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The Impact of Climate Change on Paediatric Oncology

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Abstract

Background: According to some experts, climate change will be the greatest health-related hazard in the 21st century. It is understandable that harmful effects due to climate change will be the greatest among poor populations living in the hot climate zones; however, they will have impacts worldwide.

Aims: To summarize the evidence of climate change in the field of paediatric oncology.

Methods: Articles relating to climate change and paediatric oncology were reviewed. The review was restricted to studies that included information on climate change and effects on subjects 18 years of age or younger.

Results: Currently detected harmful effects of climate change are expected to cause further unfavourable consequences within the health system and therefore within the paediatric oncology:

1. Current relationship of certain tumours to geographic regions, as well as the relative occurrence of these tumours, is changing.

2. Numbers of cases of childhood malignant diseases are expected to increase.

3. As a result of migration from economically underdeveloped countries, more foreign patients are expected to arrive in the developed world and they will require health care.

Conclusion: Increasing health-related effects of climate change are expected to lead to new challenges for the health care system – including the important field of paediatric oncology – that must be dealt with as soon as possible.

Keywords: Climate change; Paediatric oncology; Migration; Incidence; Mortality; Socio-economic status

Introduction

A number of publications have drawn attention to the serious consequences of global warming caused by accumulation of greenhouse gases (mostly carbon dioxide) and potential unfavourable effects global warming may have on children's health. According to some experts, climate change will be the greatest health-related hazard in the 21st century [1]. These harmful effects will be greatest among poor populations living in the hot climate zone; however, they will have impacts worldwide [2]. In the wealthy (developed) countries, childhood population contributes 20% to the total population, while in developing countries it can go up till 40% [3]. However besides their number and proportion it is more important to recognize the much higher sensitivity to all climate effects that children experience compared to adults. Especially in the light of the importance children have as trustees of the future [4].

Children suffer disproportionately more any harmful effects of the rapidly changing climate [5,6]. Paediatricians should be adequately informed about these trends in order to be able to help in ameliorating these adverse effects in the hope of health and well being of future generations. Hence it is of high importance, the International Society of Social Paediatrics gives an overview about the problem of climate change for children and propose action against these adverse effects [7]. However among the few paediatric publications available we have not found any data about the impact of climate change on paediatric malignant diseases. The aim of this publication is to describe some aspects of this problem. We address two questions: what changes can be expected due to climate change and what can be done about the anticipated harmful effects, as well as for prevention.

Methods

A systematic search for publications on the effect of climate change on paediatric oncology in PubMed and Medline found almost no citations. We therefore searched for publications on

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Table I: Relativ frequency of selected tumours in tropical and in developed countries.

Tumor	Country (Region)	Relative Frequency (%) of All Pediatric Tumors
Hepatocellular carcinoma	Developed countries	0,18
	Zimbabwe	3,3
Nasopharyngeal carcinoma	Developed countries	< 1,0
	Sudan	14,7
Oral carcinoma	Developed countries	0,2
	Bangladesh	3,2
Kaposi sarcoma	Developed countries	< 1,0
	Malawi	6,0
Burkitt's lymphome (endemic)	Developed countries	1,3
	Uganda	47
Skin carcinoma	Developed countries	< 3
	Tunisia	9

association of childhood cancer and consequences of climate change. The main search terms included: paediatric cancer and epidemiology (geographic patterns); childhood cancer and climate change; climate change and migration; population mixing and malignant diseases; transcultural-, communication problems and migration; (childhood) cancer and socioeconomic environment. Inclusion criteria were limited to representative publications related to different consequences of climate change. References cited in selected papers were tracked to find further studies related to the topic. We also used data described in handbooks by Pizzo and Poplack and by Kliegman et al. [8,9].

