Journal of Environment Pollution and Human Health, 2016, Vol. 4, No. 2, 52-59
Available online at http://pubs.sciepub.com/jephh/4/2/3

DOI:10.12691/jephh-4-2-3

Environment and Human Health

Maria Alzira Pimenta Dinis*

Fernando Pessoa University (UFP), UFP Energy, Environment and Health Research Unit, (FP-ENAS), Energy, Environment and Environmental & Public Health Research Laboratories, (3ERL), Praça de 9 de Abril 349, Oporto 4249-004, Portugal
*Corresponding author: madinis@ufp.edu.pt

Abstract The living environment role in the health of individuals evolves. The world changes and it is important to analyse the relevance of the environment to health at the light of different factors. Increasing evidence exists that human health is influenced by our way of living and dealing with the environment. In a society where inequalities exist, it becomes clear that a positive relation exists between a good living environment and people's well-being. From the way we interact with each other through social contacts until the way we treat environment, with its consequences, all accounts to our well-being and mental and physical health. Social relationships are directly connected to a healthy environment and are a beneficial part of this equation, allowing persons to be healthier and to live longer. Clearly, a person's individual characteristics plays a crucial role in these connections, since these relations do not constitute an exact science. It is essential to pay attention to the way emerging economies conduct their development, because it carries important responsibilities for the future of the next generation with adverse impacts caused by pollution and representing a threat to human health and well-being. The associations between environment as a whole and human health are very complex. However, some clues may enlighten us regarding some connections between both study areas.

Keywords: *environment, human health, living environment, pollution, urban planning*

Cite This Article: Maria Alzira Pimenta Dinis, "Environment and Human Health." *Journal of Environment Pollution and Human Health*, vol. 4, no. 2 (2016): 52-59. doi: 10.12691/jephh-4-2-3.

1. Introduction

As stated by Verheij [1], health is believed to be influenced by both ecological (aggregate) as well as individual characteristics, yet much large scale sociological and geographic research focuses on either the individual or his environment. Thus, it has become to make sense to study individual and environmental determinants in health simultaneously aiming to answer to the question: *What is the role of the environment in explaining the health of individuals?* In fact, this question makes even more sense today when we are able to see that scientists cannot make politics to understand what is at stake relating global warming, for instance, and all the consequences arising from their actions. We know that a more sustainable future should rely in the built environment.

In Western societies, the relevance of the environment to health has become obscured or it is narrowed, relating specific toxic, infectious or allergenic agents and broader psychosocial mechanisms are rarely given importance. On the other hand, it becomes evident that a more strategic approach needs to be found, enabling environment and health to be related, namely in what concerns contemporary health [2]. At this respect, it is also important that researchers from different disciplinary and methodological backgrounds are able to work together to maximise the value of each approach to the research and to health promotion [3,4]. Accordingly, it is clear that it is more expensive to focus our responsiveness in what is already made than to pay attention to the design of new European Union and supporting infrastructures [5]. It is also true that in the past, research emphasis has been primarily on urban constraints rather than on urban opportunities and that positive aspects of urban living potential are often insufficiently appreciated [1].

Considerable energy savings would be achieved by altering existing buildings but it is not easy to do that without expressive economic incentives. In China, a country whose environmental concerns are increasingly being considered, Wang [6] has concluded that advanced renewable energy should be developed and made available use of by rural residents, representing also considerable environmental and public health benefits. An Energy and Environmental Prediction model would be able to retrieve important information to allow the development of a sustainability plan that enables to improve energy efficiency since, unfortunately, energy is still considered by societies as relatively cheap. Among other data, the model enables to predict housing energy use and carbon dioxide emissions, neighbourhood quality and home hazards, between several other parameters. More recently, the work of three authors [5] aimed to automate the collection of data through the use of pattern recognition and satellite imaging to identify building types and age, allowing to speed up data access and acquisition, thus representing an improvement towards data collection.

2. The Effect of Living Environment on Human Mental and Physical Health

According to different authors, it is important to account with the effect of living environment in health,

since that effect is demonstrated through geographic health inequalities [4,7,8,9,10]. In fact, the very same authors acknowledge that the social ecology model emphasises that health is influenced by several aspects in terms of the physical and the social environment, besides several other features. This model has been gaining importance in terms of health promotion [11]. Hawe and Shiell [4] also suggest that epidemiology and ecological-level studies may link social capital and health, thus alerting health promoters to reverse the tendency of interventions and allowing urban designers, sociologists, geographers and ecologists to get involved into public health.

Maas et al. [12] also state there is increasing evidence that a positive relation exists between the amount of green space in the living environment and people's health and well-being. In fact, the authors refer that green space may have a beneficial effect on health because it promotes social contact through activities occurring in meeting places. The therapeutic power of green spaces has been studied in the last decades, with accumulating evidence available for their restorative power [13,14,15]. Shared gardening - already appearing on Portugal, for example, under the designation of "community garden" - is one of those activities.

Social contacts may in fact assume different forms and it is well recognised that social relationships are important in terms of different health aspects [4,16]. Kawachi et al. [17], among several other authors, say that social engagement is important for persons to live longer [17, 18] and to be healthier, both physically and mentally [18,19]. There are numerous references in the literature relating neighbourhood relationships benefits. It is important to be aware that, however, neighbourhood in urban areas is more likely to deteriorate due to dealing with vandalism, for instance, or lower levels of social control, since that kind of living environment acts as a constraint. On the opposite, people living in more rural areas tend to socialise more, according to Maas et al. [12] The same authors have performed a study which showed that people with more green space in 1 km radius around their home have better self-perceived health, have experienced fewer health complaints in the last 14 days and have a lower propensity for psychiatric morbidity. However, the study has also shown that it is not possible to establish a clear relationship between green space proximity to home and people's health, but there seems to be a clear positive relation between green space and social support.

Verheij [1] also says that the extent to which the environment exerts influence on a person's health is dependent on that person's individual characteristics. In that sense, gender may be differently influenced by the environment, implying that, for instance, social networks may be more important to women's health than for men's health, since it has to do with a group being more tied to the house and immediate neighbourhood, and that is the case of women. The same author explains that the referred urban disadvantages regarding health may also have to do with urban constraints emphasis, rather than opportunities. On the other hand, the possible effect on health of both urban constraints and opportunities may in fact depend on the person living in that environment, as implied before when referring to individual characteristics. In recent years, some international organizations have been giving prominence to the relationship between the physical environment and human health [18,20,21,22,23,24]. Until now, physical environment is seen as a narrow activity with only limited relevance to human health [2].

