

Cancer prevention: Infection and environment as risk factors

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Infections and environmental factors can be potent cancer risk factors and therefore important areas where cancer prevention can play a vital role. This chapter explains, firstly, how infections such as Hepatitis B and C, HIV, *H pylori* and HPV can lead to specific cancers and how these impact on the Eastern Mediterranean Region. The second part looks at environment risks such as climate change, air pollution, exposure to chemicals and the use of fossil fuels, as well as the impact of radiation. The current situation across the region is assessed and recommendations are put forward for the health authorities involved.

Infections as risk factors for cancer and their prevalence in the EMR

The well-established infectious causes of cancers are *Hepatitis B* (HBV) and *Hepatitis C virus* (HCV) responsible for liver cancer, *Helicobacter pylori* (*H pylori*) bacteria responsible for stomach cancers, *Human immunodeficiency virus* (HIV) responsible for Kaposi sarcoma, non-Hodgkin lymphoma and cervical cancer, *human papillomavirus* (HPV) responsible for cervical, vulvar and vaginal cancers in females, penile cancer in males, anal and oropharyngeal cancers in both sexes, *Epstein Barr virus* (EBV) is responsible for nasopharynx cancer, Hodgkin lymphoma and Burkitt lymphoma and *Schistosoma haematobium* (*S haematobium*) parasites responsible for bladder cancer. The highest burden of cancers attributed to a single risk factor in the Eastern Mediterranean region (EMR) is from those associated with infections, with an estimated PAF of 15.3% for males and 12.2% for females (1). The highest PAF for infection (29.3%) was reported in males from Egypt, a country well known for a very high prevalence of HBV and HCV infections (2).

HBV and HCV infections and liver cancer

Viral hepatitis is a major worldwide healthcare problem and its prevalence is generally higher in the EMR compared to

the western world. Less than 1% of the European or North American population have chronic HBV infection, compared to up to 8% in some countries in the Middle East (3). Egypt, has the highest worldwide prevalence of HCV reaching up to 17.5%, whereas it is less than 1% in Lebanon, Saudi Arabia and Iran (4–6).

Chronic HBV and HCV infections can cause liver cirrhosis and lead to hepatocellular carcinoma, if left untreated (7). A study conducted by Sharafi et al, observed that HBV and HCV infections are responsible for 70% of liver cancers in the Middle East and North Africa (MENA) region (8). They demonstrated a 16.1% increase in the age-standardized incidence rate (ASR) of liver cancer attributable to HBV in the region between 1990 and 2017. The reported increase in ASR (31% and 47% for HBV- and HCV-related liver cancers, respectively) was highest in Egypt. Some of the countries have reported a reduction in liver cancer during the same period. Qatar reported the highest decrease in ASR of HBV- and HCV-related liver cancer, by 36% and 35.6%, respectively (8).

H pylori infection and gastric cancer

H pylori is a gram-negative bacteria that colonizes the gastric mucosa. Chronic infection leading to gastric atrophy is

responsible for nearly 90% of the non-cardia gastric cancers (cancers occurring away from gastro-esophageal junction) (9). Non-cardia cancers are nearly twice as common as the cardia cancers (10). Those infected with *H pylori* have six times higher risk compared to the non-infected, yielding an attributable fraction of 74.7% for *H pylori* in non-cardia gastric cancers (11). Regular intake of salt preserved vegetable, meat or fish may damage the gastric lining, promote *H pylori* colonization and they have an additive effect (12).

A systematic review of 26 publications from eight EMR countries involving 13,692 participants with ages ranging between few months to 97 years, revealed a prevalence ranging between 22% and 88% (13). Living in rural overcrowded areas with poor sanitation, lower educational levels and low socioeconomic conditions were independent risk factors. The prevalence of *H pylori* and the incidence of gastric cancer has demonstrated a strong positive correlation – e.g. the *H pylori* prevalence exceeded 90% among adults aged 40 years or more living in the Ardabil province of Iran, which reported the highest gastric cancer incidence in the country (14). However, a decreasing trend in *H pylori* prevalence is observed in the EMR over recent years, as is the case in many developing countries (15).

