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Original Article

Summary of the 2016 World Health Organization Report and 2021 Compendium on environmental diseases

Sintesi del Rapporto del 2016 e del Compendio del 2021 dell'Organizzazione Mondiale della Sanità sulle patologie ambientali

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ABSTRACT

The report written by the World Health Organization (WHO) in 2016 presents an extensive assessment to show how the improvement of the environment can promote health and well-being. The awareness of how many diseases could be avoided by focusing on environmental risk factors would give a boost to global efforts to promote preventive health. The results obtained by the quantitative analysis on the burden of diseases attributable to the environment, confirm that 24% of global deaths and 26% of deaths among children under 5 years are caused by modifiable environmental risk factors. For this reason, this report strongly supports the idea that the environment is a solid platform for good public, community and individual health. Furthermore, in 2021, WHO with the United Nations developed a Compendium, which provides strategies and key guidance for acting on environmental conditions as a key contributor to reducing many communicable and Non-Communicable Diseases (NCDs). In the following article we examined the environment-related diseases according to WHO paperwork.

Il rapporto scritto dall'Organizzazione Mondiale della Sanità (OMS) nel 2016 presenta un'approfondita valutazione su come il miglioramento dell'ambiente possa promuovere la salute e il benessere. La consapevolezza di quante malattie potrebbero essere evitate concentrandosi sui fattori di rischio ambientali darebbe una spinta agli sforzi globali per promuovere la prevenzione. I risultati ottenuti dall'analisi quantitativa del carico di malattie imputabili all'ambiente confermano che il 24% dei decessi globali e il 26% dei decessi nei bambini sotto i 5 anni sono causati da fattori di rischio ambientali modificabili. Per questo motivo, il presente rapporto sostiene con forza l'idea che l'ambiente rappresenti una solida base sia per il bene pubblico e comunitario che per la salute individuale. Inoltre, nel 2021, l'OMS con le Nazioni Unite ha sviluppato un Compendio, che fornisce strategie e linee guida per agire sulle condizioni ambientali e contribuire alla riduzione di molte patologie trasmissibili e non trasmissibili (NCD). Nel seguente articolo abbiamo esaminato le malattie legate all'ambiente secondo i citati documenti dell'OMS.

INTRODUCTION

Main forms of environmental pollution and pollutants

Increasing awareness of the number of diseases that can be prevented by limiting or eliminating certain environmental risk factors would have an impact on strongly needed global changes such as improving preventive health measures through policy strategies, targeted interventions and state-of-the-art technologies. Environmental diseases are so defined if they are due to modifiable factors, and thus based on what we are able to modify in the environment, which in turn depends on the level of technology, the development of diagnostic methods and technologies that can detect a role of the environment on health that is not yet known. This would be achieved through the design of more effective preventive public health strategies and interventions aimed to remove health hazards and to minimize their associated risks.

The focus is on reducing the household cost associated with health care for low-income countries, reducing modifiable risk factors related to environmental diseases through low-cost solutions, as well as monitoring the progress and trends of Non-Communicable Diseases (NCDs). Thus, a comprehensive approach that requires the collaboration of all partners is needed to reduce the risks associated with NCDs and promote interventions to prevent and control them.

In fact, a systematic literature review on environmental diseases has been conducted by WHO aiming at identifying risk factors for each disease by consulting more than 100 experts worldwide.

In addition, the 2021 Compendium is presented as a set of guidelines in order to reduce environmental factors like as air pollution, water, radiation, climate changes and behaviors related to environmental factors, with the purpose of creating healthier environments, minimizing preventable deaths and disabilities, improving present and future health for people all over the world.

The environment has been defined as the set of physical, chemical, and biological factors external to individuals. Consequently, all human behaviors, individual choices and workplaces are also included, except behaviors related to the social and cultural environment; genetic factors are also excluded.

There are many countermeasures that can be deployed in short-term to facilitate the reduction of the burden of diseases due to environmental factors: promoting safer household water storage, adopting better hygiene measures, using cleaner fuels and toxic substances more carefully, both in domestic and professional environments. At the same time, actions to be put into practice in transportation, energy, agriculture and industry, in cooperation with the healthcare industry, are essential.

There are environmental factors or risk factors for which important connections have been identified for specific diseases that we can define environmental.

