

Biomagnification of Diseases: The Exposome Concept

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Abstract

The human race has gone through levels of destruction and extinctions happening for millions of years. Yet, the species tend to survive the most catastrophic situations presented before them. People have made their way into existence surpassing the mishaps simply quoted as “natural disasters.” However in recent times, humankind experiences a lot of annihilation due to “man-made” factors that impose deleterious effects on health and the economy. Exposome refers to all the factors related to exposure which can influence the state of health or well being of an individual. Hence, exposome is a collective term that includes factors exposed by an individual, even before birth as a fetus and include sources from the environment, lifestyle, and occupation. The authors have made an attempt to address the consequences of exposome on human health and disease, relating it to the present pandemic situation. More studies pertaining to the gene-environment interaction in different populations would provide insight into the development of diseases and evolutionary mechanisms conferring susceptibility or resistance to complex disease phenotypes.

Keywords: Exposure, phenotype, evolutionary mechanism

INTRODUCTION

Management of hypertension is a key to avoid complications of related diseases such as cerebrovascular, cardiovascular, and kidney disease. Elevated blood pressure (BP) in children often goes unnoticed and is precipitated as hypertensive disorder in early adulthood. Various risk factors are found to be associated with the etiology of hypertension. Recent studies have come up with the concept of exposomes, which refers to the life-long exposure as early as in the state of the conception of an individual to exogenous and endogenous factors.^[1,2] Exposome biology is an amalgamated version of exposure science, toxicology, and environmental epidemiology which has a broad spectrum of applications in immunological, metabolic,^[3] and psychological disorders. The exhaustive list of exposomes includes physical agents such as radiation, chemicals and biological entities [Figure 1]. In this context, the importance of exposomes as a contributing factor for biomagnification has been discussed in this section. Although exposome-based reports on human health and disease are scarce, the significance of the living environment has to be conveyed to the common man in the present scenario, with an intension to preserve and protect the resources around us to save humankind.

THE HUMAN EARLY-LIFE EXPOSOME PROJECT

The human early-life exposome (HELIX) project is the greatest initiative to perform exposure assessment and biomarkers to identify early life exposure to numerous environmental factors.^[4] The study was conducted in three tiers wherein individuals were recruited from six European countries including the UK, Spain, Norway, France, Greece, and Lithuania. The first level of the study consisted of 31,472 pairs of child and mother recruited at the period of pregnancy, the second level of the study included a sub-cohort of 1301 pairs who were assessed at an age of 6–11 years for several biomarkers, genetic and epigenetic signatures, exposure and health outcomes. A repeat-sampling approach was used in about 150 children and 150 pregnant women, with a goal to collect information on personal exposure.^[4] Among numerous exposures and health outcomes assessed by the

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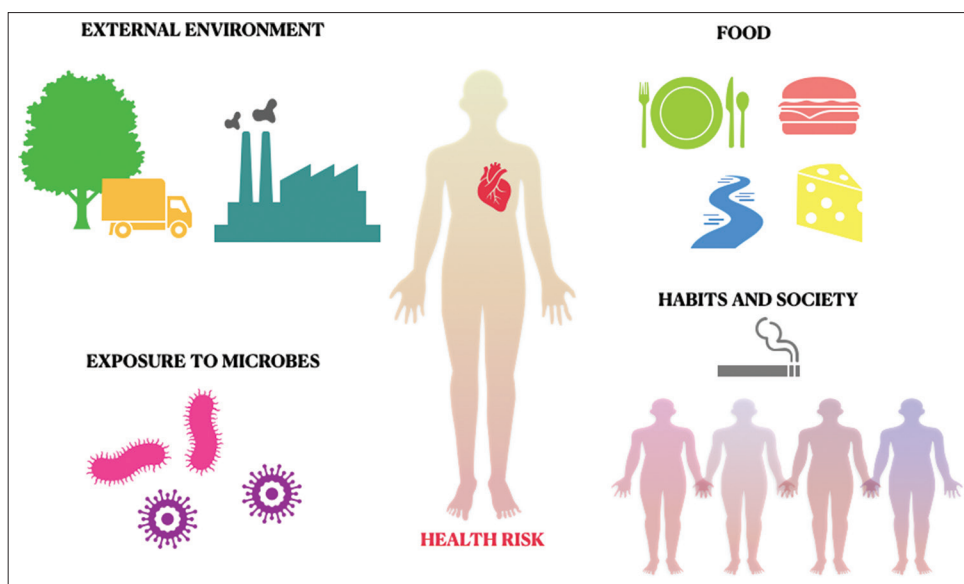


