

# PUBLIC HEALTH AND EPIDEMIOLOGICAL TRANSITION: ENVIRONMENTAL AND CLIMATE MEDIATED RISKS

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**Abstract** - Environmental and climate mediated health risks have increasingly become a priority for the health implications, as the threats are potentially catastrophic and highly complex with the dynamics of direct and indirect effects on diverse health impacts. Different stages of epidemiological transition (ET) provide insights into the health transition, which enhanced understandings of paradigmatic shifts from multi-perspectives of public health developments. This paper proposed “The Age of Environmental and Climate Mediated Health Risks” in this era is now emerged as the latest stage of epidemiological transition, with categorized underlying determinants as the driving forces under these changing patterns of epidemiological and health transition. This paper also recommends a new ecological sense of public health in support of the implied needs of health transition and sustainability developments towards the international trends of global health concerns in this newly proposed Age of Environmental and Climate Mediated Health Risks as the ultimate focus of public health movements in transition.

**Keywords** - Environmental Climate Mediated Health Risks, Public Health Transition, Epidemiological Transition, Global Health Literacy.

## I. INTRODUCTION

Many of the key determinants of health and disease provide insights into the fundamental problems in health transition, whilst an epidemiological transition (ET) enhances our understanding of paradigmatic shifts in public health interventions and developments. Concepts of health are indeed defined in much broader sense that set forth the boundaries in relation to particular health issues or determinants per se, and different determinants of health such as biological, psychosocial, environmental, socio-economical, health behaviour practices, medical advancements as well as ecological determinants imply for different public health approaches [1]. As climate change is the biggest global health threat of the twenty-first century, and from which the resultant health effects will affect most populations in the next decades, hence a new advocacy and public health movement is urgently needed [2].

This paper newly proposed ‘The Age of Environmental and Climate Mediated Health Risks’ in this era is now emerged as the latest stage of epidemiological transition, in which the underlying determinants are the driving forces under these changing patterns of this epidemiological and public health transition from multiple perspectives of many scientific studies and scholastic reviews. Evidential justifications for paradigmatic shift towards the ecological public health approaches and responses to the current health risks challenges are indeed increasingly on the global agenda. This paper recommends a new ecological sense of public health in support of the implied needs of health transition and sustainability developments towards the international trends of global health concerns in this newly proposed Age of Environmental and Climate

Mediated Health Risks as the ultimate focus of public health movements in transition.

## II. ENVIRONMENTAL AND CLIMATE MEDIATED HEALTH RISKS

Many scientific investigations have progressively refined theories and our understandings in the influence of the eco-environments on health, as concepts of diseases are evolving in diverse ways, in which environmental ecological determinants on global climate change and public health is indeed interlinked with the importance of sustainable developments in all forms of beings [2]. No region is immune from the negative impacts of climate change with “the implications for a global population of 9 billion people threatens to undermine the last half century of gains in development and global health”, which also imposed global burdens of direct and indirect profound effects on our health as shown in Figure 1 [3, p.1861].

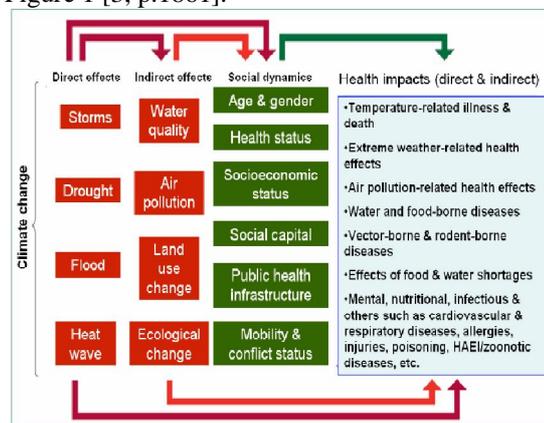


Figure 1: The direct and indirect effects of health impacts from climate change (Adapted & modified from [3, p.1867]).

The direct and indirect health risks arising from environmental-related and climate-mediated harms are now attracting an unprecedented level of global interest; air pollution will be taken as an illustrated example to further elaborate this catastrophic health risk in this paper.

In Hong Kong, air pollution is also an immediate health problem, with indications based on a cumulative calculation of the five years from January 2006 to January 2011 show costs of an alarming HK\$10.8 billion, from 5,067 premature deaths, 370,380 avoidable hospital bed days and 34.5 million avoidable doctor visits [4]. In fact, pollution is the world’s largest environmental cause of disease and premature deaths, as in 2015 diseases caused by pollution were responsible for 9 million premature deaths [5] and the polluted air was responsible in 2015 for 6.4 million deaths worldwide from 2005 to 2015 as shown in Figure 2 [6, p.12].