HIV infection and related malignancies

Over the past 20 years, the annual number of new HIV infections has declined by almost 40% globally. Unfortunately, new HIV infections and HIV-related deaths are on the rise in the EMR (16, 17). A relatively low HIV prevalence in the population (0.1%) and a lack of comprehensive surveillance systems to identify asymptomatic high-risk individuals results in inaccurate prevalence data and a slow understanding of the features of the HIV epidemic in the EMR. Nearly 70% of individuals living with HIV in the region are in Pakistan, Iran and Sudan (18). Most of the HIV infections in the region are transmitted sexually and not through shared needles from intravenous drugs.

Kaposi sarcoma (KS) is among the earliest identified HIV-associated cancers and many of the affected patients have an unusually aggressive clinical course. KS along with non-Hodgkin lymphoma (NHL) and cervical carcinoma have been designated as AIDS-defining conditions (19). Following the wide-scale adoption of potent ART, the spectrum of cancer in HIV-infected patients has changed significantly; yet the rates of KS, NHL and cervical cancer remain 800 times, 40 times and 4 times higher, respectively, in HIV-infected populations compared to non-infected ones (20).

HPV infection and related malignancies

HPV is ubiquitous and the most common sexually transmitted

infection worldwide. Approximately 200 genotypes of HPV have been identified, of which types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68 are considered as “carcinogenic”, with types 16 and 18 being the most potent of them. HPV is responsible for nearly all cervical cancers, 88% of anal cancers, 78% of vaginal cancers, 50% of penile cancers, 31% of oropharyngeal cancers, and 25% of vulvar cancers (21).

A meta-analysis including nearly a million women reported that the average global prevalence of HPV was 11.7%, with regional differences ranging between 1.7% and 35.4% (22). A systematic review and meta-analysis based on data collected from 26,536 women with normal cytology from 13 countries in the EMR estimated an average 9.3% HPV prevalence; HPV 16 and HPV 18 being the most common types with reported prevalence of 2.3% and 0.7%, respectively (23). The highest prevalence was reported in Saudi Arabia (19.0%) among the Asian countries and Morocco (19.0%) among the African countries. Women from Kuwait and Sudan had the lowest HPV prevalence (2.0% and 3.0%, respectively) among the Asian and African countries in the region.

EBV infection and related malignancies

EBV is another common infection, which infects 90% or more of the population globally, that has been found to cause Burkitt lymphoma, gastric carcinoma, Hodgkin lymphoma or nasopharyngeal carcinoma in a small minority of the infected populations. The virus tends to infect children aged 3–4 years in the low-resourced settings whereas, in more developed regions the infection does not occur before young adulthood (24). A study from Iran demonstrated that 91.5% of primary EBV infections occurred by the age of 10 years and a study from Bahrain showed the proportion to be 72.4% (25, 26). Acquisition of the infection in infancy increases the risk of malignancy. Globally, the virus is associated with approximately 1% of all cancers, causing 140,000 deaths annually (27).

Burkitt lymphoma is an aggressive form of NHL classified into endemic, sporadic, and AIDS-related. EBV is most commonly detected in the endemic types (>95%), which are mostly seen in children under 10 years in equatorial Africa, which is also an endemic zone for malaria. In the equatorial African countries that are endemic zones for malaria, the annual incidence of Burkitt lymphoma has been reported to be 5–10/100,000 children (28). The incidence is much lower in Tunisia and Egypt because they are no longer endemic for malaria.

EBV is also associated with 40–50% of Hodgkin lymphomas; overall, 90% of childhood Hodgkin lymphomas in less developed regions and 10% of gastric adenocarcinomas are associated with EBV (29). The virus is commonly detected in non-keratinizing and undifferentiated nasopharyngeal cancers as well. A systematic review reported a range of co-factors,

e.g. diet, co-infection with falciparum malaria or HIV, genetic predisposition and smoking for the EBV-associated cancers (29).

Parasite infections and related malignancies

Schistosomiasis is one of the most common parasitic infections in the EMR, which infects around 12.7 million people (30). Schistosomiasis remains highly prevalent in Egypt, Sudan and Yemen, while being almost eradicated in other countries including Lebanon, Tunisia, Jordan, Syria and Oman (31). Lack of sanitation, poor personal hygiene and inadequate supply of potable water to drink, highly correlate with the prevalence of infection (32). *S haematobium* has been known to cause squamous cell carcinoma of the urinary bladder. Egypt reported a very high prevalence (37–48%) of the infection nearly two decades ago when bladder cancer was the most prevalent cancer in males, with nearly 80% of the cancers being squamous cell carcinomas (33). However, with control of the infection, bladder cancer has significantly reduced in the country and transitional cell carcinoma has become the predominant type (34).