Figure 1: The key exposome factors which influence the health of an individual

HELIX consortium, the environmental influences on BP among children is an important fact to be focused on due to the increasing incidence of elevated BP among young adults. Three different exposome components were investigated, namely, lifestyle factors, outdoor exposure and chemical exposures which was measured using biomarkers. A total of 217 exposures of which 89 and 128 were of prenatal and postnatal types, respectively. The analysis revealed interesting results related to decreased and increased BP in the cohort studied. Elevated systolic BP was associated with the outdoor temperature at the time of pregnancy, high fish intake, cotinine concentration on mother and perfluorooctanoate concentration in the child. On the other hand, increased diastolic BP presented with high fish intake, maternal bisphenol-A and copper concentrations in child.^[1]

A very recent study by Hu *et al.*, demonstrated the association between exogenous exposures to hypertensive disorders in pregnancy (HDP). They conducted an exposome wide association study for a total number of 5784 exposure factors by recruiting 819,399 women employing the Florida Vital Statistics Birth Records. The results returned significant scores for about 12 variables including air toxicants (maleic anhydride, acrolein, 1,1,1-trichloroethane, propylene oxide, methyl tert-butyl ether), crime and safety (burglary and other offences rate), socio-demographic status of neighbours (industrialization, English speaking) and meteorological factors (vertical velocity). The study was the first of its kind which confirmed the association of several factors in the external environment with HDP.^[5]

EXPOSOME AND INFECTIOUS DISEASES

Exposomes analysis is not restricted to metabolic or psychological stress alone, but can be extended to the risk of acquiring infections too. A recent study by Conticini *et al.*

proved that increased pollution in regions of Italy, namely, Lombardy and Emilia Romagna imposed a severe risk upon healthy controls by triggering a long-term inflammatory stimulus. The regions also recorded the highest level of lethality due to SARS-CoV-2. Thus implying the fact that air pollution could increase the risk of disease severity and hence a potential co-factor associated with high lethality due to viral infections.^[6] A similar study supports the views of the study discussed, wherein the authors add to the point that pollution-induced obesity could intensify the adverse effects due to viral infection. The research group speculated that fat mass index can be related to disruption of the metabolic process resulting in weight gain in murine models. Hence, obesity developed due to pollution acts as an influencing factor of smog-induced injury to the lungs, which leads to increased virulence, high mortality and rapid spread of the virus among the individuals of Northern Italy.^[7]

The literature sources available have mainly focused on single stress factor or a group of stress factors associated with a specific disease. Furthermore, most of the studies have targeted human, animals, plants, or their environment as separate entities. A convergent approach that could connect all these entities into one would provide clues to understand the intricate mechanisms encompassing genes and the environment. As the world is moving toward building “one health” concept, extensive knowledge about exposomes might aid us in delineating the risk factors that could precipitate metabolic, genetic, or even infectious diseases.

CONCLUSION

In recent years, the description of disease based on genetic factors alone remains inconclusive, as multifactorial traits and complex disorders have several associated components worth probing. Exposome wide association studies have

to be carefully designed since the exposure information related to an individual or a population is vast, diverse, and dynamic. Hence, technological advancements and feasibility in performing procedures among a large group of individuals seem to potentially limit the access to information regarding exposomes.^[8] Despite all the addressed limitations, analysis based on exposomes should be more comprehensive supported by mathematical modelling, a robust statistical framework and the development of databases exclusively for population-based exposome analysis.^[9] Taken together, the exposome-related studies are still in its juvenile state and requires a lot of precision tools to achieve the target. Exposome research is an interesting emerging field which can provide answers to the existing spectrum of clinical presentations as why some individuals are at risk of developing diseases when compared to others, in addition to the underlying genetic and epigenetic factors governing the biological system.

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Conflicts of interest

There are no conflicts of interest.

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