Introduction to environmental risk factors for cancer, radiation and occupational exposure to carcinogens

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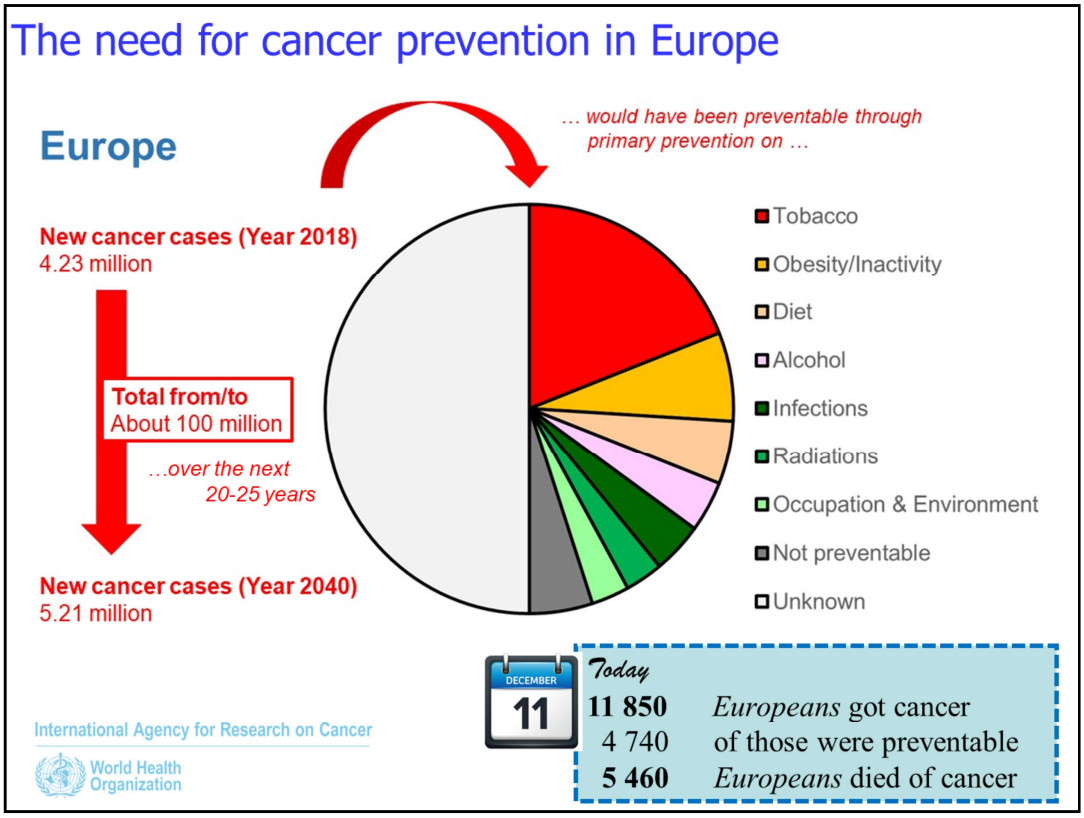


For 2018, for Europe (United Nations definition), the Global Cancer Observatory of the International Agency for Research on Cancer (IARC/WHO) had estimated 4.23 million new cancer patients. The annual number of new cancer patients is projected to increase to 5.21 million by 2040. This means that in the next 20-25 years Europe will face an epidemic of more than 100 million new cancer patients. This is not a worst case scenario but most realistic projection factoring in the prevention and early detection efforts as they are today.

With more rigorous cancer prevention many more cancer cases could be prevented, up to 40% in the long run. From detailed calculations made for France (by IARC/WHO), Germany (by the German Cancer Research Center (DKFZ)) and the UK (by University of Oxford), we estimate that for Europe we have identified about 50% of causes of cancer. Almost half of all avoidable cancers remain due to tobacco use, followed by cancers due to obesity/physical inactivity, unhealthy diet and alcohol consumption. Some cancers are preventable through vaccination against infectious agents, in particular human papillomavirus (HPV) and hepatitis B. Radiations cause 3-4% of cancers, mainly due to excessive sun exposure (ultraviolet (UV) radiation) and radon. Another 3-5% of cancers are attributable to exposures at the workplace or environmental pollutants. For a small proportion causes are known but prevention is not possible (for instance for genetic syndromes, or for cancers due to natural exposures which can be reduced but not fully eliminated).

The fact that 50% of causes of cancer remain unknown enforces the continued need for research into the causes of cancer.

4th Edition European Code Against Cancer

http://cancer-code-europe.iarc.fr/index.php/en/

The European Code against Cancer, with its 4th edition launched in 2014 under the lead of IARC/WHO, gives recommendations to the individual how to reduce their cancer risk. Among those recommendations are those how to protect yourself against ultraviolet (UV) radiation, radon and carcinogens at the workplace. The European Code against Cancer notes that population level prevention measures, for example through respective regulation, are essential components, as some protection measures are beyond the control of the individual.