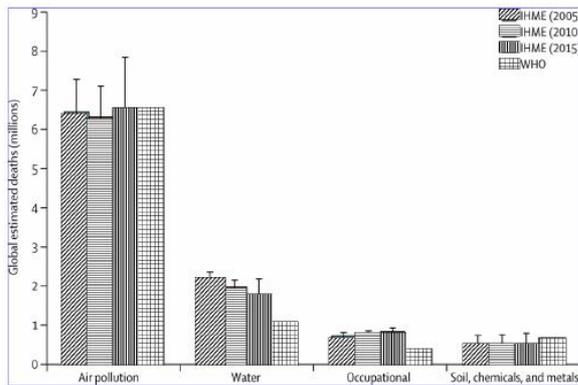


Figure 2: Global estimated deaths (millions) by pollution risk factor from 2005 to 2015 [6, p.12].

The worldwide air pollution exposure is a vast public health issue associated with various health effects, including cardiovascular and respiratory disease, cancer, pregnancy complications, and adverse birth outcomes [7], in which children face the highest risks because small exposures to chemicals in utero and in early childhood can result in lifelong disease, disability, premature death, as well as reduced learning and earning potential [5]. Higher temperatures from climate change also “tend to increase ozone levels”, and “favor the release of airborne allergens”, in addition to “reduce precipitation that can cause desertification and lead to wild fires and dust storms, all of which further affect respiratory health” [8, p.365]. “Ground-level ozone (GLO) and particulate air pollutants are elements that will be most affected by climate change” and “fine particulate air pollution is estimated to be responsible for 7 million additional deaths globally in 2012, mainly due to respiratory and cardiovascular disease” [3, p.1872]. Figure 3 shows the overall health risks from GLO and particulate air pollutants.

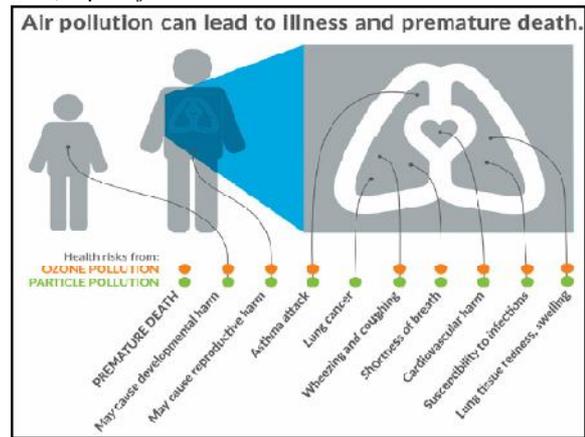


Figure 3: Health Risks from Ground Level Ozone Pollution and Particle Pollution [9].

### III. PUBLIC HEALTH AND EPIDEMIOLOGICAL TRANSITION

Health has its historic, cultural and social foundations and the field of public health has been influenced by the socio-historical context of globalization for the past 25 to 30 years, which can be seen as the prime force behind the rapid economic, political, social, environmental and cultural changes [10]. Human health and diseases are determined by many complex factors, and concepts of diseases are developed at different stages throughout the history of public health developments [1]. In view of this changing context, “the various and shifting foci observed in the historical stages of public health must be incorporated into a more encompassing view with more complex models, systems, and processes rather than the simple identification of isolated risk factors” [11, p.6]. Evidence is steadily accumulating in the concept of diseases and determinants of health that reveals these basic concepts of ET may be too deterministic in its linear stages [12]. This is especially so, as we are facing the unprecedented global environmental and climate mediated health risks, which are potentially catastrophic and highly complex with the dynamics of direct and indirect effects on such diverse health impacts, as shown in Figure 1.

Epidemiology is the study of health and disease patterns, determinants and consequences in population groups, and thus the major precepts of the Omran’s theory of epidemiological transition has focused on the primary causes of morbidity and mortality with three transitional phases being identified [13], in which “focuses on the complex change in patterns of health and disease and on the interactions between these patterns and their demographic, economic and sociologic determinants and consequences” [14, p.4]. These “basic concepts of ET are widely recognized and some prefer to term them ‘health transition’, as this implies a greater attention to the social, economic and healthcare contexts of the changes”, which also has complex parallels with other transitions, notably demographic

and in ageing and nutrition [12, p.17]. In this regard, environmental and climate mediated harms are indeed the most significant dimensions definitely should be included into these complex parallels. Therefore, this paper proposed ‘The Age of Environmental and Climate Mediated Health Risks’ as the latest stage of ET are now emerged in this era. There is no doubt that global climate change is the most topical of the global environmental changes [15], which is manifested in the rise of population growth and the aggregated pressures of consumption and emissions that impaired various global environmental systems, including changes in the world’s atmosphere and climate, stocks of biodiversity, freshwater supplies, and food-producing ecosystems [16]. The accumulative scientific studies that enhanced our understandings and changing conceptualizations of health into the current state in this proposed “The Age of Environmental and Climate Mediated Health Risks’ with their driving forces from overall underlying determinants. In fact, there are many underlying determinants that acted as driving forces into these changing patterns of disease burdens in the health transition.