Results

Regional differences of the relative frequency of paediatric malignancies

There are significant differences in the relative distribution of paediatric tumours between various geographical regions [10-27]. Selected differences are summarized in Table I. Due to increasing population mixing all over the world, the relative frequency of paediatric tumours experienced in the developed world is expected to change, too. In the developed world, leukaemia represents the most frequent form of childhood cancer followed by tumours of the central nervous system. Burkitt's lymphoma makes up only 1.3% of childhood tumours while in Africa it accounts for almost 50% of all childhood tumours. This huge difference is explained by different pathogenesis. While exposure to Epstein-Barr virus is proven in 95% of the African Burkitt's tumours, the same virus primarily causes infectious mononucleosis or asymptomatic infection in temperate zones. Similarly, T-cell Acute Lymphoid Leukaemia (ALL) caused by the Human T-cell Lymphotropic Virus type 1 (HTLV-1) that is observed in countries of the Caribbean region and Japan does not occur in other regions. In Brazil, the childhood incidence of adrenocortical carcinoma is 2.8 per million, ten times higher than the number diagnosed in other regions.

Among the tumours with great differences in geographical distribution, Kaposi's sarcoma is of high importance. It is a very rare disease within the temperate zone and occurs almost exclusively in elderly people [28]. However, in Africa it makes up 9 to 13% of all tumours, and it is often diagnosed in children, too. It is frequently associated with Acquired Immune Deficiency Syndrome (AIDS); in the United States 95% of all Kaposi's sarcoma cases occur in AIDS patients. Kaposi's sarcoma accompanying AIDS has become scarcer in countries with well-developed health care system since the introduction of antiretroviral therapy; on the other hand, in Africa it continues to spread [28]. In Zambia researchers analyzed all Kaposi's sarcoma cases diagnosed between 1980 and 1992 [12]. Of 915 cases, 9.25% involved people younger than 14 years of age. The age range was 7 months to 14 years, with an average of 5.62 years. In tropical countries, incidence of Hodgkin's lymphoma of childhood and adolescence has increased due to the pandemic occurrence of HIV infections [13].

In developing countries, liver cancer is also more frequent in children because of endemic hepatitis B. 70% to 90% of children born to HBV-positive mothers (early antigen: HBeAg) are reported to be infected within 2 years after birth, and 90% of these patients – similar to the conversion rate of elderly people – will convert to chronic active hepatitis and to cirrhosis that may lead to liver carcinoma. Vertical transmission of HBV infection of newborns and infants in developed countries has decreased drastically since the introduction of mandatory HbsAg screening of mothers and preventive vaccination [29]. Unfortunately, this does not characteristically happen in economically underdeveloped countries.

Climate change and Migration

Because of climate change, the South Temperate Zone will be marked by increasing drought; at the same time, inundated areas are spreading, vector-borne diseases increasing, and natural disasters are becoming more and more frequent [30]. Due to drought arable soil and water resources continue to decrease. Currently, food shortages and starvation are on the increase; and today these problems affect approximately 800 million people. Furthermore, drinking water supplies are on the decrease. The current situation is hardly comprehensible: 1.5 billion people lack clean potable water [31-35]. In addition, 2.6 billion people do not receive elementary health care - and these numbers are going to increase [31,34]. All these problems may lead to pandemics with enteropathogens [35]. Social tensions and the number of international conflicts are increasing. Taken together, these trends are expected to lead to increasing population migration as people attempt to escape to safer areas [4]. Children among the 200 million people who are likely to have to flee their homes as deserts spread and sea levels rise will suffer the most because of their high vulnerability to diseases [36].

Poverty and the lack of arable land result in a flow of rural populations to cities, leading to increased urbanization. On a larger

Table II: Factors leading to increase in incidence of malignant diseases due to climate change.

- Increased ultraviolet radiation in tropical countries
- Urbanization
- Population mixing (viral infections)

scale, populations from tropical and low income countries are migrating to other countries hoping for a better living. In 2007 16.7% of the population of Sweden consisted of immigrants. In the United States, just the Central and South American immigrants accounted for 15% of the total population, and by 2050 this will probably increase to 30% [37]. The proportion of people coming from Africa in France, Italy and the Benelux countries is also increasing. In Germany an ever-increasing proportion of urban population is of Turkish or Chinese origin, from the migration crisis of 2015 of Syrian, Afghan and Pakistan origin. Even in East-European countries like Hungary the proportion of Chinese immigrants keeps increasing.