Preventable cancers from environmental exposures

Exposure	Related cancer burden in Europe	
Occupation	~3-4%	~60 occupational hazards identified to be carcinogenic many specialized so the population cancer risk is low asbestos still responsible for ~50% of occupational cancer Interventions: regulatory frameworks and enforcement of compliance with worker protection Vast majority appears to be preventable
Ultraviolet (UV) radiation	~2-3%	Mainly due to leisure sun-seeking behaviour Avoid sunbed use except if for medical reasons Interventions: Prevention campaigns well defined Cancer burden can be massively reduced but not eliminated
Radon	~1%	Main reason of natural ionizing radiation exposure but exposure differs greatly within and across countries Intervention: Mitigation measures to reduce domestic exposure Cancer burden can be reduced but not eliminated
Medical radiation	~1%	Increased use of diagnostic radiation procedures (imaging) Intervention: dose optimisation, but not possible in emergencies Risk-benefit decision remains with treating physician
Air pollution	~1%	Many particles known to be carcinogenic Today's burden reflects pollution levels of 10-20 years ago Intervention: mostly beyond the control of the individual
Other pollutants/ radiations	Small	Need for more research at low dose levels of exposures Man-made ionizing radiation exposures locally (nuclear accidents)

This table shows the related cancer burden as well as interventions for the scientifically established environmental causes of cancer. At the workplace, around 60 carcinogenic substances or occupations with increased cancer risk have been identified by IARC/WHO, but as many exposures occur in highly specialized occupations of small workforces their contribution to the overall cancer burden is small. Nevertheless, the vast majority appears preventable if regulated accordingly. Asbestos, although banned, remains responsible for almost half of all occupational cancers in Europe. Lung cancer is the most common occupational cancer through inhalation of carcinogens.

Sun-seeking behaviour is the main reasons for too high UV exposure, although a proportion is due to insufficient protection of outdoor workers. Sunbed use should be avoided. Countries like Australia have developed very successful campaigns to reduce the skin cancer burden, but there is room for improvement in Europe. As some sun exposure is important for vitamin D production and outdoor physical activity is beneficial, a good balance between too much and too little sun exposure is important. Naturally occurring radon may accumulate in houses and lead to harmful domestic exposure, causing lung cancer. Radon varies within and across countries but maps are published by most national radiation protection authorities to identify areas of higher radon levels. Interventions are possible to reduce domestic radon levels, although exposure cannot be fully eliminated. Each European receives an annual background ionizing radiation dose from radon and other natural radiation sources. More and better imaging technologies are used for diagnosis of disease, leading to increased radiation (X ray) exposure, especially from computed tomography (CT). Dose optimisation when applying imaging techniques reduces exposure but is difficult to apply in emergency situations when accurate diagnosis is potentially life-saving. This risk-benefit

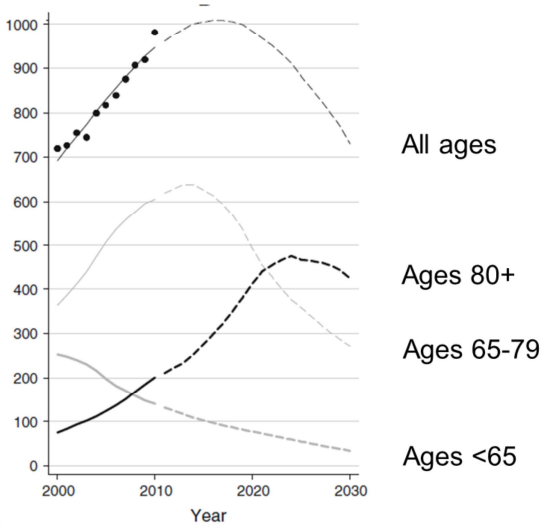
considerations should therefore be made by the treating physician. Many particles in air pollution are scientifically established causes of cancer. Air pollution-related cancer burden in Europe is low compared to regions of the world where indoor burning of solid fuels for cooking and heating is common practice. However, today's cancer burden from air pollution is a reflection of ambient air pollution levels from 10-20 years ago. Contaminants of water and soil, as well as man-made radiation sources related to nuclear power production, are small contributors to the cancer burden. For many chemicals there is however insufficient scientific data of whether and, if yes, at which exposure levels they cause cancer in humans.