In terms of public health policy, the physical environment, comprising the full spectrum of biological, physical and chemical entities, either natural or man-made, has been a target across the world [2]. The social environment is in fact multi-defined, both in terms of concept and measurement. Stokols [25] believes that people will experience better health when living in environments where they are happier due to being socially more active, experiencing a better relation between neighbours and feeling more safe. A set of different features contributes to this understanding. Several authors [26,27,28] have chosen a random set of adults, recruited from 10 different areas in England, to perform a study aiming to explore the relative importance of the perceived physical and social neighbourhood environment for physical and mental health. They interviewed those persons and used multiple regression to explore the independent associations between environmental factors and physical and mental health. They have come to the conclusion that socio-economic factors alone could not explain the associations between neighbourhood perceptions and health. According to these authors, it seems that in terms of physical health it is important to have the possibility of walking to different areas in the neighbourhood, and that social support is more important in terms of mental health.

Healthy communities were defined by Dannenberg et al. [29] as the ones that were able to protect and improve the quality of life of their citizens, promote healthy behaviours and minimise hazards for their residents, while preserving the natural environment. This understanding emphasises the effect on health of the built environment, widely acknowledged, including all created and modified environment. According to Kawachi et al. [30], sedentary lifestyles and social isolation reduce the degree of cohesiveness in social relations and decrease social capital. Thus, structural degradation may follow because residents are less willing to maintain their physical environment [31].

The review performed by Verheij [1] and centred in explaining urban-rural variations in health, has led to the conclusion that regarding cancer as a very important disease, most types were more common in urban areas with the exception of leukemia, Hodgkin's disease and possibly cancer of the oesophagus. For most types of cancer urban excess seems to be typical of men, probably due to gender differences in lifestyle. Regarding musculoskeletal disorders, urban morbidity was higher than rural morbidity in women. In terms of the circular system, urban excess morbidity was found. Several authors cited by Verheij [1] referred urban environment to be more stressful, thus leading to higher levels of mental disorder. On the other hand, inequalities have been increasing in almost all developed countries, and also in Portugal [32]. Disadvantaged groups suffer from the lack of accessibility to health care and are more susceptible to loneliness, illnesses and mental disorders.

Poverty leads to exclusion, and this one leads to isolation, banishing people from social networks. In this context, the surrounding environment (social and physical

one) is even more important because it acts as an anchor in people's lives. Therefore, there are many different aspects playing different roles in the relation between the living environment and human health.

The work environment has also effect on health. At this regard, Bambra et al. [33] have studied several reviews on the subject and came to the conclusion that adequate organisational workplace interventions may potentially reduce health inequalities between employees, particularly between gender, men and women.

3. Evidence-Based Study for Identifying Health Risk Factors and Some Clues to the Future

Epidemiology has the power to influence the quality of evidence base, and thus it presents difficulties for the discipline of environmental health [2]. According to Susser and Susser [34] its development has been continuously refined due to its confront with the causes of different nature of chronic disease. The two authors have identified a paradigm they have chosen to call "black box paradigm", where the ecological perspective is diminished and health status and risk are linked. This paradigm was dominating the era of chronic disease epidemiology.

It is true that epidemiology - always focusing in questions arising from the difficulties resulting from the study design [2,35] - points to risk factors in individual behaviour or life style and so, change in life style would become the direct target for policy and required actions. Those actions involve two concerns: the mode of intervention and the means of the intervention. The first one has to do with the fact that the intervention is able to remove an exposure or reduce it to safe levels, and the second one implies issues like the environmental control in legislative, fiscal and administrative structures [2]. On the other hand, and according to the same authors, interventions should have two important components: a significant progress towards a desired change and a process must exist whereby the intervention may be applied and be effective.

At this point, it makes sense to emphasise that the Commission of the European Communities [21] has pursed regulations in 2003 not taking into account antagonistic, additive or synergistic interactive effects between polluting agents. Morris et al. [2] state, at this respect, that many plausible interventions cannot perhaps be undertaken under an exclusive regulatory approach and that environmental health must embrace new ways of gathering, arranging and interpreting evidence and putting less emphasis on strict legislation. On the other hand, Joas et al. [36], explain in detail how human biomonitoring surveys are a useful instrument in policy surveillance, identification of new risks, and benefits for risk assessment and chemicals regulation in the European Union. An integrated conceptual framework combining biomonitoring, environmental and clinical epidemiology and social sciences, was developed by Andersen et al. [37] to characterize environmental challenges and related health issues, thus combining experts from different areas of knowledge and contributing to provide novel estimates of the burden of early childhood diseases attributable to environmental exposures and allowing epidemiology to promote an increased use of biological evidence.

A potential source of error in epidemiological studies is recall bias, this is, people believing to be exposed to hazardous substances, for instance, are more susceptible to report health conditions and subjective symptoms, they believe to be attributable to the suspected exposures [38]. This may result in incorrect data. On the other hand, it is important to make sure that when existing, extrapolations between evaluating the risk to health in situations far lower than those where toxic potential was originally demonstrated are hardly sustainable, given the scarce data for very low levels of exposure. A similar situation happens when making extrapolations from animal studies to humans.

The role for physical development in terms of socio-economic health is not always clear. Medical science, for example, is investigating the possibility of the poorer being more susceptible to a myriad of stresses, even when taking into account the existence of comparative behaviours, thus emphasizing the importance of environment not presenting an obvious risk. One must then be cautious when viewing public health something far beyond evidence, when considering it as including moral and philosophical criteria which will deliver a beneficial outcome [2]. Conventional science may not be the solution for all questions.