Climate change and the incidence of malignancies

Foreseeable challenges of climate change may include not only the occurrence of tumours that are now unusual in developed countries but also increased incidence of childhood cancer.

The role of climate change in increased incidence of skin cancer is documented [38-42]. Furthermore, tumour-causing effect of urbanisation has been shown, and as noted, urbanisation is increasing as the climate changes. In 2005, Adelman et al. [42] studied the incidence of acute lymphoid leukaemia in patients less than 5 years old in large cities of various size and within the regions close to or far from large cities [43]. They found an increased relative occurrence of leukaemia in parallel with the size of community in which children lived. In studies on the incidence of cancer in the vicinity of nuclear power plants, higher rate of immigration within a short time period was found to be associated with increased incidence of malignant diseases. In Great Britain, Kinlen et al. [44] studied variations in occurrence of childhood leukaemia and non-Hodgkin's lymphoma in regions where more than 1000 people were working on rural non-nuclear construction sites at least 20 km from large towns. They stated that during the construction and the following year there were 37% more cases of leukaemia and non-Hodgkin's lymphoma, which was similar to or even exceeded the increase of frequency seen within the construction area of the Sellafield nuclear plant.

A study of several case clusters of childhood leukaemia and lymphoma has demonstrated that besides population-mixing where sudden increase in population, there may be mixing when there is higher proportion turnover without rapid growth; both of these processes may contribute to an increased incidence of these childhood malignancies, possibly as the result of infectious agents that induce malignancies [45]. In Japan the occurrence of the leukaemia caused by HTLV-1 infection was increased significantly by migration from the endemic area – redrawing the epidemic map of Tokyo [14]. In Hungary, Nyári et al. [46] demonstrated an increased incidence of malignant diseases among children due to migration. In France the effect of change of domicile between 1990 and 1999 on incidence of childhood hemopoietic malignancies was studied. They found that migration increased the number of malignant cases, and the farther away a person came from the greater the change was. The higher percentage of population was not native born (newly arrived population), the greater the relative risk of childhood leukaemia was found [47-48]. From publications summarized here,

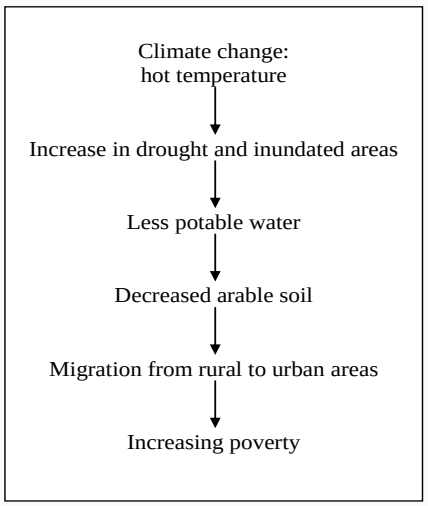

Figure 1: How Climate Change Affects Health.

it can be predicted that climate change will potentially increase the incidence of childhood cancer due to a higher rate of migration from the developing world, by population mixing, and furthermore by increasing exposure of children to negative environmental effects of climate change like ultraviolet radiation [40-41]. Table II However, the exact magnitude of all these effects cannot be yet calculated.

Climate change and socio-economic changes

Besides urbanization and migration there is another link between climate change and malignant diseases: increased poverty caused by the climate change [34]. Figure 1 poverty means deprivation: an unhealthy lifestyle, destitution and low access to health-care system. It is not surprising that more than 30 foreign and several Hungarian studies have shown a connection between the socio-cultural status and mortality [49-52]. A similar association with respect to malignant diseases has also been shown [53]. According to a Swedish survey published in 2009 unfavourable effect of deprived social conditions on tumour-related mortality continues to increase [54]. In 1997 the International Agency for Research on Cancer (IARC, Lyon, France) collected data on cancer-related mortality from 20 countries and analyzed them according to socioeconomic status. The resulting report revealed that the relative risk of tumour-related death in the lowest income class was significantly higher than that of the highest social class for both men and women [54].