The most analyzed modifiable environmental factors referred to environmental diseases are:[1] i) air, water or soil pollution by chemical pollutants or biological agents; ii) ultraviolet and ionizing radiations; iii) noise and electromagnetic fields; iv) occupational hazards; v) construction, including houses and roads; vi) major infrastructures such as railways and airports; vii) breeding places to meet the specific ecological needs of vectors; viii) agricultural methods, irrigation patterns; ix) climate changes caused by human activities, ecosystem changes; x) environmental factors related to behaviors, such as availability of safe water for hand-washing or physical activity promoted by improved urban design.

In contrast, alcohol and tobacco use, drug abuse, diet, unemployment, natural biological agents (such as pollen), and person-to-person transmission of diseases that cannot be prevented through environmental interventions are not considered.

WHO has identified 5 key points on this issue:

i) Environmental risks represent a large fraction of global burden of disease: a significant number of deaths are imputable to modifiable environmental components, amounting to 24% of total deaths, most of which are preventable. There were approximately 12.6 million deaths caused by living or working in unhealthy environments in 2012, about 1 in 4 deaths.
ii) Environmental impact of human health changes throughout life as well as by gender: environmental risk factors contribute to the development of more than 100 diseases. In particular, children under 5 years of age and adults from 50 to 75 years are more influenced by the environment. Children are more susceptible to lower respiratory tract infections and diarrheal diseases, while adults are more susceptible to non-communicable diseases (NCDs) which are diseases not caused by infectious agents such as cancer, cardiac and metabolic diseases. Men are more susceptible to environmental factors than women.
iii) Low- and middle-income countries hold the highest burden of environment-related diseases: 7.3 million deaths have been estimated for these countries, mostly due to indoor and outdoor air pollution.
iv) All deaths from environmental diseases have not changed since 2002 but show a strong shift to noncommunicable diseases: the number of deaths caused by environmental pollutants are unchanged since 2002, but it is evident a marked increase in NCDs. Although these diseases are often associated with aging, about 17 million deaths attributed to NCDs occur between 30 and 69 years of age.
v) There is an evident increase of quantitative link between health status and surrounding environment: of 12.6 million deaths attributable to environmental factors, 8.1 million were estimated using comparative risk assessment methods. Coronavirus (COVID-19) pandemic in 2020 served as additional reminder of the intrinsic link between human health and nature.

If we consider what the leading causes of death due to environment-related diseases are, it is estimated that most of these, especially 29% of Ischemic Heart Disease (IHD) deaths, 28% of strokes, 21% of cancers, 55% of respiratory infections, 61% of diarrheal diseases, 53% of Chronic Obstructive Pulmonary Disease (COPD), 40% of road traffic injuries, and 76% of unintentional poisonings, could be prevented if environmental improvements occurred globally.[2]

Strategies to reduce the burden of environmental disease

The 2016 WHO report highlights viable strategies to improve the environment and prevent diseases. These include the use of clean technologies and fuels in domestic environments, which could reduce acute respiratory infections, chronic respiratory diseases, cardiovascular diseases, and burns.

Increased access to safe water, appropriate sanitation, and promotion of hygiene measures may further reduce diarrheal diseases.

Anti-tobacco legislation reduces exposure to secondhand smoke, decreasing the incidence of cardiovascular diseases and respiratory tract infections.

Finally, improving urban transit, urban planning, and building more energy-efficient housing can reduce air pollution-related diseases.

Out of 133 disease groups listed in the Global Health Observatory, in 101 a significant link with the environment was found. Among these groups, 92 were at least partially quantified in the 2016 WHO report. The main information on the major environmental disease categories is summarized below.

Infectious diseases

Lower respiratory tract infections include pneumonia, bronchitis and bronchiolitis and cause 1.5 million deaths globally every year. The main environmental risk factor is stove smoking, accounting for 33% of cases. Air pollution and secondhand smoke are responsible for 7.9% and 9.3% of disease burden, respectively.

Upper respiratory tract infections include pharyngitis, laryngitis, sinusitis and they are mainly caused by air and household pollution, secondhand smoke and crowding.

Vector-borne diseases are caused by parasites and viruses. They account for more than 17% of all infectious diseases and they cause more than 700,000 deaths annually.[3] These include malaria, dengue, Chagas disease, human African trypanosomiasis, and leishmaniasis.

The 2017-2030 WHO Global Response for Vector Control provides strategic guidance to countries and development partners

to urgently enhance vector control as a key approach to preventing diseases and responding to epidemics. The global response is based on integrated vector management.

In addition, a crucial pre-requirement for human health and well-being turns out to be a safe WASH. This acronym refers to Water, Sanitation and Hygiene for the whole community.