4. Specific Concerns Relating Waste Practices

In fact, the connections between environment and health may assume different aspects. We all recognise that in developing countries, public health attention is focused on urgent problems such as infectious diseases, malnutrition and infant mortality. However, in developed countries, where industry assumes special relevance, health concerns are also clearly related with wastes generated by industry [38]. Orloff and Falk [38] have gathered information from several sources relating waste activities in several countries. According to them, infectious diseases are the world's primary cause of death in children and young adults and malnutrition affects one in each three children in developing countries. Given the lack of economic resources in those countries, it is not difficult to understand why so little attention is being paid to health impacts of wastes, in opposite to deaths caused by urgent health issues. In developing countries, major sources of hazardous wastes are frequently related to mining and ore processing, oil production and agriculture. In third world countries management practices of wastes may be considered inadequate due to insufficient financial investment and lack of awareness, particularly in healthcare centers [39].

Landfilling is the most popular means of hazardous waste disposal and may consist, in some of those countries, in burying the wastes or dumping them on the surface of unused land. Such processes, if conducted in the absence of good practices, may contaminate valuable water resources. It is known that water quality is a major concern in respect to the presence of potentially harmful bacteria, protozoa, and chemicals [40].

If landfilling is, in developing countries lacking economic resources, the primary means of hazardous waste disposal, incineration, also assumes great importance, being able to reduce the waste to be landfilled up to 90%, its weight by 60 to 70%, with facilities also designed to generate electricity. One of the main concerns of incinerating hazardous chemicals has to do with products of incomplete combustion, namely dioxins, among others. As outlined by Dinis [41], in a review focusing some common solid waste management technologies and their effects in the environment and health, landfills bring with it inevitable consequences like gas generation and leachates. At the present, plastics - and its current usage is not sustainable - which accumulate in landfills assume particular importance, due to correlation of adverse effects to the human health that include reproductive abnormalities [42]. On the other hand, incineration can be used where no other technological solution is available, but, in both cases, there will always be consequences to those living nearby, like odours, litter, noise, heavy traffic, and more [41]. According to Sharma et al. [43], who reviewed the impact of incinerators on human health and environment, 10% – 25 % of the total wastes generated by health-care organizations, are biomedical wastes, which are hazardous to humans and the environment and need specific treatment and management. Incineration was the method of choice for the treatment of infectious wastes and it is now known that it poses a significant threat to public health and the environment. The major impact on health is the higher incidence of cancer and respiratory symptoms and the effect on the environment is in the form of global warming, acidification, photochemical ozone or smog formation, eutrophication, and human and animal toxicity. Incineration may be considered the appropriate alternative for reducing the waste volume, but it is harmful for public and environmental health, being necessary to use lesser environment technologies.

However, a clear association between wastes and human health effects does not seem to be possible, without further assessment [41,44,45]. The weakness in most related epidemiological studies seems to lie in adequate documentation of exposure to hazardous chemicals [38,41], and, at this respect, Johnson [46] has summarised some investigations regarding the impact of hazardous waste on human health, conducted in the United States and in other countries. Thus, in developing countries, and against a high background of death and disease, it seems to be difficult to attribute a disease to toxic chemical exposure.

5. Examples of Associations between Environment and Health throughout the World

Throughout the world it's not difficult to encounter examples of environmental exposure to contamination due to human negligence. In fact, it is fair to say that environmental contamination, one of the biggest problems of our world, is causing heavy and irreparable damage to our environment and directly or indirectly to the human health [47]. The extraordinary economic growth that some countries like China and India are experiencing brings with it a huge responsibility, which cannot be left behind, and are able to compromise the future of the next generations. According to that, the Chinese Environmental Bureau has recently modified its National Ambient Air Quality Standards, since recent air pollution monitoring shows that standards have been exceeded. The benefits of attaining updated standards would have prevented natural, cardiovascular and respiratory deaths [48].

Ground water and surface water resources have been deleteriously impacted in both countries by agricultural runoff, industrial effluents, discharges of untreated human wastes and deliberate dumping. Other countries in Central and Eastern Europe have suffered indiscriminate dumping of hazardous waste in the past with nitrates, heavy metals and other contaminants, which were responsible for heavily contaminating surface water and groundwater. In the Russian Federation, for example, thousands of contaminated groundwater areas have been identified [38]. In order to protect inhabitants, specially children, soils must be remediated, reclaimed and restored, since metallic elements are persistent n the environment, and they bio-accumulate, bio-concentrate and bio-amplify up the food chain [49,50,51]. In a recent study, heavy metals, having implications for food safety, in agricultural soils of the European Union have been studied and the results show that 6.24% of the agricultural land needs local assessment and eventual remedial actions [52]. The same authors also report the effect of the different heavy metals on human health. Recent studies also reveal the concern around general human toxicity, human carcinogenicity, ecological toxicity, endocrine disruption, and antibiotic resistance surrounding active pharmaceutical ingredients in the environment, a crescent source of worry [40,53], also related to sewage transfer to land and water release. Dore et al. [51] stated that wet deposition is the most important process for the transfer of metals from the atmosphere to the land surface, suggesting that major missing sources of annual heavy metal emissions are currently not included in the official inventories.

Many more examples can be found all over the world. Although health effects of exposure to air pollution are established, it is difficult to effectively communicate health risks to public and policy makers [54,55]. According to Schnell et at. [13], studies using mathematical models based on measurements extracted from a small number of fixed monitoring stations are vulnerable to several critiques due to the highly complexity of pollutant distribution patterns, among other factors. It is clear that in most large urban areas air pollution comes, associated with increased cardiopulmonary mortality and morbidity in the population [48,56-69], from the combustion of fossil fuels largely used in motor vehicles, industrial processes, heating and electricity, petrochemical plants and chemical industry [70]. Particularly, cardiovascular and respiratory diseases are associated with short- and long-term exposures to elevated air pollution [48,60,71,72]. On the other hand, in countries under former soviet domination, the production quotas were achieved mainly by burning high sulphur coal, causing numerous environmental and health problems. The situation is being controlled now in those countries, and in the European Union environmental legislation is becoming increasingly restrictive. However, countries like China and India, together with other Asian

