often a focus. Tobacco, alcohol, and food manufacturers use marketing to promote use of their products and create an environment of consumption. This Series paper gives examples of many agencies and departments of governments that use advertising, social marketing, education, regulation, and law to create an environment more conducive to people making healthy choices and adopting healthy habits.

Declaration of interests

I declare no competing interests.

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