Evidence-based interventions to minimize exposure and/or reduce the impact of infection

Prevention of hepatitis infection using the following strategies is the best way to reduce liver cancer burden in the EMR:

- **Preventing transmission of HBV from mother to baby:** Pregnant women should be screened for HBV and the newborn baby of the HBV positive mothers should be administered the hepatitis B vaccine along with immune globulin within 12 hours of birth. The pregnant women should receive prophylactic tenofovir therapy depending on the viral load.
- **Vaccination against HBV:** Three doses of the vaccines should be given to all children with the first dose given at birth. All adults at high risk for HBV infection, such as healthcare workers, intravenous (IV) drug users, or men who have sex with men should also be vaccinated.
- **Application of safety rules for injections, surgical procedures and blood transfusions:** These should be practised at all healthcare facilities. The IV drug users should have access to sterile needles.

High-risk populations should be screened routinely for hepatitis B and C infection. Treating HBV and HCV infected patients with conventional or pegylated interferon (IFN)-alpha the nucleoside analogs lamivudine, entecavir and telbivudine or the nucleotide analogue adefovir, dipivoxil and tenofovir will arrest progression to cirrhosis and liver cancer.

Limited, moderate quality evidence from a meta-analysis

of six RCTs demonstrates that searching for and eradicating *H pylori* (usually with a 14-day therapy combining a proton pump inhibitor, amoxicillin and clarithromycin) can reduce the incidence of gastric cancer by a significant 34% in asymptomatic infected individuals (35). However, there was no impact on all-cause mortality and the harmful effect of the resistance developed against the antibiotics used for other common illnesses need to be carefully considered. Screening for *H pylori* or gastric cancer is not yet recommended for healthy asymptomatic populations and multicentre, double-blind, randomized controlled trials to evaluate the effect of *H pylori* eradication to prevent gastric cancer in 40–60 year old individuals is ongoing in the Republic of Korea (36). Preservation of food in refrigerators, improving food hygiene and avoiding salt-preserved foods can significantly reduce gastric cancer incidence.

Educating the population to avoid high-risk behaviour and ensuring safe and hygienic injection and surgical practices at every health facility are important primary prevention measures for HIV. Screening of women during pregnancy and regular screening of the high-risk populations can detect the infection early. The countries with high prevalence should have their own guidelines for screening. Every HIV positive individual should have access to counselling, further investigation and anti-retro-viral therapy (ART) as necessary. Men and women living with HIV should be made aware of the symptoms of common cancers associated with the infection. Every sexually active woman attending an ART clinic should be screened for cervical cancer following the national guidelines.

Vaccinating girls between 9 and 13 years of age with vaccine against HPV is the most effective primary prevention measure for cervical and other HPV-related cancers. Vaccination of adolescent girls together with quality-assured screening of women after 30 years of age may lead to elimination of cervical cancer as a public health problem. The World Health Organization has recommended HPV detection-based screening of sexually active women starting at the age of 30 years for the countries that can afford the test. Achieving a high coverage of the target population and ensuring appropriate treatment of the screen-detected precancers and cancers are absolutely essential to achieve the desired impact of screening in reducing cervical cancer incidence and mortality.

Improving sanitation, educating the children about hygienic practices and ensuring a regular supply of clean drinking water are crucial in decreasing the rate of transmission of EBV and schistosomiasis. Water filtration using chemicals and modern filtration systems has proven to decrease or even cease the transmission of certain parasites in drinking water. Improving the water supply infrastructure and regular maintenance of the water pipes prohibit any urine or stool contamination of

the drinking water. The population needs to be educated about the appropriate source of water to drink and use for cooking. Intermediate hosts like certain snails (*Biomphalaria spp.*, *Oncomelania spp.*, and *Bulinus spp.*) help in the transmission of schistosomiasis. Interrupting the life cycle of these species by using chemical molluscicides, can reduce the transmission of schistosomiasis. Controlling malaria through appropriate vector-borne disease control measures can reduce the EBV-associated cancers in children.