and developing African countries, where air pollution is in fact emerging, have not been able to control the situation, while becoming increasingly more urbanised and industrialised [38]. Air pollution may induce adverse health effects through different biological pathways, causing lung and systemic inflammation, leading to vascular endothelial dysfunction, and initiating and progressing to atherosclerosis [73,74] Potential to elicit adverse effects in the cardiovascular system has also been reported [75]. Air pollution is however much more that this and recently a quantitative study by Blanes-Vidal et al. [76] provided the dirst dose-response association between ambient NH_3 exposures and psychosocial effects caused by odor pollution in non-urban residential outdoor environments, concluding that it affects the social health and quality of life of residents, even at concentrations where traditional toxicity is not expected. Given the interest in the health effects of air pollution, multipollutant exposure metrics studied by Oakes et al. [77] highlight the balance between complexity and simplicity in health risk assessment. On the other hand, health impact of air pollution goes beyond the direct costs of medical treatment, including loss of production and consumption, as well as pain and suffering [64]. It is important that environmental-health policy makers may proactively implement prevention strategies to reduce air pollutants [66]. Also, assessment of air pollution exposure must take into account variables such as gender and socio-economic status, considering scientific as well as social aspects [67]. Thus, air pollution will continue to be a major focus of policy and research activity in public health [78].

The problem becomes much worse than it sounds because it crosses borders, causing harmful effects to other countries [70]. More recently, in May/June 2011, a problem has been witnessed relating crop contamination by the *Escherichia coli* bacteria which gained relevance in the world. As a result, it became clear that there are issues of human and animal health protection and crop and food safety that affect all European countries, demanding a concerted action within the EU. As referred by Rodrigues et al. [79] there are technical aspects of site characterisation, risk assessment and remediation that can be harmonised at the same time that there are trans-scientific aspects of these processes that require political choices and that need to be customised by all European Union Member States. This became evident in that crisis.

Soil contamination has been identified as one of the major threats to soil function in Europe, predominantly associated with industrial production and commercial services, municipal waste treatment and disposal, the oil industry - extraction and transport - and industrial waste disposal [80]. However, situations like the ones herein mentioned, clearly highlight, if it's true that the crops being yielded were already contaminated, the relation between soil health and human health. Crops can easily absorb and accumulate heavy metals from contaminated soils because most metallic elements are highly soluble in water [50,81,82,83]. Soil contamination can affect human health significantly through routes such as dietary intake, inhalation, ingestion and dermal contact [50,84,85,86,87]. In that sense, soil contamination may have important consequences in terms of soils' ability to function, failing in terms of providing valuable materials and substrate to human activities, failing in terms of ecological systems and biological cycling of nutrients or even being unable to act as filter and buffer, affecting the hydrosphere, compromising groundwater resources and threatening aquatic ecosystems [88].

In the particular case of Portugal, comprehensive soil contamination and pollution assessments have been developed, particularly at mining sites, with important research into risk assessment and, more recently, soil biology, ecotoxicology and toxicity studies. A more limited number of studies have focused on diffuse and line sources of contamination such as the impacts of urban development on soil systems and the study of metal contamination deriving from highway runoff [89].

Correspondingly, the adverse impacts caused by air pollution raises a question arising increasing attention each year, particularly in a decade where energy dependency on petroleum is meaningful. There have been serious efforts being pursued in order to reduce the impacts, risks and effects of atmospheric pollutants representing a serious threat to human health, namely in Europe where Künzli et al. [64] estimated that thousands of premature deaths are annually attributed to poor quality alone. Sun et al. [90] observed a clear association between exposure during pregnancy to fine particulate matter (PM) and decreased birth weights. Associations between PM with risk for lung cancer have been found by Raaschou-Nielsen et al. [91].

Air pollution effects can be felt in human health and on the environment, but also building materials and historical monuments are severely affected by it [92], acting as passive repositories for air pollutants present in the surrounding atmosphere [93]. There are a number of studies focusing in air pollutants which confirm the need to continue to reduce emissions, particularly when referring to vehicular transport. However, in Portugal, for example, few studies have analysed the acute effect of air pollution on health [94,95]. de Almeida et al. [94] argue that their study is the first linking air pollution to daily mortality in Portugal, finding the association between O_3 exposure, in particular, and the mortality risk of cardiovascular diseases was stronger than non-accidental mortality risk, in Oporto in summer. According to the same authors and just to illustrate the importance of their findings, they claim that taking into consideration that global climate change is likely to increase the number of hot sunny summer days, substantial efforts have to be made to decrease O_3 precursor pollutants in order to decrease health risks. Willers et al. study also highlights the effect of heat, combined with air pollution, on mortality [96]. Thus, in order to account for the effects of climate change in human health, adaptation strategies promoting urban health and well-being in the face of climate change will require an understanding of the feedback interactions that take place between the dynamical state of a city, the health of its people, and the state of the planet and Proust et al. [97] propose conceptual models to do it.

6. Concluding Remarks

New types of interventions are necessary when considering the different ways environment and health are connected. Innovative strategies of intervention, either in

terms of modes and means, placing less emphasis on legislation need to be adopted. Goals to achieve it need to be clearly articulated. An individualistic view of health is not compatible with medical science and epidemiology if faced in an ecology perspective.

As Nogueira [98] argues, the living environment plays a very important role in health and interventions should be addressed looking at neighbourhood environment as a potential source of stress and disease, or well-being and health. Orloff and Falk [38] have called the attention that traditional health practice emphasises prevention and the same principle should be extended to pollution management. In reality, it should be applied to all aspects being relevant to the associations between environment and health, and affecting the world's health and the human health. It's clearly evident that all aspects of human intervention negatively affecting the environment will have negative consequences of human health and the environment itself. In this overview, many aspects relating the analysis of the living environment and human health were necessarily left behind because it is not possible to address of relating issues. Today, we even know that changes in ecosystems, affecting the environmental matrix, and caused be deforestation, for example, may expose humans to peaks of infections, since the dynamics are variable and vectors unpredictable [99]. The scientific examination of the impact of environmental factors on human health will improve the quality of life of people and will allow to achieve health-promoting environments [100]. More comprehensive interdisciplinary research studies are required to fully understand how society can effectively intervene in practical terms, in order to allow people to fully take advantage of the living environment so that it may positively have reflections on human health policies. We then need to act in order to urge society to take actions to control environmental hazards and, at the same time, to enhance health benefits that the living environment is able to provide us. According to that, Europe has recently created human biomonitoring programmes that will help to improve the environmental health of people living in Europe, identifying critical exposure to chemicals and their sources and deriving risk reduction measures [101]. After all, according to the ecosystem health theory, a healthy ecosystem, whether natural or artificial, significantly contributes to the good health status of the human population [102] and it is necessary to think that all fields of science must be integrated in a multidisciplinary manner [103]. Targeted policies for sensitive population groups will contribute to assertive health policies [104].