Poor water sanitation may result in a set of communicable diseases through ingestion of contaminated water, inadequate personal hygiene, contact with water containing pathogens and the presence of vectors stagnating in water bodies.

Diarrheal diseases represent one of the leading causes of mortality in children under 5 years. A large part of these is caused by oro-fecal pathogens. The main transmission route depends on type of pathogen, local infrastructure (appropriate sanitation and clean water) and human behaviors. It has been estimated that 829,000 deaths for diarrheal diseases were caused by unsafe WASH in 2016.

Other diseases caused by inadequate personal and water hygiene include malnutrition, malaria, soil-transmitted helminth infections, schistosomiasis and trachoma.

Intestinal nematode infections impact children's physical growth and cognitive development, and they cause micronutrient deficiencies.

Malaria is caused by *Plasmodium* protozoan, transmitted by the bite of infected *Anopheles* mosquitoes. It is considered a serious disease with 627,000 deaths estimated in 2020. It should be taken into account that 42% of malaria cases could be prevented through environmental management strategies.

Trachoma, a chronic and contagious eye disease caused by *Chlamydia trachomatis*, is the leading cause of blindness worldwide. Risk factors include difficult access to household water supply, limited access to toilets, crowding, and the presence of flies.

Schistosomiasis is due to infection of trematodes, parasites of *Schistosoma* genus, which invade vessels of the bowels or urinary tract. About 200-250 million people are reported to be infected in endemic regions, with 200,000 estimated deaths per year. Current understanding of schistosomiasis transmission suggests that 100% of the disease burden is due to environmental risk factors.

Chagas disease is caused by *Trypanosoma cruzi* protozoan. In 30-40% of cases it leads to severe cardiac, nervous system or gastrointestinal alterations. The parasite is transmitted by the bite of *Triatominae* insects, commonly present in Central and South America. It is estimated that 6-7 million people are infected with it.

Lymphatic filariasis is caused by infection with *Filarioidea*'s family nematode parasites. About 51 million people contracted the infection in 2018, mainly in Southeast Asia and Africa. The infection can also be the cause of disabilities found in older age. Lymphatic filariasis is associated with polluted water in coastal cities and inland irrigation systems.

Onchocerciasis disease is caused by *Onchocerca volvulus* parasite and it is the second most important cause of blindness after trachoma. More than 99% of the infected people live in 31 countries in West and Central Africa. Disease transmission can be increased by human-related forest degradation, as deforested areas provide favorable habitats for the black fly, which acts as a vector.

Leishmaniasis is an infectious parasitic disease caused by protozoa of *Leishmania* genus. WHO estimates from 700,000 to 1 million cases per year: among these, between 0.2 and 0.4 million cases of visceral leishmaniasis and between 0.7 and 1.3 million cases of cutaneous leishmaniasis are estimated each year.

Dengue fever is a viral disease transmitted to humans via mosquitoes, presenting a high spreading rate compared to other viral conditions. An estimate carried out in 2013 indicated 390 million infections every year, including 96 million with clinical manifestations. Rapid urbanization, inadequate water supply services, increased population mobility and global trade are important determinants of reappearance of the disease.

Japanese encephalitis is caused by a flavivirus and it is the leading cause of viral encephalitis in Asia. 68,000 clinical cases are estimated each year, causing 20,400 deaths. Japanese encephalitis mainly affects children, while most adults have natural immunity after childhood infection.

Acquired Immune Deficiency Syndrome (AIDS) is due to Human Immunodeficiency Virus (HIV) infection; the most affected region globally is sub-Saharan Africa with about 68% of infected adults, followed by the Caribbean, Eastern Europe and Asia. Sexual transmission accounts for the majority of HIV infections, but in some regions, like Eastern Europe and Central Asia, drug injection is the main risk factor.

Sexually transmitted diseases such as chlamydia, gonorrhea, syphilis and trichomoniasis affect about 500 million people yearly.[4] The occupational burden of sexually transmitted diseases except AIDS is about 8% in adults.

Hepatitis B and C, caused by Human Hepatitis B Virus (HBV) and Human Hepatitis C Virus (HCV), respectively, are viral liver infections that can evolve chronically causing cirrhosis or liver cancer. More than one million people die each year for hepatitis B and C-related liver diseases. Although HBV is highly sexually transmissible there are other transmission routes such as injecting drugs. An estimated 296 million people are living with chronic HBV infection, with 1.5 million new infections per year and 820,000 deaths in 2019. Moreover, around 58 million people are currently living with HCV infection, with 1.5 million new cases per year and 290,000 deaths in 2019.[5]

Tuberculosis, caused by *Mycobacterium tuberculosis*, causes the death of about 1.5 million people each year. About a third of the world's population is infected with the latent bacteria, but only in a small fraction of cases will the disease progress to an active state. Malnutrition increases the risk of progression to tuberculosis and worsens the prognosis by compromising the immune system.

