CHAPTER 5

IMMUNOLOGICAL EFFECTS OF CLIMATE CHANGE: SYSTEMIC RESPONSES TO ENVIRONMENTAL STRESSORS

Fatma YILMAZ AYDIN [1]

INTRODUCTION

Humans have developed an immune system to protect themselves against environmental threats and to maintain their health. Climate change not only jeopardizes the health of our planet but is also increasingly affecting our immune health. In the post-industrial era, intensified deforestation, urbanization, mining, and the growing use of fossil fuels along with waste produced by agriculture and industry—have led to fundamental changes in the physical and chemical nature of the Earth. There is mounting evidence that climate-related exposures such as air pollution, temperature fluctuations, wildfires, extreme weather events, and biodiversity loss significantly impair immune system functioning. In recent years, increasing urbanization, widespread antibiotic use, exposure to toxic chemicals, reduced contact with biodiverse environments, less diverse diets, and lack of physical activity have collectively created conditions that elevate the global risk of skin and mucosal barrier dysfunction, microbial dysbiosis, and immune dysregulation (1). The epithelial barrier hypothesis posits that exposure to air pollutants and other toxic substances in water, air, and food such as household cleaners, detergents, food emulsifiers, preservatives, microplastics, and pesticides damages the epithelial barrier. This damage enhances the penetration of microbes and allergens, leading to an increase in pro-inflammatory responses (2). A defective epithelial barrier has been demonstrated in asthma and allergic diseases (3). Furthermore, intestinal barrier defects and microbial dysbiosis have been implicated in various autoimmune diseases, allergic conditions, and cancers (4,5).

Moreover, the loss of biodiversity is increasingly disrupting the development of tolerogenic immune responses. Under normal conditions, naïve T helper (Th) cells differentiate

[1] Assoc. Prof. Dr., Dicle University, Faculty of Medicine, Department of Internal Medicine, fatmay83@hotmail.com, ORCID iD: 0000-0002-8101-2497

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