

CANCER CONTROL

PRIMARY PREVENTION

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A. INTRODUCTION

Primary prevention strategies aim to reduce the risk of disease in the general population. Over the past several decades, the increasing burden of chronic disease has led to an increased emphasis on primary prevention to modify the prevalence of risk factors for chronic conditions.

Primary prevention efforts have tended to focus on changing attitudes, knowledge, beliefs and behaviours at the individual level. Current approaches emphasize the social, physical, economic and environmental determinants of risk-related decisions. A comprehensive strategy for primary cancer prevention includes a population-based approach to changing the prevalence of major lifestyle-associated risks for cancer. Jurisdictions may adopt or adapt the best evidence-based interventions that are suitable to their local circumstances.

While largely the responsibility of public health, primary prevention is most effective when many groups with vested interests come together for change. Effective primary prevention requires multi-sectoral and multi-level collaboration. The World Cancer Research Fund's policy for Food, Nutrition and Physical Activity identifies nine important actors: i) multinational bodies; ii) civil society organizations; iii) government; iv) industry; v) media; vi) schools; vii) workplaces and institutions; viii) health and other professionals; and ix) individual people who make up a society.¹

This chapter reviews major cancer risk factors and suggests primary prevention interventions to reduce the burden of risk for each.

B. OVERVIEW OF CANCER RISK FACTORS

Exposure to cancer risk factors can greatly increase the chance of developing cancer. Table 1 summarizes the association between exposure to risk factors and the risk of developing a range of cancers.

Table 1: Association Between Selected Exposures and Risk of Cancer^{2,3}

Exposure		Associated with an increased risk of cancers:	
Tobacco	Active smoking	↑oral cavity ↑pharynx ↑nasopharynx ↑nasal cavity and paranasal sinuses ↑esophagus ↑stomach ↑colon and rectum ↑liver ↑pancreas	↑larynx ↑lung ↑uterine cervix ↑ovary ↑kidney ↑bladder and organs of the urinary tract (including ureter) ↑bone marrow (myeloid leukemia)
	Second-hand smoke	↑lung	
	Parent to child	↑hepatoblastoma	↑leukemia
Diet and Metabolic Factors	Abdominal adiposity	↑colon and rectum ↑pancreas	↑endometrium ↑breast
	Overweight/obesity	↑esophagus ↑kidney ↑pancreas	↑colon and rectum ↑endometrium ↑breast
	Dietary fibre	↓colon and rectum	
	Fruits and vegetables	↓oral cavity ↓pharynx ↓larynx ↓esophagus	↓lung ↓stomach ↓prostate
	Processed and red meat	↓colon and rectum	
	Salt, salted and salty foods	↑stomach	
	Physical activity	↓colon and rectum ↓post-menopausal breast	↓endometrium
Alcohol		↑oral cavity ↑pharynx ↑esophagus	↑colon and rectum ↑larynx ↑liver
Infection	Human Papillomavirus (HPV)	↑cervix ↑oral cavity	↑pharynx ↑cancers of the anogenital tract
	Hepatitis B Virus	↑liver	
	Hepatitis C Virus	↑liver	↑Non-Hodgkin's Lymphoma
	Helicobacter Pylori	↑stomach	
Environmental and Occupational Factors	Workplace carcinogens	↑lung ↑mesothelioma	↑leukemia ↑bladder

1. KEY RESOURCES

- *Cancer Risk Factors in Ontario: Evidence Summary*, a report prepared by Cancer Care Ontario in 2013, reviews the epidemiologic evidence linking a broad range of risk factors to various types of cancer.²
- The International Agency for Research on Cancer *Monographs* identify environmental factors that can increase the risk of human cancer. These include chemicals, complex mixtures, occupational exposures, physical agents, biological agents and lifestyle factors. National health agencies can use this information as scientific support for their actions to prevent exposure to potential carcinogens.⁴
- *Taking Action to Prevent Chronic Disease: Recommendations for a Healthier Ontario*, a report prepared by Cancer Care Ontario and Public Health Ontario, identifies policy-based interventions and system-wide changes to address four risk factors associated with chronic disease (i.e., alcohol, healthy eating, physical activity, tobacco), and provides overarching recommendations for a co-ordinated approach to chronic disease prevention.⁵
- The 2011 High Level Meeting on Prevention and Control of Non-communicable Diseases, organized by the United Nations, and which addressed the prevention and control of non-communicable diseases worldwide.⁶