#### **IV. UNDERLYING DETERMINANTS: DRIVING FORCES IN HEALTH TRANSITION**

##### **A. Implications of Transitional Changes**

The theory of epidemiologic transition from Omran represents the continuing efforts “to crystallize the mechanisms of interaction that characterized the patterns, determinants and consequences of health and disease changes in a variety of social contexts” [13, p.755]. Under this framework of mechanisms, Omran argued that the health transition is part of the epidemiologic transition, not vice versa, despite the concept of ‘health transition’ was proposed as a wider framework that included not only epidemiological characteristics but also the ways in which societies responded to changing health situations as ‘a dynamic process’ whereby the health and disease patterns evolve in diverse ways as a response to different determinants [17]. As Murray’s studies have quantified the epidemiological transition for 188 countries from 1990 to 2013 indicated “the substantial effect of country variation on the epidemiological transition pattern that reinforces the importance of estimating the burden of disease for each country individually” [18, p.2181]. In this regard, many health risks both locally and globally are in transition with conditions are constantly and continuously changing, and the implications of these changes in fact are the reflection of underlying determinants that drive the changing patterns of health transition. These changes generally come with ‘modernisation’ that acted as part and parcel of the process and occurred at a different pace in varying countries [14].

In the actual fact of point, this will also depend in part on how well these indicators being measured and organized, as these underlying determinants are constantly and continually exerting forces into the background and driving these transitional changes. The underlying determinants under the current epidemiological and health transition in this proposed environmental and climate mediated risks are more diverse from multiple variants with much broader and widened perspectives, which are broadly categorized as: Global drivers, Global changes, Ecological determinants, Other health determinants, and Public health in transition, as follows [1,2,12,19,20]:

##### **A. Global drivers**

- Population sizes, rapid growth, and their dynamics and demographic transition
- consumptions: energy, transport, material,
- food-producing systems: agriculture, livestock, fisheries
- science and technology
- economic intensifications with increasingly more human-induced anthropogenic activities

##### **B. Global changes**

- climate change
- biodiversity loss and change
- desertification and ocean acidification
- ozone depletion; global warming; melting of glaciers; sea level rise, etc.
- global pollutants: air, water, soil, chemical, all municipal wastes, landfills, eco-toxicity by Persistent Organic Pollutants (POPs), etc.
- freshwater depletion and contamination
- diminishing sustainability of ecological and natural resources
- stress on food-producing systems, etc.

##### **C. Ecological determinants**

- disruptions from the above global change
- eco-environments and ecosystems disturbances, including freshwater ecosystems, marine ecosystems and forest systems
- human-animal-ecosystems interface (HAEI) or zoonotic diseases (zoonoses)
- climate mediated health risks as shown in Figure 1

##### **D. Other Health determinants**

- economic and nutritional determinants
- Socio-cultural and political determinants
- Medical advancements
- Others

**E. Public health in transition:** its developments and movements towards ecological approaches

In this view of context, health transition is very often seen as closely related to the stages of epidemiologic transition, as it undergoes the constant changes imposed by those underlying determinants per se. In fact, different stages of epidemiological transition widened our insights in preventive medicine and the evolution of public health, with which it also offers a broader understanding of health transition linkages in

relation to those underlying determinants. Public health in transition can be summarized as the changes of public health revolutions: (1) in the nineteenth century were the sanitary and hygiene movements; (2) by the early twentieth century the definition of public health expanded beyond environmental concerns and scientific-technological advances; and (3) this third revolution defined as arose from the internationalization of public health policies with “a shift in perspective from input to outcomes: governments were to be held accountable for the health of their populations, not just for the health services they provided” [21, p.2].

Echoing from this perspective, the proposed paradigmatic shift towards ecological public health is indeed the practical implications for the needs of transitional changes under the driving forces imposed by those underlying determinants. Table 1 summarized the continuations of epidemiological and public health in transitions, which embraced with paradigmatic shifts onto the conceptualization of the transitional changes that associated and interacted with the categorized underlying determinants over the time, which also reflected from the extracted Five Models of Public Health in response to different stages of Epidemiological Transition.