Recommended priority interventions in the EMR to control infection-related cancers

There is great variability in resources and human development across the countries of the EMR. The gross national income (GNI) per capita varies between US\$ 1,850 in Afghanistan and US\$ 124,506 in Qatar (37). This is often reflected in the risk profiles, cancer control efforts and their success in reducing the burden of infection-related cancers in these countries. Great

variability exists even among countries that are geographically close by. For example, liver cancer is the number one cancer among Egyptian males while the cancer is not included in the top 10 cancers among Tunisian males and incidence of gastric cancer in Iranian males is six times higher than that reported in males in Saudi Arabia. Every EMR country has to prioritize its cancer control interventions depending on the cancer burden and risk profiles. Primary prevention is the most efficient tool to reduce the burden of infection related cancers.

Increased awareness of the population and health providers, screening of the high-risk populations and high coverage of HBV vaccination starting with the first dose at birth should be the priority to reduce HBV and HCV infections in all EMR countries. The coverage to three doses of the hepatitis B vaccine is quite low (<80%) in Lebanon, Pakistan, Somalia, Syrian Arab Republic and Yemen and needs to be improved (38). Even in countries with high vaccination coverage of children, healthcare workers who are at high risk for HBV

Infection related cancer	Priority recommendation(s)	Monitoring indicator(s)*
Gastric cancer (<i>H pylori</i>)	Water sanitation	<i>H Pylori</i> prevalence by antibody-based tests (serology and urine test), urea breath test (UBT), and stool antigen test (SAT)
Liver cancer (HBV and HCV)	Hep B vaccination starting with a dose at birth	Hep B vaccination coverage (birth dose and all recommended doses); prevalence of chronic HBV and HCV
	Screening of pregnant women and high-risk populations for HBV and HCV	Proportion of pregnant women and high-risk populations screened
	Safe injection practices	Supply of disposable syringes and needles
	Treatment of HBV and HCV infections	Treatment coverage of HBV and HCV patients
AIDS-defining cancers (HIV)	Primary prevention through population awareness	Provision of HIV/AIDS awareness in schools
	Screening of high-risk population for HIV; screening of pregnant mothers	HIV prevalence in general and high-risk population; HIV prevalence in pregnant women;
	Access to further investigations and antiretroviral therapy (if required) for the HIV positive men and women	Percentage of HIV positive patients who are eligible and currently receiving ART
Cervical and other ano-genital cancers related to HPV	HPV vaccination of girls before they reach 15 years of age	HPV vaccination coverage
	Screening of women starting at 30 years of age (25 years for WLHIV)	Cervical cancer screening coverage
Bladder cancer (Schistosomiasis)	Water sanitation	Availability of clean potable water
All infection related cancers	Improved population awareness; better and prompt access to diagnosis and treatment for symptomatic population	Incidence of cancer
		Stage distribution of the cancers
		Delays in accessing diagnosis and treatment from symptom onset

*Additional indicators included in the national programmes for control of Hepatitis and HIV should be monitored

infection are still sub-optimally vaccinated (39). In Egypt, a significant decrease in the incidence of HCV infection was noted in young adults after the implementation of prevention programmes by the Ministry of Health, such as safe blood transfusion activity, the use of auto-disabled syringes and the increase in awareness campaign in schools and universities (40). Such interventions along with access to treatment for hepatitis need to be strengthened further in countries with a high burden of liver cancer.

Until we have more evidence on effectiveness of *H pylori* eradication, countries in the EMR should focus on reducing the prevalence of infection by ensuring the supply of safe drinking water, improving living conditions and sanitation and creating a supply chain for fresh and better-preserved food. Creating population awareness about other risk factors of stomach cancer like obesity, physical inactivity, tobacco smoking, consumption of salt-preserved food, or processed meat should also be prioritized.

Interventions targeted to reduce the HBV/HCV prevalence (education of population and providers, proper sterilization, transfusion and injection practices, screening of high-risk populations and continued surveillance) are appropriate to keep the HIV prevalence at the current low level in the EMR. Access to ART should be improved and every ART clinic should have the facilities to screen eligible women for cervical cancer.