C. TOBACCO

Tobacco use is the single greatest avoidable risk factor for cancer mortality worldwide, and is estimated to cause between 15 and 40 per cent of cancer deaths.^{7,8}

Tobacco smoke is composed of hundreds of chemicals, several of which are lethal carcinogens. Although tobacco exposure is most intense in active smokers, the detrimental health effects of tobacco also impact non-smokers through second-hand smoke and parent-to-child exposure during pre-conception and pregnancy.

Consumption of tobacco without burning – through products such as chewing tobacco or snuff, which are placed in the mouth or are sucked (dipped), chewed, gargled, applied to the gums or teeth, or inhaled through the nasal passages – can also cause cancer, as per Table 1 above.^{9,10}

A comprehensive tobacco control strategy and policy should have three essential aims; these are described below, along with suggestions, examples and resources that may be adopted or adapted to local circumstances.¹¹ The aims may require action in a range of priority areas, including lobbying, demand reduction, second-hand smoke, regulation of ingredients, packaging and labelling, public awareness, advertising, cessation programs, illicit trade, sales to minors and research. Effective tobacco control actions engage stakeholders in multiple sectors (e.g., public, private, advocacy, public), target multiple levels (i.e., local, regional, national), and focus broadly on individual tobacco users, tobacco providers and society at large.

The success of tobacco control strategies can be measured in the short term (e.g., cigarette consumption per capita, prevalence of smoking, intensity of smoking). Due to the long latency of cancer, however, the effect of interventions on cancer may not be evident for 10 to 20 years, which can prove challenging for monitoring and evaluation.¹²

Exposure to Second-Hand Smoke

National cancer control programs and tobacco strategies should aim to have 100 per cent smoke-free environments at workplaces and in public spaces.¹³ As the World Health Organization Framework Convention on Tobacco Control (Article 8) outlines, approaches “including ventilation, air filtration and the use of designated smoking areas (whether with separate ventilation systems or not), have repeatedly been shown to be ineffective and there is conclusive evidence, scientific and otherwise, that engineering approaches do not protect against exposure to tobacco smoke”.¹⁴

Simple, clear and enforceable legislation is necessary to protect people from exposure to second-hand smoke.¹⁴ The public should be active partners in developing, implementing and enforcing legislation. An example is the Smoke-Free Ontario Act (Canada), which prohibits smoking in enclosed public places, all enclosed workplaces, and in motor vehicles when children under 16 years of age are present. The act also eliminates designated smoking rooms in restaurants and bars, protects home healthcare service workers from second-hand smoke in private residences, and prohibits smoking on patios that have food and beverage service if they are either partially or completely covered by a roof.¹⁵

Successful implementation and enforcement of smoke-free legislation requires thorough planning, adequate resources, and monitoring and evaluation programs to assess the legislation's success and to respond to tobacco industry activities that undermine the legislation.¹⁴ If smoke-free legislation already exists, it may be refined and expanded to protect more people more fully from second-hand smoke.