In less favourable social conditions the diagnosis is often delayed by lower education and limited access to health-care so malignant diseases often get recognized in an advanced stage. Infections occur with a higher rate, patients show decreased resistance, release after intensive therapy is hampered by poor conditions seen in patients' home, compliance is not optimal [55,56]. In consequence longer hospitalization is needed and complication rate is higher. Increasing poverty due to climate change is expected to lead to a less favourable outcome of childhood malignant diseases.

Discussion

We can state that the currently increasing harmful effects of climate change will cause unfavourable changes within the health-care system and therefore within paediatric oncology.

1. Current relationship of certain tumours to geographic regions, as well as the relative occurrence of these tumours, is

changing.

2. The numbers of cases of childhood malignant diseases are expected to increase.

3. As a result of migration from economically undeveloped countries, more foreign patients are expected in the developed world and will challenge health care system.

What can be done to prevent or decrease the effects of climate change?

The basic questions are:

- How can we get prepared for these changes?

- What can we do to prevent and/or diminish these negative effects?

The most important step would consist of stopping the main cause of the process – decrease gas emissions – that lead to climate change and are in direct association with impoverishment of the developing world, increase in number of starving people, and number of early deaths. This is an issue of social attitude, of socio-political decision-making. However, there is need for physicians' help in drawing attention to the serious health-related consequences of climate change and to the fact that this may concern not only those living in tropical areas and the developing world but will inevitably have a global effect, concerning the developed world, too.

An imposing task will be to expand the medical university curriculum to include the presentation of health effects of climate change and related actions of health-care system that will be required [57]. University undergraduate and post-graduate courses should include special types of childhood malignant diseases that so far occurred mostly in the tropical areas. This is prerequisite not only in preparation for the expected effects, but also for informing the society about the health effects of climate change. Further studies, publications, and conferences dealing with climate change and its challenges for health-care system, as well as implications for oncology, may also help in drawing attention to this problem and may shape the social context [34].

Supporting the developing world's health-care system, partly by voluntary personnel participating in education of students who come from the developing countries to the universities of the developed world may help a great deal in eliminating climate change-related hazards, as well as in preparation for them [58]. A significant decrease in malignant diseases caused by hepatitis B and AIDS could be achieved in the developing countries by the introduction of systematic screening and vaccination of pregnant women and newborns. A successful model is provided by Taiwan, where incidence of hepatocellular carcinoma of between 6 and 9 years of age was reported in 1997 to decrease from 0.52 per 100,000 to 0.13 per 100,000 after the introduction of hepatitis B vaccination [15]. The treatment of HIV-positive mothers during pregnancy could decrease congenital AIDS disease of newborns from the current 20 to 30% to a level of 1 to 2%.

Due to significantly increased migration to the economically developed countries, we will have to be able to treat more children suffering oncologic diseases arriving from tropical or Far Eastern countries. This will be complicated by the fact that often neither the children nor the parents will be able to speak the local language. This may create yet another problem: during the healing process it is very important to establish a good physician-child and physician-parent relationships which requires mutual understanding. Without this, neither history-taking, nor explanation of treatment and obtaining consent can be accomplished efficiently, and any further discussion of the problems arising on both sides becomes impossible. Access to help of interpreters and presentation of written material may solve this problem. In order to gain trust – without which there is no healing – we have to understand each other, and we have to respect patients' cultural and religious attitudes [37]. In different cultures non-verbal communication may be different. We have to struggle with this problem, which is globally affecting the developed world, by providing special training on the importance and methods of a trans-cultural approach to the staff of health-care system. We have to be aware that it takes time to adapt this attitude [37,59]. Multiple studies should be conducted to deal with this problem, and ways of solution of arising difficulties should be presented during special training for nurses and physicians. We must not forget that discrimination on racial or ethnic basis has not disappeared completely, and our society has not been able to eliminate it. We must see to it that it does not have any effect in the health-care system.

Conclusion

In summary, the increasing health-related effects of climate change may pose problems and challenges for the health-care system – including the important area of paediatric oncology – that must be dealt with as soon as possible.

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