Countries with a high burden of cervical cancer in the region should follow the WHO guidelines on implementing both HPV vaccination of the adolescent girls and screening women for cervical cancer. However, there are countries that already have a very low incidence of cervical cancer. They may prioritize vaccination and consider screening only if cervical cancer shows an upward trend. High income countries with low cervical cancer burden may consider screening women infrequently (once every 10 years) with an HPV detection test. Well-designed, community-based, behavioural intervention programmes targeting young people to encourage safer sexual behaviours will guard against future shifts in the prevalence of sexually transmitted infections including HPV.

Creating healthy living conditions through better urban planning and public health engineering will ensure improved sanitation and access to safe drinking water and reduce prevalence of EBV, *H pylori* and schistoma infections.

Finally, every country needs to improve cancer registration and cancer early diagnosis facilities. A well-organized population-based cancer registry covering even a fraction of the population is immensely useful to understand the changing profiles of risk factors and the impact of cancer control measures. Ensuring prompt diagnosis of men and women with symptoms of common cancers and providing good quality treatment without any delay should be a matter of right for every citizen.

Environmental risk factors for cancer

Environmental risk factors for cancer and their prevalence in the EMR

Climate change, pollution, chemical exposures, and radiation contribute to 22% of the disease burden in the EMR (41). In 2014, the EMR was reported to be the second worst impacted region by climate change after Africa, with significant health effects (42, 43).

Air pollution and climate change

The WHO estimated that nearly 7 million people die of outdoor (ambient) and indoor (household) air pollution every year globally (44). The EMR region witnessed rapid industrialization, rising population size and climate change that resulted in high levels of air pollution in urban areas (45). Changes in air quality have been linked to various cancers namely leukaemia, bladder cancer and lung cancer, which constitute around 40% of all cancer cases in men in the region (46). According to the WHO Global Ambient Air Quality Database the highest levels of particulate matters (PM) were reported in the EMR over all other WHO regions. Various EMR countries (Bahrain, 2007; Egypt, 2011; Jordan, 2010; Kuwait, 2014; and Pakistan, 2010) reported an annual PM_{2.5} (particulate matter of less than 2.5 micrometres in diameter) levels above the WHO guideline value of 10 µg/m³ (47). A study of the Gulf Cooperation Council (GCC) countries indicated that the PM_{2.5} levels were not only high, but also were associated with excessive natural dust due to the storms that frequent the region (48). The same study reported other factors that contribute to air pollutants in the GCC region, which are heavy traffic, excessive use of subsidized energy, ongoing infrastructure projects, water desalination, and fossil fuel burning.

Household or indoor air pollution is caused by smoking, burning fossil fuels, and the use of domestic electricity generators with children and women the worst sufferers. It was estimated in 2010, that indoor pollution was causing more annual deaths than outdoor pollution in Afghanistan (41,164 deaths), Pakistan (114,806 deaths), Sudan (15,567 deaths) and Yemen (7,695 deaths) (49).

The WHO Conference on Health and Climate reviewed the evidence of climate change on health and estimated a quarter of a million deaths globally that would be attributed to climate change between 2030 and 2050 (50). The EMR is the second region after Europe to be vulnerable to heat exposure (51). It would be particularly challenged with 1–2°C temperature increase by 2030–2050 impacting health (52). It is well established that climate change has impact on cancer risk factors, cancer survival and access to cancer care (53). Two countries, Egypt and Iran (54), have reported that a temperature rise in the region would result in increased heat stress and skin cancer.

Table 2: The cancer sites associated with different chemicals, metals, dust and fibres, and occupations classified as “carcinogenic to humans” (Group 1), IARC (69)

Cancer sites	Chemicals	Metals	Dust and fibres	Industrial processes
Lungs	Diesel engine exhaust, Indoor emissions from combustion of coal, Benzo[a]pyrene, Coal tar pitch, Soot, Sulphur mustard	Arsenic, Beryllium, Cadmium, Chromium, Nickel and their compounds,	Asbestos, Silica dust	Aluminium production, Coal gasification, Coke production, Iron and steel founding
Mesothelioma			Asbestos, Erionite	Painting
Larynx, nasopharynx, nasal cavity and paranasal sinus	Acid mists, strong inorganic, Formaldehyde	Nickel compounds	Leather dust, Wood dust	Isopropyl alcohol production
Liver	Vinyl chloride			
Urinary bladder	Aromatic amines and dyes	Arsenic and inorganic arsenic compounds		Aluminium and Auramine production, Painting
Leukemias and lymphomas	Formaldehyde, Benzene, Ethylene oxide			Rubber production industry
Skin cancer	Coal tar pitch, Soot, Mineral oils,	Arsenic and inorganic arsenic compounds		Coal tar distillation