Challenges in Primary Prevention of environmental causes of cancer

Challenge #1:
Long duration between exposure and occurrence of cancer
Reversing trends likely to take decades (*see Figure*)

Challenge #2:
Risk at low doses is for many known and suspected carcinogens not well understood
Challenge to invest limited resources for prevention into successful cancer control

Challenge #3:
Risk perception *vs* Scientific evidence



Mesothelioma mortality in former West Germany (indicator of exposure to asbestos)

Schonfeld et al., Cancer Causes Control 2014

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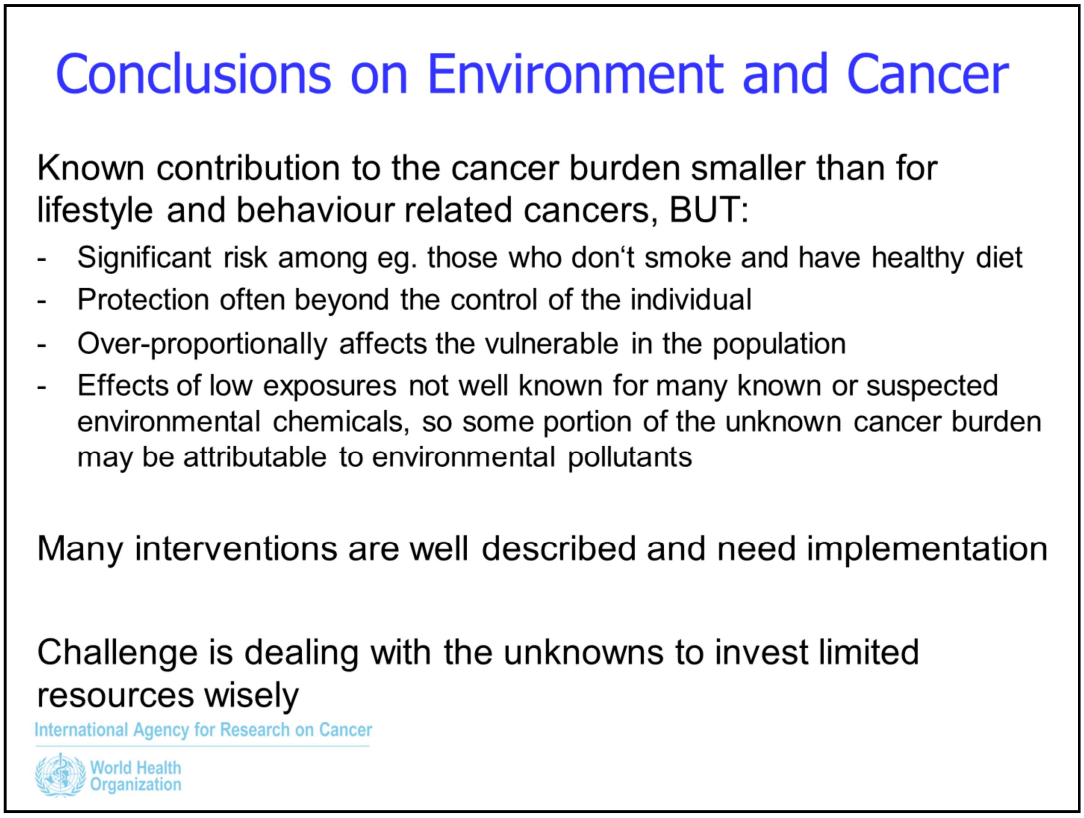
A possible barrier in implementing primary prevention measures is the long duration it takes until the benefits are clearly measurable. Hence, investment today will pay out in the long run, over many decades later. The example shows mesothelioma deaths in West Germany, a cancer virtually entirely due to asbestos exposure, banned in Germany in the early 1990s. So the peak of asbestos-related cancer deaths was only reached almost 30 years later when the increasing trend was reversed. It is therefore the eleventh hour to rigorously implement primary prevention strategies now as it becomes increasingly challenging for future generations.

Another challenge is that the magnitude of risk at low doses for many chemical agents is not known, while it is well established that for most environmental exposures cancer risk increases with increasing dose. For example for pesticides, some of them have been shown to be carcinogenic, in studies of pesticide applicators or farmers who have higher exposures. But their effect at lower doses from exposure to the general population through, for example, traces in diet or drift from agricultural fields or contamination of drinking water is not known. This poses challenges on priority setting in cancer control on factors with less scientific certainty compared to those well described.

Primary prevention against environmental causes of cancer is sometimes also hampered by risk perception, especially when concerns about harms are not in line with the respective scientific evidence, as often in the case of radiation exposures.



Although on population level less cancers are due to environmental factors (including work place exposures and radiations) compared to unhealthy behaviours such as particularly smoking, but also too high body weight/physical inactivity, unhealthy diet or alcohol consumption, there are important reasons to enforce prevention strategies against environmental cancer. First, for people with healthy lifestyle environmental exposures may become their main risk of cancer. Second, protection against environmental contaminants is often beyond the control of the individual and exposures are involuntary. Third, it is often the weakest members of Society who are not able to protect themselves against environmental cancer, including at the workplace. Fourth, the contribution of environmental cancer may be underestimated.

As many interventions to reduce the cancer burden related to environmental cancers are known, those should be implemented along with monitoring of their success. Challenges dealing with the unknowns remain but resources should be invested wisely, driven by science not concerns.