7. Limitations and Recommendations

The present review does not intend to be focused on one aspect of the possible associations between Environment and Human Health. Instead, it reports several issues regarding concerns present in our society, that reveal these associations are expanding and getting more and more clear. Because of that, many aspects were left behind, but, at the same time a different picture of the situation arises, due to the interconnection between so many different aspects of the problem. It is important that public awareness of all problems associated with the presented association are communicated, in order for actions to be taken regarding a public framework to be established by governments and local institutions, which must also take into account resources sustainability.

References

[1] R. A. Verheij, "Explaining urban-rural variations in health: A review of interactions between individual and environment," *Social Science & Medicine,* vol. 42, no. 6, pp. 923-935, 1996.

[2] G. P. Morris, S. A. Beck, P. Hanlon *et al.*, "Getting strategic about the environment and health," *Public Health,* vol. 120, no. 10, pp. 889-903, 2006.

[3] C. Phoenix, N. J. Osborne, C. Redshaw *et al.*, "Paradigmatic approaches to studying environment and human health:(Forgotten) implications for interdisciplinary research," *Environmental science & policy,* vol. 25, pp. 218-228, 2013.

[4] P. Hawe, and A. Shiell, "Social capital and health promotion: a review," *Social Science & Medicine,* vol. 51, no. 6, pp. 871-885, 2000.

[5] P. Jones, J. Patterson, and S. Lannon, "Modelling the built environment at an urban scale--Energy and health impacts in relation to housing," *Landscape and Urban Planning,* vol. 83, no. 1, pp. 39-49, 2007.

[6] Y. Wang, "The analysis of the impacts of energy consumption on environment and public health in China," *Energy,* vol. 35, no. 11, pp. 4473-4479, 2010.

[7] A. Ellaway, S. Macintyre, and A. Kearns, "Perceptions of Place and Health in Socially Contrasting Neighbourhoods," *Urban Studies,* vol. 38, no. 12, pp. 2299-2316, November 1, 2001, 2001.

[8] H. Frumkin, "Beyond toxicity: human health and the natural environment," *American journal of preventive medicine,* vol. 20, no. 3, pp. 234-240, 2001.

[9] A. E. M. de Hollander, and B. A. M. Staatsen, "Health, environment and quality of life: an epidemiological perspective on urban development," *Landscape and Urban Planning,* vol. 65, no. 1-2, pp. 53-62, 2003.

[10] K. E. Pickett, and M. Pearl, "Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review," *Journal of Epidemiology and Community Health,* vol. 55, no. 2, pp. 111-122, February 1, 2001, 2001.

[11] A. Wagemakers, L. Vaandrager, M. A. Koelen *et al.*, "Community health promotion: A framework to facilitate and evaluate supportive social environments for health," *Evaluation and Program Planning,* vol. 33, no. 4, pp. 428-435, 2010.

[12] J. Maas, S. M. E. van Dillen, R. A. Verheij *et al.*, "Social contacts as a possible mechanism behind the relation between green space and health," *Health & Place,* vol. 15, no. 2, pp. 586-595, 2009.

[13] I. Schnell, O. Potchter, Y. Yaakov *et al.*, "Human exposure to environmental health concern by types of urban environment: The case of Tel Aviv," *Environmental Pollution,* vol. 208, pp. 58-65, Jan, 2016.

[14] K. M. Korpela, M. Ylén, L. Tyrväinen *et al.*, "Determinants of restorative experiences in everyday favorite places," *Health & Place,* vol. 14, no. 4, pp. 636-652, 12//, 2008.

[15] H. Staats, A. Kieviet, and T. Hartig, "Where to recover from attentional fatigue: An expectancy-value analysis of environmental preference," *Journal of Environmental Psychology,* vol. 23, no. 2, pp. 147-157, 6//, 2003.

[16] L. F. Berkman, T. Glass, I. Brissette *et al.*, "From social integration to health: Durkheim in the new millennium," *Social Science & Medicine,* vol. 51, no. 6, pp. 843-857, 2000.

[17] I. Kawachi, B. P. Kennedy, K. Lochner *et al.*, "Social capital, income inequality, and mortality," *American Journal of Public Health,* vol. 87, no. 9, pp. 1491-1498, Sep, 1997.

[18] K. M. Leyden, "Social capital and the built environment: The importance of walkable neighborhoods," *American Journal of Public Health,* vol. 93, no. 9, pp. 1546-1551, 2003.

[19] I. Kawachi, and L. Berkman, "Social cohesion, social capital, and health," *Social Epidemiology,* L. Berkman and I. Kawachi, eds., New York: Oxford University Press, 2000.

[20] W. Bank, *Making Sustainable Commitments: An Environment Strategy for the World Bank*: World Bank Publications, 2001.

[21] CEC, "A European environment and health strategy," Commission of the European Communities, 2003.

[22] OECD, "OECD environment programme 2005–2006," Organization for Economic Cooperation and Development, 2005.

[23] WHO, "Health and the environment in the WHO European region: situation and policy at the beginning of the 21st century." p. 203.

[24] UNEP, UNICEF, and WHO, *Children in the new millennium: environmental impact on health*, p.^pp. 150: UNEP, UNICEF & WHO, 2002.

[25] D. Stokols, "Establishing and maintaining health environments: toward a social ecology of health promotion," *American Psychologist*, vol. 47, no. 1, pp. 6-22, 1992.

[26] A. M. Almedom, "Social capital and mental health: An interdisciplinary review of primary evidence," *Social Science & Medicine*, vol. 61, no. 5, pp. 943-964, 2005.

[27] C. Gidlow, T. Cochrane, R. C. Davey *et al.*, "Relative importance of physical and social aspects of perceived neighbourhood environment for self-reported health," *Preventive Medicine*, vol. 51, no. 2, pp. 157-163, Aug, 2010.