Non-communicable diseases

Several risk factors may be strongly related to Non-Communicable Diseases (NCDs). These include overweight, obesity, and physical inactivity.

Tumors

About one-fifth of the world population and one-third of people living in industrialized countries develop cancer during their lifetime. Cancers account for 8% of the global environment-driven disease burden. About 20% of all cancers globally are attributable to the environment, with about 2 million deaths each year; occupational exposure to carcinogens is a major global risk causing 2-8% of all cancers. The following incidence data refer to 2020 Global Cancer Observatory and World Cancer Research Fund International.

Lung cancer is the largest contributor to cancer mortality, being responsible for nearly 1.8 million deaths in 2020. Smoking is the leading risk factor, followed by more than 20 environmental and occupational carcinogens especially air pollution and radon, while

asbestos exposure also increases the risk of developing pleural mesothelioma. It is estimated that 14% of lung cancers are due to outdoor pollution, 17% to indoor pollution, 6.5% to residential radon, 1.8% to secondhand smoke and 6.6% to occupational hazards.

Colorectal cancer caused over 916,000 deaths in 2020.[6] It is estimated that 27% of these cancers may be attributable to low physical activity, which can be modulated by the environment. In recent years, radiations and asbestos have also been considered as possible environmental risk factors for colorectal cancer.

Breast cancer is the cancer with the highest mortality rate in women, with 685,000 deaths in 2020.[6] Thirty percent of the cases appear to be partially due to low physical activity.

Lymphomas, leukemias and multiple myeloma are the leading cause of more than 700,000 deaths in 2020.[6] Chemicals, ionizing radiation and pesticides are possible environmental risk factors.

Mouth and oropharynx cancer caused more than 364,000 deaths in 2020.[7] It is also estimated that 3.6% of laryngeal cancer and 0.5% of nasopharyngeal cancer are attributable to occupational hazards.

Bladder cancer led to more than 212,000 deaths in 2020.[7] Active smoking is the main risk factor; other factors include exposure to arsenic in drinking water, *Schistosoma haematobium* and aromatic amines.

Melanoma and skin cancers caused more than 120,000 deaths in 2020.[7] UV exposure and solarium use are associated with an increased risk of melanoma, basal and squamous cell carcinoma.

Cataracts and hearing loss

Cataracts are the leading cause of blindness worldwide, with about 20 million people suffering from them. Exposure to UV light is a significant factor in cataracts development; other environmental factors include cooking fumes as well as aging and prolonged use of steroid medications.

Hearing loss can be caused by infectious diseases such as measles or chronic ear infections, but also by the use of ototoxic drugs, aging, head damage or noise pollution.

Air pollution diseases

The combined effects of indoor and outdoor pollution cause about 7 million premature deaths each year, most of which are due to increased mortality from stroke, IHD, COPD, lung cancer, and acute respiratory infections.

More than 90% of people live in places characterized by air pollution, resulting in 4.2 million deaths each year, according to 2016 data. Among all the death events due to air pollution, 38% are caused by IHD, 20% by stroke and 43% by COPD.

Air pollution particularly affects children's health; indeed, it has been linked to respiratory infections, adverse birth outcomes, negative effects on brain development and lung function, obesity, asthma, cancers and increased mortality.[8] However, pollution also seriously compromises the health of elderly people.

About 3.8 million deaths per year (according to 2016 data) are attributable to Particulate Matter (PM): of these, 27% are attributable to IHD, 18% to stroke and 54% to COPD.

Secondhand smoke and radon are also a major source of air pollution: 1.3 million and 84,000 deaths per year, respectively, have been estimated (according to 2019 data).[9] Environmental tobacco smoke exposure has been shown to cause cardiovascular, respiratory and other diseases. In contrast, an increased risk of lung cancer is found due to radon exposure.

Finally, another source of risk comes from humidity, which can lead to microbial pollution caused by bacteria and mold that grow inside domestic environments, potentially causing respiratory symptoms, allergies and asthma, as well as alterations of the immune system.