Pro-Tobacco Influences

Three strategies are important to counter pro-tobacco influences, as described below.¹⁶

Control the Relationships Between the Public, Government and Tobacco Industry

A positive public-government relationship is key to tobacco control. The social norm approach aims to get societal backing for tobacco control measures by focusing on the smoker and changing the view of cigarette smoking in larger society.¹⁷ With regard to the government-tobacco industry relationship, public health policies for tobacco control should be protected from "commercial and other vested interests of the tobacco industry in accordance with national law".¹⁴ Implementation guidelines can stipulate when it is appropriate for lawmakers to meet with the tobacco industry, and suggest tight control over political campaign contributions from the tobacco industry. With regard to the public-tobacco industry relationship, anti-industry messages can cause smokers to become angry and rebel against the tobacco industry's use of nicotine addiction and manipulative advertising, making them more likely to consider quitting.^{17,18}

Regulate and Reduce Pro-Tobacco Marketing

Tobacco marketing reaches a broad audience through tobacco advertising, promotion and sponsorship of events, and packaging. Regulating, reducing or eliminating tobacco marketing can help reduce pro-tobacco influences and control the relationship between the public and the tobacco industry. Successful regulation of tobacco marketing has occurred in many jurisdictions. For example, after legislation to control tobacco marketing was enacted in Brazil, the prevalence of smoking amongst adults dropped from 35 per cent in 1989 to 22 per cent in 2003. In the later part of this time period, legal restrictions were placed on advertising tobacco products, sponsorship and merchandising relating to cultural and sports events was prohibited, and health warnings with images were required on cigarette packaging.^{12,19,20} Another example is the Smoke-Free Ontario Act in Ontario, which bans the public display of tobacco products at the point of purchase and prevents the promotion of tobacco products in entertainment venues.¹⁵ Ongoing evaluation and monitoring of requirements is an important component of any regulatory program.

Use Taxation to Counter the Price-Lowering Effects of Tobacco Subsidies

Several national cancer control plans in the European Union include increased taxes on cigarettes. Examples of goals are: "increase duty on cigarettes each year above the rate of inflation"; "set tobacco levies as high as possible within the tax policy framework"; and "increase duty by at least 50 cents every two years".²¹

In the United States, California faced challenges and realized positive outcomes when it introduced a tobacco tax in 1988.¹¹ The proceeds from the tax were used to support public health programs to reduce tobacco use, provide healthcare services, fund tobacco-related research and protect environmental resources. Programs were delivered through competitive grant projects and local health departments, and resulted in multiple partnerships that improved the spread of programs into a wide range of communities. The program made California a United States leader in tobacco control and significantly reduced smoking-attributable mortality in the state.^{11,12,17}

Public Education and Cessation Support

The risk of smokers getting sick and dying is significantly reduced after smoking cessation.²² The Canadian Cancer Society provides a comprehensive national public education and smoking cessation program. The multi-pronged Smokers' Helpline program includes the following:²³

- A website that provides a suite of programs, including a calculator tool to estimate the money saved by quitting, an online quit program and an online quit community.
- Telephone-based services, including a telephone helpline, where individuals can speak with a quit coach, build a quit plan and receive one-on-one guidance.
- Text messaging, with interactive support, scheduled reminder messages and help to cope with cravings.

Successful education and support must recognize the diversity of the population. Marginalized populations that have been historically exploited by tobacco companies are often not reached by health promotion programs. Special effort should be made to include these groups in tobacco control programming. In addition, culturally-specific tobacco cessation and education programs may be necessary for certain subsets of the population. In Ontario, for example, the Aboriginal Tobacco Program recognizes the traditional and sacred relationship between the community and tobacco. It aims to create "tobacco-wise" (rather than tobacco-free) communities, where tobacco is honoured as a sacred plant while also recognized for its harmful effects in cigarettes.²⁴

2. KEY RESOURCES

- The International Agency for Research on Cancer's *Monographs* summarize the scientific evidence on the association between tobacco smoke and cancer in volumes 89 and 83.²⁵
- The World Health Organization Framework Convention on Tobacco Control is an international treaty seeking to protect present and future generations from the devastating health, social, environmental and economic consequences of tobacco consumption and exposure to tobacco smoke. The framework is an important resource for tobacco control planners and is supported with seven guidelines to aid in implementation.¹⁴

D. METABOLIC FACTORS

Metabolic factors include obesity and body composition, diet and physical activity, all of which are interrelated. Diet and physical activity are independently associated with cancer risk and are also major determinants of body composition and obesity, another risk factor for cancer.²⁶ Evidence-based policies that promote a healthy diet, exercise and maintaining a healthy body weight help prevent cancer, and chronic disease generally.