Occupational exposure

The International Agency for Research on Cancer (IARC) has classified a range of chemicals, other agents and industrial processes as carcinogenic (Group 1: definitely carcinogenic) to humans and prolonged exposure to them at workplace is a significant occupational hazard (Table 2). Exposure to carcinogens in work environment has been linked with cancer of lungs, mesothelioma, larynx, nasopharynx, nasal cavity and paranasal sinus, liver, urinary bladder, leukemias and lymphomas and non-melanoma skin cancer (55). Workers in the mining, chemical and fertilizer industries, building construction and agricultural sector have the highest risk of exposure. The proportion of certain cancers attributed to carcinogens in the workplace are: mesothelioma, 94.9%; sino-nasal, 34.4%; lung, 14.5%; nasopharynx, 8.2%; and urinary bladder, 5.3% (56).

IARC has classified ionizing radiation as a Group 1 carcinogen that significantly increased the risk of mortality from cancers of lung, breast, ovaries, urinary bladder and gastrointestinal tract (57). Workers may be exposed to a high dose of ionizing radiation due to their specific nature of jobs. Radon (²²²Rn) is an inert gas with several radioactive isotopes which is formed by the radioactive decay of uranium-238 present in small quantities in soils and rocks. The gas escapes from rocks and soils into the air and tends to get concentrated in enclosed spaces, such as underground mines or the basements of houses. Inhalation of radon is the second-most common cause of lung cancer next to smoking and up to 14% of lung cancers are attributed to this carcinogen (58). Those working in medical diagnostic centres offering X-rays or CT

scans, radiation therapy centres, atomic energy plants or atomic weapons establishments are also exposed to ionizing radiations and have significantly higher mortality from rectal cancer, laryngeal cancer, all uterine cancers and leukaemias excluding chronic lymphoid leukemia (59).

Chronic exposure to aromatic amines, paints and black carbon and prolonged use of arsenic- or chlorine-contaminated water increases the bladder cancer risk and tobacco smoking has a synergistic effect (60). West Asian countries have significantly higher bladder cancer incidence (ASR 16.4/100,000) compared to the global average (ASR 9.6/100,000) (61). This cancer is the second most common cancer in males in Lebanon (16.8% of all cancers), Egypt (11.2% of all cancers), Iraq (9.7% of all cancers) and Jordan (9.5%) (61).

Other environmental factors

Exposure to the carcinogenic compounds listed in Table 2 may happen due to contamination of water and food with these chemicals. Chemicals used as pesticides and fertilizers, effluents from industries, discarded items and waste from households may contain many harmful chemicals that may contaminate water and get into the food chain. Persistent organic pollutants (POPs) like polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), polychlorinated dibenzo-p-dioxins and -furans (PCDD/Fs), polybrominated diphenyl ethers (PBDEs), organochlorine pesticides or PAHs are released by various industries and the population may be chronically exposed to them even at small doses. These have been linked with breast cancer, prostate and non-Hodgkin lymphoma and leukemias (62). Radon exposure in the

households is an important cause of lung cancer, as mentioned earlier. However, this is not a major problem in the EMR. Even natural radionuclides may get into food and water and cause chronic exposure to radiation (63). Prolonged exposure to sun and exposure to ultraviolet radiation significantly increases the risk of skin cancers – both melanoma and squamous cell carcinoma. The tanning lamps used more frequently by youth emit UV radiation at doses that far exceed the dose to which skin is vulnerable when exposed to sunlight. In 2009, IARC classified the radiation emitted by tanning lamps as a carcinogenic to skin.