IHD is the leading cause of death and disability worldwide: hypertension, diet, physical activity and cigarette smoking are the most important risk factors, but many other environmental factors are crucially involved in its development. The most important risk factor is air pollution, which increases both the risk of developing IHD and the risk of dying from the same disease. Household fumes, several chemicals (such as lead and arsenic) and noise pollution are also been recognized as risk factors for this disease. Globally, 35% of total burden of IHD is attributed to environmental causes.

Heart attack is the second leading cause of death globally. Its risk factors are similar to those of IHD, being hypertension the main. Other important risk factors are dietary habits and active smoking. Evidence of the association between IHD and prolonged exposure to fine particulate matter (PM 2.5) is increasing. The use of chemical agents has also been associated with increased risk of both developing hypertension and having a heart attack.

COPD is a progressive disease characterized by a gradual loss of lung function, whose main risk factor is active smoking. Indoor air pollution is also associated with the development of COPD.

Asthma is an inflammatory condition of the respiratory system; although the main determinant of asthma is genetic predisposition, it is equally recognized that air pollution plays a role in inducing oxidative stress, that in turn lead to inflammatory responses, the latter being peculiar characteristics of asthma.

Major diseases of the musculoskeletal system include: rheumatoid arthritis, osteoarthritis, back and neck pain, and gout. These are part of a group of about 150 musculoskeletal conditions. In addition of being associated with poor ergonomic habits (occupational exposure), they may also be associated with obesity and other factors having an environmental component.

It has been estimated that 6% of infant deaths are due to congenital anomalies. Exposure to secondhand smoke in pregnant women appears to increase the risk of congenital malformations, while the potential role of prenatal exposure to pesticides, organic solvents, air pollutants, and congenital heart disease has been explored.

Behavioral, neurological and mental disorders

Fifteen percent of adults older than 60 years suffer from a mental or neurological disorder. The main ones include: depressive unipolar disorder, bipolarism, schizophrenia, alcohol or drug abuse, anxiety, eating disorders. Most of these diseases are linked to environmental or occupational activities.

Depression is frequently associated with job stress and with specific occupations: for example, it is frequently diagnosed among war veterans. Depressive states affect more than 350 million individuals worldwide.

Post-traumatic stress disorder is associated with disasters such as floods, earthquakes and fires.

Anxiety-related disorders may be associated with occupation; environmental factors may exert an influence on the risk of developing schizophrenia. Alcohol and drug abuse may also be associated with the work environment.

Major neurological disorders include: Alzheimer's disease, Parkinson's disease, multiple sclerosis, headaches and migraines.

For Parkinson's disease, the association with occupational and non-pesticide exposure has been investigated.

Epilepsy appears to be related to brain injury, neurotoxic exposures and air pollution. Epilepsy is also considered to be the consequence of some environment-related diseases, such as stroke and the cerebral form of malaria.

In multiple sclerosis, lack of sun exposure (related to vitamin D deficiency), passive smoking and Epstein Barr virus (responsible for infectious mononucleosis) increase the incidence of the disease.

Insomnia appears to be related to both occupational and residential exposure to noise, as well as occupational stress, irregular shift work or jet lag.

Lights, air quality, smells, stress and noise play a major role in migraine.

Exposure to several chemicals has also been associated with developmental effects on the nervous system. Exposure to lead in infancy has been associated with attention deficits, and there is abundant evidence on the association between many other chemical compounds and disturbances on nervous system development. Perinatal exposures to endocrine disruptors, such as some insecticides, appear to be associated with autism and attention deficit, although current evidence is limited.

Intentional and unintentional injuries

Environmental diseases also include both unintentional (including traffic accidents, poisonings, falls, burns, drownings) and intentional injuries (including interpersonal violence, self-harm).

CONCLUSIONS

The WHO and United Nations Compendium aims to provide an overview of health and environmental guidelines to be applicable to environmental conditions to try to reduce many communicable and non-communicable diseases as well as intentional and unintentional injuries, all of which are listed as environmental diseases in the 2016 WHO report. Preventive actions through the creation of a healthier environment should be an important component of most disease control strategies.

The 2030 Agenda for Sustainable Development calls to reduce by one third deaths from the four major NCDs (cardiovascular diseases, tumors, chronic respiratory diseases and diabetes). Better management of NCDs, including detection, screening, and treatment of these diseases, as well as access to palliative care for patients who need it, is imperative. High-impact interventions can be delivered through primary health care to enhance early detection and treatment. In fact, these interventions have been shown to be good economic investments because they can reduce more expensive treatment.

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