[28] M. J. de Silva, K. McKenzie, T. Harpham *et al.*, "Social capital and mental illness: a systematic review," *Journal of Epidemiology and Community Health*, vol. 59, no. 8, pp. 619-627, August 1, 2005, 2005.

[29] A. L. Dannenberg, R. J. Jackson, H. Frumkin *et al.*, "The impact of community design and land-use choices on public health: A scientific research agenda," *American Journal of Public Health*, vol. 93, no. 9, pp. 1500-1508, Sep, 2003.

[30] I. Kawachi, B. P. Kennedy, and R. G. Wilkinson, "Crime: social disorganization and relative deprivation," *Social Science & Medicine*, vol. 48, no. 6, pp. 719-731, Mar, 1999.

[31] S. Srinivasan, L. R. O'Fallon, and A. Dearry, "Creating healthy communities, healthy homes, healthy people: Initiating a research agenda on the built environment and public health," *American Journal of Public Health*, vol. 93, no. 9, pp. 1446-1450, Sep, 2003.

[32] P. Santana, "Poverty, social exclusion and health in Portugal," *Social Science & Medicine*, vol. 55, no. 1, pp. 33-45, Jul, 2002.

[33] C. Bambra, M. Gibson, A. J. Sowden *et al.*, "Working for health? Evidence from systematic reviews on the effects on health and health inequalities of organisational changes to the psychosocial work environment," *Preventive Medicine*, vol. 48, no. 5, pp. 454-461, 2009.

[34] M. Susser, and E. Susser, "Choosing a future for epidemiology. I. Eras and paradigms," *American Journal of Public Health*, vol. 86, pp. 668-673, 1996.

[35] C. Needleman, "Applied epidemiology and environmental health: emerging controversies," *American Journal of Infection Control*, vol. 25, pp. 262-274, 1997.

[36] A. Joas, L. E. Knudsen, M. Kolossa-Gehring *et al.*, "Policy recommendations and cost implications for a more sustainable framework for European human biomonitoring surveys," *Environmental Research*, vol. 141, pp. 42-57, 8//, 2015.

[37] Z. J. Andersen, R. J. Sram, M. Ščasný *et al.*, "Newborns health in the Danube Region: Environment, biomonitoring, interventions and economic benefits in a large prospective birth cohort study," *Environment International*, vol. 88, pp. 112-122, 3//, 2016.

[38] K. Orloff, and H. Falk, "An international perspective on hazardous waste practices," *International Journal of Hygiene and Environmental Health*, vol. 206, no. 4-5, pp. 291-302, 2003.

[39] M. S. Hossain, A. Santhanam, N. A. N. Norulaini *et al.*, "Clinical solid waste management practices and its impact on human health and environment - A review," *Waste Management*, vol. 31, no. 4, pp. 754-766, Apr, 2011.

[40] S. J. Harris, M. Cormican, and E. Cummins, "Antimicrobial Residues and Antimicrobial-Resistant Bacteria: Impact on the Microbial Environment and Risk to Human Health-A Review," *Human and Ecological Risk Assessment*, vol. 18, no. 4, pp. 767-809, 2012, 2012.

[41] M. A. P. Dinis, "A concise review on some frequently used solid waste management technologies and their effects into the environment and human health," *Revista da Faculdade de Ciências da Saúde*, no. 6, pp. 320-330, 2009.

[42] R. C. Thompson, C. J. Moore, F. S. vom Saal *et al.*, "Plastics, the environment and human health: current consensus and future trends," *Philosophical Transactions of the Royal Society B-Biological Sciences*, vol. 364, no. 1526, pp. 2153-2166, Jul 27, 2009.

[43] R. Sharma, M. Sharma, R. Sharma *et al.*, "The impact of incinerators on human health and environment," *Reviews on environmental health*, vol. 28, no. 1, pp. 67-72, 2013, 2013.

[44] P. E. Rushbrook, "Regional health issues related to hazardous wastes," *Central European Journal of Public Health*, vol. 2 Suppl, pp. 16-20, 1994.

[45] M. T. Smith, C. S. Lea, and P. A. Buffler, "Human population changes caused by hazardous waste," *Central European Journal of Public Health*, vol. 3, no. 2, pp. 77-79, 1995.

[46] B. L. Johnson, *Impact of hazardous waste on human health*: Lewis Publishers, 1999.

[47] C. Zani, F. M. Restivo, M. Carcelli *et al.*, "A biotechnological approach for the development of new antifungal compounds to protect the environment and the human health," *Journal of Public Health Research*, vol. 4, no. 3, pp. 185-189, 2015, 2015.

[48] H. Lin, T. Liu, J. Xiao *et al.*, "Quantifying short-term and long-term health benefits of attaining ambient fine particulate pollution standards in Guangzhou, China," *Atmospheric Environment*, vol. 137, pp. 38-44, 7//, 2016.

[49] C. J. French, N. M. Dickinson, and P. D. Putwain, "Woody biomass phytoremediation of contaminated brownfield land," *Environmental Pollution*, vol. 141, no. 3, pp. 387-395, 6//, 2006.

[50] X. Liu, Q. Song, Y. Tang *et al.*, "Human health risk assessment of heavy metals in soil–vegetable system: A multi-medium analysis," *Science of The Total Environment*, vol. 463–464, pp. 530-540, 10/1/, 2013.

[51] A. J. Dore, S. Hallsworth, A. G. McDonald *et al.*, "Quantifying missing annual emission sources of heavy metals in the United Kingdom with an atmospheric transport model," *Science of The Total Environment*, vol. 479–480, pp. 171-180, 5/1/, 2014.

[52] G. Tóth, T. Hermann, M. R. Da Silva *et al.*, "Heavy metals in agricultural soils of the European Union with implications for food safety," *Environment International*, vol. 88, pp. 299-309, 3//, 2016.

[53] T. L. Sorell, "Approaches to the Development of Human Health Toxicity Values for Active Pharmaceutical Ingredients in the Environment," *Aaps Journal*, vol. 18, no. 1, pp. 92-101, Jan, 2016.

[54] S. C. van der Zee, P. H. Fischer, and G. Hoek, "Air pollution in perspective: Health risks of air pollution expressed in equivalent numbers of passively smoked cigarettes," *Environmental Research*, vol. 148, pp. 475-483, 7//, 2016.