Evidence-based interventions to minimize exposure and/or reduce the impact of environmental risk factors

The WHO has an operational framework for building climate resilience consisting of 10 components (leadership and governance; health workforce; vulnerability, capacity and adaptation assessment; integrated risk monitoring and early warning; health and climate research; climate resilient and sustainable technologies and infrastructure; management of environmental determinants of health; climate-informed health programmes; emergency preparedness and management and climate and health financing) and lists the interventions related to each risk (64). The climate change mitigation strategies and actions applicable to the healthcare sector include:

- ➔ improve energy supply and distribution efficiency;
- ➔ on-site renewable energy sources;
- ➔ reduced-energy devices;
- ➔ passive cooling, heating and ventilation strategies;
- ➔ facility wastewater and solid waste management;
- ➔ reduced greenhouse gas (GHG) emissions from anaesthesia gas use and disposal;
- ➔ reduced procurement carbon footprint;
- ➔ telehealth/telemedicine;
- ➔ health facilities in proximity to public transport and safe walking/cycling;
- ➔ conserve and maintain water resources. (65)

Standardized and reliable measurements can be used to determine air pollution level and the various types of pollutants in the atmosphere (66). Extensive campaigns can serve in increasing population awareness on cancer prevalence, risk factors, early detection and prevention (67). Various sources of air pollution need to be identified and adequate solutions should be made separately for each. Finally, building capacity in the health sector to engage with other sectors and contribute to preventive action in countries is a must (68).

Pragmatic population-based policies, an inter-sectoral approach and effective legislative actions are necessary to protect the individuals and the environment from exposure

to industrial carcinogens (69). These include earmarking the industries and workplaces using or emitting toxic chemicals, enforcing measures to minimize worker exposure to the workers, encouraging the substitution or phasing out the harmful chemicals and processes and treatment of effluents before releasing them into the environment. The pollution control board needs to be empowered to monitor the industries and act. Labour laws should look after the interests of workers and ensure that they are adequately compensated for cancers occurring due to willful negligence by industry. The threshold levels of emissions of carcinogenic agents should be fixed for every industry and strictly monitored. Incentivizing industries to minimize the use harmful chemicals and processes through accreditation, tax reliefs may also motivate them to introduce better and cleaner technologies. Those working in situations where exposure to ionizing radiations may happen, should follow national and international regulations for radiation protection, including regular measurement of exposure using the dosimeters. Education of employers, workers, health professionals and labour organizations is essential to recognize the work hazards, follow risk mitigation measures and report unusual occurrences of clusters of cancer cases.

Current status of implementation of interventions in the EMR and the scope for improvement

Health authorities in the region need to support actions that address environmental pollution in a committed, coherent and coordinated manner (70). A sustainable programme with a clear agenda and constant follow-up are the key factors to making these policies a success. However, implementing this range of public health measures in the EMR is challenging in countries that are in conflict and preoccupied with economic crises and political adversities (71).

The Eastern Mediterranean Regional Office (EMRO) of WHO passed a resolution in 2008 (Box 1). The regional office proposed a framework for action on climate change and health which included several response targets, action requested from countries and WHO support. (WHO EMRO, 2017). Since the adoption of resolution EM/RC55/R.8 (WHO EMRO, 2008) in 2008, the majority of EMR countries had a second or third National Communication to the UNFCCC (UNFCCC) that included health as a section with variations in coverage and depth. The Paris Agreement in 2015 that was endorsed by 18 EMR countries aims to curb GHG emissions and commits countries to strengthen adaptation (UN, 2015). It includes implementing plans that should protect human health from the impact of climate change. Climate and health country profiles were initiated by WHO and to date only 10 countries (Egypt, Iran, Jordan, Kuwait, Morocco, Oman, Pakistan, Tunisia, UAE and Lebanon) have profiles. Table 3 summarizes the common

national responses of these countries. In addition to what is listed in Table 3, other laws and actions were taken by Oman, Jordan, Morocco, Pakistan, Tunisia and Lebanon.

The status of development or implementation of health adaptation to climate change as reported by countries are presented in Table 4.

Countries in the region still have to scale up and prioritize their actions towards curbing the health burden of climate change to implement the sustainable development goals successfully. In addition, mapping of environmental health risks should also be considered across the health priorities road map (41). Regulation of the industries with policies and laws to protect the interest of the workers as well as the general public is of great importance to control environmental exposure to carcinogens. An intersectoral approach involving the ministries of industry, water and natural resources, transport, food supply and health is needed to ensure industry compliance to quality standards and norms, proper disposal of household and industrial wastes, incentivizing organic farming, etc. Raising awareness among the public, policy-makers and all relevant stakeholders about the long-term benefit of a clean and healthy environment is crucial. Routine measurement of radon levels in buildings in EMR countries is not recommended.