3. OBESITY AND BODY COMPOSITION

The obesity epidemic is fundamentally due to sedentary lifestyles and the consumption of high-fat, energy-dense diets.²⁷ Greater body fatness increases the risk of a range of cancers, as noted in Table 1. Body fatness tends to be measured using the body mass index (BMI), a measure of weight adjusted for height. The World Health Organization provides general cut-offs for overweight and obesity.²⁷ In addition to general BMI cut-offs, ethnic-specific cut-offs have been developed to acknowledge the fact that fat distribution around the body varies by ethnic group. Two people with the same BMI will have different disease risks based on their fat distribution.²⁸ There is also a positive dose-response relationship between body fatness and the risk of cancer, even within the "healthy" weight range.^{29,30}

Improved nutrition, healthy eating and increased physical activity are key interventions to prevent obesity.

4. DIET

Diet is the dynamic, complex collection of the food one consumes. The long latency of cancer and the difficulties associated with measuring diet and discerning its effects from other factors makes the relationship between diet and cancer challenging to study. Regardless, there is sufficient evidence to suggest that four major food categories are associated with cancer risk: dietary fibre, vegetables and fruits, red and processed meats, and salt. Consumption of dietary fibre and vegetables – and, to a lesser extent, fruits – appears to have a protective effect against cancer. Conversely, the consumption of red and processed meats, salt, and salted or salty foods appear to increase the risk of disease. As noted earlier, high-fat and energy-dense diets also result in increased cancer risk through overweight and obesity. While individual nutrients likely play a role in modifying cancer risk, the relationship between nutrients and cancer risk is hard to determine since people consume whole foods rather than nutrients, with the exception of dietary supplements. A food-based approach is presented here, which aligns with the Diet and Cancer Report.²⁶

Strategies to improve nutrition must take into account food security, healthy eating and sustainable food systems.³¹ Interventions aimed at changing diet at the individual level are unlikely to have long-term, sustainable results unless they are paired with population-level strategies. These must be developed through the partnership of multiple sectors and include appropriate government policy levels.

The agency or arm of government responsible for cancer control may have the greatest impact on improving diet by advocating for, collaborating on and supporting a food and nutrition strategy to guide action, influence decisions and provide resources to support healthy eating policies. This strategy should acknowledge the interconnectedness of agriculture, food, health, culture, social and economic development.³² Potential areas for action in such a strategy include the following:

- Compulsory food skills in school curricula.^{1,31}
- Mandatory nutritional information labelling for packaged food and fast food retailers, which allows consumers to make healthier food choices and encourages restaurants to make healthier offerings.³¹
- Restrictions on advertising and marketing of fast food and other processed and sugary foods to children on television, in other media and in supermarkets.¹
- Healthy eating policies and practices in publicly-funded institutions, such as universities, hospitals and recreation centres, and a requirement that schools provide meals that meet high nutritional standards.^{1, 31}

5. PHYSICAL ACTIVITY

Both physical inactivity and sedentary behaviour pose a risk to health. In contrast, being physically active reduces the risk of cancer independent of body fatness.²⁹

The best interventions to improve physical activity will depend on the setting, available infrastructure, and the values and opinions of stakeholders and the population. Public health research on promising interventions is focused on school-based programs and active transportation, enabled by policy and the built environment. Physical activity can also be encouraged in the workplace, through mass media campaigns and in primary care settings. Each of these is described briefly.