[55] R. Beelen, G. Hoek, O. Raaschou-Nielsen *et al.*, "Natural-Cause Mortality and Long-Term Exposure to Particle Components: An Analysis of 19 European Cohorts within the Multi-Center ESCAPE Project," *Environmental Health Perspectives*, vol. 123, no. 6, pp. 525-533, Jun, 2015.

[56] Y. Sun, G. Zhuang, Y. Wang *et al.*, "The air-borne particulate pollution in Beijing—concentration, composition, distribution and sources," *Atmospheric Environment*, vol. 38, no. 35, pp. 5991-6004, 11//, 2004.

[57] G. Yang, Y. Wang, Y. Zeng *et al.*, "Rapid health transition in China, 1990–2010: findings from the Global Burden of Disease Study 2010," *The Lancet*, vol. 381, no. 9882, pp. 1987-2015, //.

[58] R. Beelen, O. Raaschou-Nielsen, M. Stafoggia *et al.*, "Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project," *The Lancet*, vol. 383, no. 9919, pp. 785-795.

[59] A. J. Ghio, M. S. Carraway, and M. C. Madden, "Composition of Air Pollution Particles and Oxidative Stress in Cells, Tissues, and Living Systems," *Journal of Toxicology and Environmental Health, Part B*, vol. 15, no. 1, pp. 1-21, 2012/01/01, 2012.

[60] W.-T. Liu, K.-Y. Lee, H.-C. Lee *et al.*, "The association of annual air pollution exposure with blood pressure among patients with sleep-disordered breathing," *Science of The Total Environment*, vol. 543, Part A, pp. 61-66, 2/1/, 2016.

[61] F. Liu, Y. Zhao, Y.-Q. Liu *et al.*, "Asthma and asthma related symptoms in 23,326 Chinese children in relation to indoor and outdoor environmental factors: The Seven Northeastern Cities (SNEC) Study," *Science of The Total Environment*, vol. 497–498, pp. 10-17, 11/1/, 2014.

[62] M. Zhou, G. He, Y. Liu *et al.*, "The associations between ambient air pollution and adult respiratory mortality in 32 major Chinese cities, 2006–2010," *Environmental Research*, vol. 137, pp. 278-286, 2//, 2015.

[63] M. Zhou, Y. Liu, L. Wang *et al.*, "Particulate air pollution and mortality in a cohort of Chinese men," *Environmental Pollution*, vol. 186, pp. 1-6, 3//, 2014.

[64] N. Künzli, R. Kaiser, S. Medina *et al.*, "Public-health impact of outdoor and traffic-related air pollution: a European assessment," *The Lancet*, vol. 356, no. 9232, pp. 795-801, 2000.

[65] J. K. Vanos, "Children's health and vulnerability in outdoor microclimates: A comprehensive review," *Environment International,* vol. 76, pp. 1-15, 3//, 2015.

[66] J. K. Vanos, C. Hebbern, and S. Cakmak, "Risk assessment for cardiovascular and respiratory mortality due to air pollution and synoptic meteorology in 10 Canadian cities," *Environmental Pollution,* vol. 185, pp. 322-332, 2//, 2014.

[67] P. Pant, S. K. Guttikunda, and R. E. Peltier, "Exposure to particulate matter in India: A synthesis of findings and future directions," *Environmental Research,* vol. 147, pp. 480-496, 5//, 2016.

[68] S. Li, G. Williams, and Y. Guo, "Health benefits from improved outdoor air quality and intervention in China," *Environmental Pollution,* vol. 214, pp. 17-25, 7//, 2016.

[69] D. Fecht, A. L. Hansell, D. Morley *et al.,* "Spatial and temporal associations of road traffic noise and air pollution in London: Implications for epidemiological studies," *Environment International,* vol. 88, pp. 235-242, 3//, 2016.

[70] UNEP, "Global Environment Outlook 2000," R. Clarke, ed., 2000.

[71] M. Carugno, D. Consonni, G. Randi *et al.,* "Air pollution exposure, cause-specific deaths and hospitalizations in a highly polluted Italian region," *Environmental Research,* vol. 147, pp. 415-424, 5//, 2016.

[72] M. Wang, R. Beelen, M. Stafoggia *et al.,* "Long-term exposure to elemental constituents of particulate matter and cardiovascular mortality in 19 European cohorts: Results from the ESCAPE and TRANSPHORM projects," *Environment International,* vol. 66, pp. 97-106, 5//, 2014.

[73] A. K. Lund, J. Lucero, S. Lucas *et al.,* "Vehicular Emissions Induce Vascular MMP-9 Expression and Activity Associated With Endothelin-1–Mediated Pathways," *Arteriosclerosis, Thrombosis, and Vascular Biology,* vol. 29, no. 4, pp. 511-517, 2009.

[74] E. Tamagawa, N. Bai, K. Morimoto *et al.,* "Particulate matter exposure induces persistent lung inflammation and endothelial dysfunction," *American Journal of Physiology - Lung Cellular and Molecular Physiology,* vol. 295, no. 1, pp. L79-L85, 2008.

[75] Q. Sun, X. Hong, and L. E. Wold, "Cardiovascular Effects of Ambient Particulate Air Pollution Exposure," *Circulation,* vol. 121, no. 25, pp. 2755-2765, 2010.

[76] V. Blanes-Vidal, J. Bælum, E. S. Nadimi *et al.,* "Chronic exposure to odorous chemicals in residential areas and effects on human psychosocial health: Dose–response relationships," *Science of The Total Environment,* vol. 490, pp. 545-554, 8/15/, 2014.

[77] M. Oakes, L. Baxter, and T. C. Long, "Evaluating the application of multipollutant exposure metrics in air pollution health studies," *Environment International,* vol. 69, pp. 90-99, 8//, 2014.

[78] P. T. C. Harrison, "Links between environment and health: possible future directions," *The Science of The Total Environment,* vol. 249, no. 1-3, pp. 103-105, 2000.

[79] S. M. Rodrigues, M. E. Pereira, E. F. da Silva *et al.,* "A review of regulatory decisions for environmental protection: Part I—Challenges in the implementation of national soil policies," *Environment International,* vol. 35, no. 1, pp. 202-213, 2009.