Stages of ET	Underlying Determinants	Five Models of Public Health***
1. The Age of Pestilence & Famine* (~100 centuries ago)	<ul style="list-style-type: none"> <li>• Poor sanitary &amp; contaminations</li> <li>• Poor use of ecological resources &amp; lack of social &amp; economic capitals</li> <li>• Domestication of animals brought other disease vectors</li> <li>• Public health emerges</li> </ul>	(1) Sanitary Environmental: The environment is a threat to health.
2. The Age of Receding Pandemics* (~200 yrs ago)	<ul style="list-style-type: none"> <li>• Increased economic growth</li> <li>• Improves use of ecological resources &amp; food safety</li> <li>• Public health developments</li> <li>• Provides basic social services</li> </ul>	(2) Social Behavioural: Health is a function of knowledge and behaviour patterns.
3. The Age of Degenerative and Man-Made Disease* (~late 20 century)	<ul style="list-style-type: none"> <li>• Improves medical care &amp; social determinants</li> <li>• Public health movements e.g. vaccination programmes</li> </ul>	(3) Bio-Medical: Health improvement requires understanding of biological causation.
4. The Age of Delayed Degenerative Diseases**	<ul style="list-style-type: none"> <li>• Prevalence of one or more diseases means a relatively long period of morbidity with increasing of life expectancy on average</li> <li>• Health promotion &amp; Primary health care emphasized</li> </ul>	(4) Techno-Economic: Economic and technological growth is the prime elevator of health. Life-styles, etc.
My newly proposed “The Age of environmental & Climate mediated health risks”	<ul style="list-style-type: none"> <li>• A. Global drivers</li> <li>• B. Global change</li> <li>• C. Ecological determinants</li> <li>• D. Other health determinants</li> <li>• E. Public Health in Transition</li> </ul>	(5) Ecological Public Health: Health depends on the successful coexistence of the natural world and social relationships.

**Table 1: Paradigm shifts of epidemiological and public health in transitions with the categorized underlying determinants** [\*13,\*\*\*19, p.101,\*\*22].

## B. Transitional Changes in Hong Kong

Hong Kong is one of the most affluent international cities with the most densely populated areas in the

world, which experiences rapid and profound changes in health transition over the past one and half centuries in the history of public health. With high mortality from fevers (malaria) and dysentery amongst military and civilian populations in the early year of the 19th century to the “epidemics of smallpox (1887-1888), Cholera (1890) and plague (first notified in 1894) continued to take their toll along with fevers, malaria, dysentery, typhus and so on” [21, p.14], till now towards the 21st century the health statistics in HK indicated that the infectious and parasitic diseases has reduced from 12.8% to 2.8% as from 1963 to 2013 [23]. Other defining moments such as SARs epidemics and avian flu also have its historical accounts that lead to further public health improvements by setting up Center for Health Protection in June 2014. In general, the HK population health has now reached increasing life expectancy (> 80yrs), with low Infant Mortality Rate (8.2) and low Crude Death Rate (6.4) as in 2016 [23]. These changing patterns of health transition in the historical accounts are, indeed the outcomes of powerful economic, socio-cultural and political, medical and public health advancements in its development of health system. However, the inevitable rising trends in non-communicable diseases and the actual and potential risks in the evolution of communicable diseases, as well as the current environmental and climate health risks are also the integral parts of public health concerns in this era of the proposed epidemiologic transition.

## V. PARADIGM SHIFT TOWARDS ECOLOGICAL PUBLIC HEALTH PERSPECTIVES AND APPROACHES

With the benefit of hindsight, it is important to recognize determinants within and between different domains and levels interact along complex and dynamic pathways to ‘produce’ health at the population level, and health itself can also be influenced by its multilevel and multivariate determinants, thus different approaches for public health have also been adjusted to accommodate the transitional needs of the situations to counter these multiple influences [1]. As “the basis of much public health thinking is based upon the appeal to evidence and science” [19, p.332], and hence as public health enter the third millennium, evidentially witnesses some dramatic improvements in many health indicators over a historically miniscule period of time, which have also acknowledged that public health is not only an end result of but also a means to development [24], and what is leading to justify the public health actions should be the ultimate concerns. From the shifts in perspectives of public health in transition, the ecological perspectives and approaches for improving the effectiveness of public health movement is much broader. As it is recognized that

an ecological perspective encompasses context in the broadest sense, which include physical, social, cultural, and historical aspects in the trends with the local and global level of globalization, urbanization, and large scale environmental change, as well as attributes and behaviours of persons within; thus the key features of an ecological public health include understanding health as a pattern of relations and viewing health as a process nested in these contexts [25].