School-Based Programs

School-based programs have repeatedly been proven effective.³³ They are cost-effective, since they usually use existing infrastructure and can be delivered by teachers. These programs also help form healthy habits, since participating in physical education in childhood and adolescence is one of the best predictors of physical activity into adulthood.³⁴ A recent Cochrane review of school-based physical activity programs in children and adolescents six to 18 years of age found good evidence that these programs are effective at increasing the duration of physical activity, improving respiratory fitness, reducing blood cholesterol and reducing time spent watching television.³⁵

School-based physical activity programs can be implemented in various ways. In Ontario, for example, elementary school children are required to have a minimum of twenty minutes of sustained moderate to vigorous physical activity each school day, during instructional time.³⁶ Other examples of successful school-based programs include the Coordinated Approach to Health (CATCH) program in the United States, the Pathways program for reducing obesity in Indigenous Americans, and Know Your Body in Crete.^{37,38,39} Ideally, school-based programs or physical activity requirements should include high school-aged children and young adults, since physical activity declines as children grow into young adulthood.⁴⁰

Active Transportation

Active transportation includes walking, cycling and any other non-motorized transport. At the population level, regions that have higher levels of active transportation also have lower obesity rates.⁴¹ On average, for each hour spent in a car per day the likelihood of obesity increases six per cent, while each kilometre walked daily is associated with a 4.8 per cent reduction in the likelihood of obesity.⁴² Transportation policy and infrastructure to encourage active transportation include convenient networks for pedestrians and cyclists that are well lit, connected, have safe road crossings and are accessible to public transport. In Bogota, Columbia, for example, a major initiative to improve the bicycle infrastructure – Ciclovía – increased active transportation by residents and reduced the proportion of commuters traveling by car from 17 per cent to 12 per cent.⁴³

Increasing space for recreational activity also reduces barriers to physical activity. Simple interventions, such as point-of-decision prompts about the health benefits of taking the stairs rather than an escalator, are effective.³³

Workplace Programs

In the workplace, sedentary behaviour is common. Health and wellness interventions can not only improve health, but also employee morale. Worksite nutrition and exercise programs have demonstrated a positive effect on employee weight outcomes.⁴⁴ Johnson & Johnson's health and wellness program can serve as a model for others.⁴⁵

Mass Media Campaigns

Mass media campaigns promoting physical activity are successful when they are paired with community-based, supportive activities, and when they are associated with policies that address local barriers to participating in physical activity.³³ The Agita Sao Paulo mass media campaign in Brazil promoted existing physical activity programs and sports and recreational centres to residents of the province. The proportion of active or very active individuals increased by 10.2 per cent as a result of the campaign.⁴⁶ The long-term effects and clinical outcomes of mass media campaigns are somewhat unknown.³³

Primary Care

Primary care can be an effective point of contact to improve physical activity. Interventions that include a brief goal-setting session, a health risk appraisal with a healthcare professional, and a follow-up consultation with an expert in physical activity have effectively increased physical activity.³³ In New Zealand, physicians can provide their patients with a Green Prescription, which refers them for a physical activity consultation at a local recreation centre. This program is cost-effective and has been effective at changing physical activity behaviour and self-reported quality of life.⁴⁷ While primary care is not strictly a primary prevention strategy, evolving the medical culture to provide preventative care could have major positive results.

6. KEY RESOURCES

- The World Cancer Research Fund and the American Institute for Cancer Research Institute's *Food, Nutrition, Physical Activity and the Prevention of Cancer*²⁶

E. ALCOHOL

Alcohol is carcinogenic to humans.⁴⁸ Although light to moderate alcohol consumption has a mildly protective effect on cardiovascular disease, there is no safe amount of alcohol in relation to cancer.^{48,49} The risk of cancer increases with two or more drinks per day and increases as more alcohol is consumed. The negative effects of drinking are amplified in those who smoke.⁹

Interventions to reduce alcohol consumption depend on existing alcohol policies in individual settings and require collaboration with institutions that regulate alcohol availability, sales and pricing. Four potential areas for policy intervention related to alcohol are described below. The first three areas require legislative action by government as well as lobbying by cancer organizations and other groups with a vested interest in alcohol control.