Countries should increase their awareness campaigns and advocacy efforts, assess vulnerability to climate change, develop early warning surveillance and preparedness systems, and increase their resilience to extreme weather occurrences and reduce GHG emissions and other climate pollutants (72). Given the paucity of research in the region on the impact of climate change and environmental pollutants on health, there is an urgent need to conduct national and regional research to fill the knowledge gap, identify vulnerable populations and provide evidence for policy-makers (73).

Conclusion

Every EMR country has to prioritize its cancer control

Box 1: EMR Resolution on Health and Climate Change (EM/RC55/R.8)

- Endorsed a regional framework for health sector action in Member States to protect health from the effects of climate change.
- Urged countries to implement the framework for action.
- Urged countries to establish high-level effective coordination mechanisms for strengthening institutional capacity to protect health from climate change and to facilitate the engagement of the health sector in the national UNFCCC processes.
- Urged countries to establish early warning capacity for climate-sensitive diseases by integrating environmental monitoring information with the existing health surveillance system.

Source: (WHO EMRO, 2008)

interventions depending on the cancer burden and risk profiles. Primary prevention is the most efficient tool to reduce the burden of infection-related cancers. Therefore, it's imperative for each country in the EMR to take the necessary preventive measures to combat infection-related cancers by adopting an evidence-based approach that suits its' priorities.

The following measures are highly recommended:

- Increase awareness of the general population and high-risk groups about the excess risk of cancer due to certain types of infections and the importance of taking adequate preventive measures such as avoiding high-risk behaviour, safe food handling and preservation, proper personal hygiene. Governments should ensure there is a regular supply of clean drinking water.
- The screening of high-risk populations and high-levels of coverage by HBV vaccination, starting with the first dose at birth, should be the priority to reduce HBV and HCV infections in all EMR countries.
- Screen all pregnant women for HBV surface antigens during early prenatal visits and ensure that hospitals where infants are delivered have HBV surface Antigen testing capabilities.
- Countries with high burden of cervical cancer in the region should follow the WHO guidelines to implement both HPV

Table 3: National response by common actions and country

Response	Egypt	Iran	Jordan	Kuwait	Morocco	Oman	Pakistan	Tunisia	UAE	Lebanon
Ratified the UNFCCC	1992	1992	1992	1995	1995		1994	1992		1994
Ratified KYOTO PROTOCOL	1999	2005	2003	2005	2002	2005	2005	2003		2006
National Plan for Health and Climate Change	2011		2013		2009		2012		2017	2017
Commitment to reduce GHG emissions		4% by 2030	11% by 2025		32% by 2030					15% emissions reduction by 2030

Source (WHO)

Table 4: The status of development or implementation of health adaptation implementation climate resilient measures of climate change as reported by countries*

Measure	Egypt	Iran	Jordan	Kuwait	Morocco	Oman	Pakistan	Tunisia	UAE	Lebanon
Country is currently implementing projects or programmes on health adaptation to climate change	x	√	x	NA	√	x	√	x	NA	√
Country has implemented actions to build institutional and technical capacities to work on climate change and health	√	√	x	NA	x	x	√	√	NA	x
Country has conducted a national assessment of climate change impacts, vulnerability and adaptation for health	x	√	√	NA	√	√	x	√	NA	√
Country has climate information included in Integrated Disease Surveillance and Response (IDSR) system, including development of early warning and response systems for climate-sensitive health risks	x	√	x	NA	x	√	x	√	NA	x
Country has implemented activities to increase climate resilience of health infrastructure	x	x	x	NA	√	x	x	x	NA	√

*WHO UNFCCC Health and Climate Change Country Profile Project.

vaccination of the adolescent girls and screening of women starting at 30 years of age for cervical cancer.

- ➔ Well-designed, community-based, behavioural intervention programmes targeting young people to encourage safer sexual behaviours will guard against future shifts in the prevalence of sexually transmitted infections including HIV and HPV.
- ➔ Improve cancer registration and cancer early diagnosis facilities. A well-organized population-based cancer registry is immensely useful in understanding the changing profiles of risk factors and the impact of the cancer control measures. ■

Disclaimer

Where authors are identified as personnel of the International Agency for Research on Cancer / World Health Organization, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy or views of the International Agency for Research on Cancer / World Health Organization.

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