The ultimate goal of the ecological public health is about shaping the conditions for good health for all, hence the ecological thinking should address these transitions from evidence to knowledge through (a) reinvigorate public health institutions and structures, and (b) re-energize public health as a social movement, and (c) unify natural and human sustainability [19]. In fact, the importance of this ecological paradigm are evidentially enhanced our “understanding of health-disease process from different perspectives and stages across public health developments in terms of the patterns in health transition, in turn, is an integral part of evidences supporting this paradigm shift” [1, p.9003]. In this sense, “epidemiology is in transition from a science that identifies risk factors for disease to one that analyses the systems that generate patterns of disease”, which contains a broad conception of the determinants of population health [26, p.498]. Therefore, strategies to broaden the evidence-base for public health developments are utmost essential, as relevant for holistic views from different levels of perspective of determinants that impacted various health effects, as projected from the underlying determinants at the different stages of epidemiologic transition have already summarized in Table 1. In this context, the actual and potential health risks under different stages of ET provided considerable practical implications, inter alia:

- 1. The changing patterns** in the burdens of disease can provide a valuable indication of effectiveness and efficiency for healthcare and health services planning;
- 2. Indicating the need** for evidential justifications to different models and approaches of public health movements.

As paradigm shifts onto the ecological public health approaches under this newly proposed ‘Age of Environmental and Climate Mediated Health Risks’, the capacity building in support of this global trend of transition for the needs of public health movements is utterly essential. Ironically, “there is a widespread lack of awareness of climate change as a health issue” [3, p.1905], despite health risks profiles in populations have reflected changes in environmental conditions over many millennia. This recognition of how environmental and climate change can affect health and survival is therefore the prime focus on my

further recommendations, which are generated in line with the proposed health concerns as follows:

**a) Sustainability developments:** A new ecological sense of public health is the need to decipher relationships

between environmental issues and human and animal health is the path of articulation to promote a sustainable future [2], by embracing with “One Health” vision and “One World” concept for ecological harmony and preserve the eco-environments for our co-existence of healthy ecosystems, healthy animals and healthy humans [1].

**b) Global health literacy:** As WHO illustrated that “the growing recognition that health cannot be relegated exclusively to health professionals” as health should be treated as a priority within the global development agenda for mobilizing support, including “a worldwide campaign for global health literacy” [27, p.17 & 8].

**c) Health promotion for Sustainable Diets:** Sustainable diets are kind of ‘plant-based’ diets that produced with

low environmental impacts, as against climate-mediated harm caused by food production system and environment on our health is always a complex issue, emission of methane from enteric fermentation of livestock production has generated a substantial greenhouse gas sources [28].

**d) Transdisciplinarity in education:** A viable education can only be an integral education of the human being, a new principle of relativity from transdisciplinarity in education could serve as driving forces to cultivate the orientations of accountable behaviours with the necessary mentalities of ‘Trans-Reality’ towards sustainable ways of living for a changing globalized society [2]. The concept of “A Culture For Health’ that was derived from the Fifth wave of public health development [29], is therefore recommended for enhancement and empowerment in the cultivation of the intended accountable behaviours as part of sustainable ways of living for global interdependency.

## CONCLUSION

Epidemiologists face difficulties in assessment of these environmentally-induced health risks, as many of the causal pathways are of a complex and indirect kind, as well as the often coexisted multivariate causality of disease precludes ready attribution to any particular environmental change [16]. In addition, mortality is not always the direct result of morbidity, people do not necessarily die from the diseases they have during a lifetime. Therefore, mortality does not precisely reflect the burden of disease on a community. In fact, these phenomena also imposed increasing complexity of public health problems and hence its developments in transition will not be entirely distinctive, as there are many different predisposing factors and determinants overlapping

with each others to form multiple burdens of disease concerns rather than any particular health risks or indicators per se. As a result, any single or partial perspective of public health and epidemiological in transitions will only invite the danger of misrepresentations, as these phenomena of patterns are very often interlinked, inter-related and associated with multi-variants under varied broad underlying determinants in non-linear and diverse manner.

In this regard, the problems posed by environmental and climate mediated risks to the health and livelihoods of

communities across the globe are daunting, and our efforts are seemingly unable to keep pace with the increasing range and complexity of the current environmental hazards, especially the most significant human-induced environmental problem of global climate change [8].

Henceforth, the collaborative efforts to tackle such global health concerns are absolutely unavoidable, and the projected recommendations herewith are the extension of the notion and health needs for 'The Age of Environmental and Climate Mediated Health Risks' as the significant dimension for public health movements in transition.

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