Socially-Responsible Pricing

Similar to tobacco, pricing and taxation are the strongest policies to counteract pro-alcohol influences.⁵⁰ Alcohol taxes can generate revenue – ideally for health and public health programs – and reduce alcohol-related harm.⁵¹ Socially-responsible pricing interventions can include: i) establishing minimum pricing per standard drink across all alcoholic beverages, indexed to inflation; ii) maintaining average prices at or above the consumer price index; and iii) adopting disincentive pricing policies for higher alcoholic content beverages. These interventions have been linked to reduced alcohol consumption per capita and decreases in chronic disease associated with alcohol use.⁵¹

Alcohol Availability

Reducing the times and places alcohol can be purchased increases the physical effort needed to obtain alcohol, which reduces demand, consumption and, subsequently, the health-related problems associated with drinking.⁵¹ Alcohol availability can be reduced by restricting the hours and days of sale at outlets selling and serving alcohol, including special events. Stabilizing or reducing the density of on- and off-premises alcohol outlets per capita also limits availability. Government-run retailing systems and monopolies, rather than private off-premises alcohol retail sales, enables government to limit the number of sales outlets, restrict hours of sale, and remove the profit motive for increasing sales. Limiting alcohol availability has proven to be cost-effective.⁵¹

Alcohol Marketing and Promotion

Marketing and promotion of alcohol can reinforce pro-drinking attitudes, increase the likelihood of heavy drinking, predispose minors to drink before the legal age, and promote and reinforce drinking as a positive, glamorous and relatively risk-free activity.⁵¹ Restricting the frequency and breadth of alcohol advertising, especially as a glamorous and successful lifestyle choice, can influence cultural norms around alcohol and decrease the prevalence of underage drinking.⁵¹

Despite good intentions, school-based and public education strategies have been unable to counter well-financed pro-alcohol marketing. Even educational programs that have shown initial promise have not demonstrated sustainable results with long-term follow-up.⁵¹

Access to Brief Interventions

One-on-one counselling in a medical setting for high-risk drinkers is effective for reducing alcohol consumption and alcohol-related problems.^{52,53} Counselling interventions usually include behavioural treatment delivered in one to three sessions. These interventions could be promoted to physicians and be part of medical training.

7. KEY RESOURCES

- *Alcohol: No Ordinary Commodity*⁵¹

F. INFECTION

About one in 14 cancers are attributable to infection in high-income countries, whereas infections explain nearly a quarter of all cancers in developing countries.

The viruses that account for the majority of infection-related cancers are human papillomavirus (HPV), hepatitis B virus (HBV), hepatitis C virus, and *Helicobacter pylori*.⁵⁴

A substantial number of other infections have been associated with increased cancer risk including:⁵⁴

- Human immunodeficiency virus, type 1 (HIV-1)
- Epstein-Barr virus (EBV)
- Human herpesvirus 8 (HHV-8, a.k.a. Kaposi's sarcoma-associated herpesvirus [KSHV])
- Human T-cell lymphotropic virus, type 1 (HTLV-1)
- *Opisthorchis viverrini*
- *Clonorchis sinensis*
- *Schistosoma haematobium*

Vaccines are an important tool for the primary prevention of infections. Screening and treatment of infections can also reduce cancer risk.

The HBV and HPV vaccines are currently the most promising interventions available to remove the risks associated with exposure to these viruses and reduce the incidence of liver and cervical cancer respectively.⁵⁵ Other strategies can complement vaccination programs, such as treating *H. Pylori* or aiming to reduce the transmission of infection through sexual activity and tattoo and piercing salons.