[80] EEA, "Progress in management of contaminated sites (CSI 015)," 2007.

[81] X. Wang, T. Sato, B. Xing *et al.,* "Health risks of heavy metals to the general public in Tianjin, China via consumption of vegetables and fish," *Science of The Total Environment,* vol. 350, no. 1-3, pp. 28-37, 11/1/, 2005.

[82] K. K. Tiwari, N. K. Singh, M. P. Patel *et al.,* "Metal contamination of soil and translocation in vegetables growing under industrial wastewater irrigated agricultural field of Vadodara, Gujarat, India," *Ecotoxicology and Environmental Safety,* vol. 74, no. 6, pp. 1670-1677, 9//, 2011.

[83] W. H. Cheng, and C. K. Yap, "Potential human health risks from toxic metals via mangrove snail consumption and their ecological risk assessments in the habitat sediment from Peninsular Malaysia," *Chemosphere,* vol. 135, pp. 156-165, 9//, 2015.

[84] I. Al-Saleh, N. Shinwari, I. El-Doush *et al.,* "Comparison of mercury levels in various tissues of albino and pigmented mice treated with two different brands of mercury skin-lightening creams," *Biometals,* vol. 17, no. 2, pp. 167-175, 2004.

[85] M. Komárek, V. Ettler, V. Chrastný *et al.,* "Lead isotopes in environmental sciences: A review," *Environment International,* vol. 34, no. 4, pp. 562-577, 5//, 2008.

[86] M. T. Abel, B. Suedel, S. M. Presley *et al.,* "Spatial distribution of lead concentrations in urban surface soils of New Orleans, Louisiana USA," *Environmental Geochemistry and Health,* vol. 32, no. 5, pp. 379-389, 2010.

[87] Y. Lu, W. Yin, L. Huang *et al.,* "Assessment of bioaccessibility and exposure risk of arsenic and lead in urban soils of Guangzhou City, China," *Environmental Geochemistry and Health,* vol. 33, no. 2, pp. 93-102, 2011.

[88] N. M. van Straalen, "Assessment of soil contamination – a functional perspective," *Biodegradation,* vol. 13, no. 1, pp. 41-52, 2002.

[89] S. M. Rodrigues, M. E. Pereira, E. F. da Silva *et al.,* "A review of regulatory decisions for environmental protection: Part II--The case-study of contaminated land management in Portugal," *Environment International,* vol. 35, no. 1, pp. 214-225, 2009.

[90] X. Sun, X. Luo, C. Zhao *et al.,* "The associations between birth weight and exposure to fine particulate matter (PM2.5) and its chemical constituents during pregnancy: A meta-analysis," *Environmental Pollution,* vol. 211, pp. 38-47, 4//, 2016.

[91] O. Raaschou-Nielsen, R. Beelen, M. Wang *et al.,* "Particulate matter air pollution components and risk for lung cancer," *Environment International,* vol. 87, pp. 66-73, 2//, 2016.

[92] N. Marinoni, M. P. Birelli, C. Rostagno *et al.,* "The effects of atmospheric multipollutants on modern concrete," *Atmospheric Environment,* vol. 37, no. 33, pp. 4701-4712, Oct, 2003.

[93] K. Slezakova, D. Castro, A. Begonha *et al.,* "Air pollution from traffic emissions in Oporto, Portugal: Health and environmental implications," *Microchemical Journal,* vol. 99, no. 1, pp. 51-59, 2011.

[94] S. P. de Almeida, E. Casimiro, and J. Calheiros, "Short-term association between exposure to ozone and mortality in Oporto, Portugal," *Environmental Research,* vol. 111, no. 3, pp. 406-410, 2011.

[95] E. Casimiro, J. Calheiros, F. D. Santos *et al.,* "National assessment of human health effects of climate change in Portugal: Approach and key findings," *Environmental Health Perspectives,* vol. 114, no. 12, pp. 1950-1956, Dec, 2006.

[96] S. M. Willers, M. F. Jonker, L. Klok *et al.,* "High resolution exposure modelling of heat and air pollution and the impact on mortality," *Environment International,* vol. 89–90, pp. 102-109, 4//, 2016.

[97] K. Proust, B. Newell, H. Brown *et al.,* "Human Health and Climate Change: Leverage Points for Adaptation in Urban Environments," *International Journal of Environmental Research and Public Health,* vol. 9, no. 6, pp. 2134-2158, Jun, 2012.

[98] H. Nogueira, "Healthy communities: The challenge of social capital in the Lisbon Metropolitan Area," *Health & Place,* vol. 15, no. 1, pp. 133-139, Mar, 2009.

[99] N. D. Preston, P. Daszak, and R. R. Colwell, "The Human Environment Interface: Applying Ecosystem Concepts to Health," *One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases: The Concept and Examples of a One Health Approach,* Current Topics in Microbiology and Immunology J. S. Mackenzie, M. Jeggo, P. Daszak *et al.,* eds., pp. 83-100, 2013.

[100] T. Otsuki, H. Matsuzaki, S. Lee *et al.,* "Environmental factors and human health: fibrous and particulate substance-induced immunological disorders and construction of a health-promoting living environment," *Environmental Health and Preventive Medicine,* vol. 21, no. 2, pp. 71-81, Mar, 2016.

[101] U. Fiddicke, K. Becker, G. Schwedler *et al.,* "Lessons learnt on recruitment and fieldwork from a pilot European human biomonitoring survey," *Environmental Research,* vol. 141, pp. 15-23, 8//, 2015.

[102] S. Tarocco, I. Amoruso, and G. Caravello, "Holistic model-based monitoring of the human health status in an urban environment system: pilot study in Verona city, Italy," *Journal of preventive medicine and hygiene,* vol. 52, no. 2, pp. 73-82, 2011-Jun, 2011.

[103] P. Corvol, "Man and environment, or the complexity of human health," *M S-Medecine Sciences,* vol. 16, no. 10, pp. 1015-1016, Oct, 2000.

[104] A. N. Skouloudis, and P. Kassomenos, "Combining environment and health information systems for the assessment of atmospheric pollution on human health," *Science of The Total Environment,* vol. 488-489, pp. 362-368, 8/1/, 2014.