HBV Vaccination

It has been estimated that childhood administration of the HBV vaccine could reduce the global burden of liver cancer by 60 per cent.⁵⁶ Countries that are not already doing so should aim to launch or expand programs for HBV vaccination in infants and high-risk populations. A pentavalent vaccine – which also provides protection against diphtheria, tetanus, pertussis and *Haemophilus influenza* type B – is likely the most cost-effective approach.

A successful HBV vaccination program begins with a reduction in infection. In China, for example, nearly 10 per cent of the population were chronic carriers of HBV. Following increased vaccination coverage supported by the Gavi vaccine alliance, less than one per cent of children under five are chronic HBV carriers.⁵⁷ Over the longer-term, this will reduce the risk of liver cancer in the population.

HPV Vaccination

The World Health Organization has endorsed administering the HPV vaccine to adolescent girls, ideally before the onset of sexual activity.⁵⁸ HPV vaccination programs should not detract from screening programs, since the vaccine only covers two or four strains of the virus and does not entirely protect women who have been infected.⁵⁹ Screening may eventually need to occur less frequently. Women with an HPV-related lesion should not be excluded from vaccination programs if they meet the eligibility criteria, since a vaccination may protect them from further infection.⁶⁰

The extent to which universal HPV vaccination is a priority depends on the prevalence of HPV, the incidence of cervical cancer, the affordability of the vaccine and the infrastructure available for vaccine administration in any given setting.⁵⁸ In Qatar, for example, where there is a relatively low incidence of cervical cancer, the vaccine will initially be offered to those who want it voluntarily, but will eventually be integrated into routine vaccination programs.⁶¹

To help address the cost barriers of the vaccine, low-income countries can take advantage of special pricing offered through the Gavi alliance.⁵⁷ Higher-income countries can take advantage of tiered prices. The reduced vaccination schedule of two, rather than three, doses for those less than 15 years of age may reduce vaccination costs.^{55,62} Cultural barriers may be overcome through effective and culturally-specific health education strategies that market the vaccine as an intervention for cervical cancer, rather than for a sexually transmitted infection.⁵⁵

8. KEY RESOURCES

- The International Agency for Research on Cancer's *Monographs* summarize the scientific evidence for the association between biological agents and cancer in volume 100.⁹
- The International Agency for Research on Cancer's *Global burden of cancers attributable to infections in 2008* estimated the proportion of cancers worldwide attributable to infection.⁵⁴

G. ENVIRONMENTAL AND OCCUPATIONAL FACTORS

Exposure to certain substances present in the environment can increase the risk of cancer. These substances – or “exposures” – can exert harmful effects through direct contact with an individual, such as being absorbed by the skin or other body tissues, or inhaled. The level of cancer risk associated with exposure depends on the extent of exposure (i.e., time and intensity), the correlation between the exposure and cancer, other risk factors, and a person's individual susceptibility.

Environmental exposure – which includes harmful agents in the air, water or soil – can occur in the workplace, at home or outdoors. Occupational exposures occur in the workplace due to the presence of carcinogenic substances. Recently, shift work – work that is outside normal hours and during the night – has also been recognized as a potential cancer risk factor.⁶³

9. THE ROLE OF GOVERNMENT AND EMPLOYERS

Government is responsible for regulatory and policy initiatives to reduce exposure to potentially harmful environmental and occupational substances. Governments can: legislate and impose stringent and enforceable emission controls in transport and point sources; publicly disclose potentially harmful substances in drinking water; monitor radon in communities with higher environmental exposures; make grants available for renovations and upgrades; regulate the domestic and industrial use of pesticides; and many other actions.⁶⁴

Employers should be mandated to educate workers about cancer and cancer-causing agents in the workplace, and eliminate or reduce exposure to carcinogens by removing them from the workplace or changing processes to minimize exposure.⁶⁵

10. KEY RESOURCES

- See the *Cancerpedia: Cancer Control Oversight and Policy* and *Cancerpedia: Licensing, Regulation and Accreditation* chapter for more information about the classification and regulation of carcinogens.

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