Abstract

This study was performed to determine why children brought up in sterile environments are more susceptible to autoimmune diseases and allergies than children raised in pathogen-saturated environments. Research about the adaptive immune system was used to identify five possible causes. Literature suggests that the cause for the high rate of autoimmune diseases and allergies must be isolated and administered to all children.

Introduction

I started this project in order to find the reason for the higher rates of allergies and autoimmune diseases in western society when compared to third world countries. Scientists have already determined that a high concentration of pathogens provided lower rates of autoimmune diseases and allergies, and vice versa. I undertook this literature research project to isolate some possible causes for the higher rates of autoimmune disorders that scientists could then test in a laboratory. If the causes were later isolated in a laboratory, society could reduce allergies and autoimmune diseases and still maintain our standards of living by using our findings to provide a “vaccine” administered to young children that would protect them from allergies and autoimmune diseases.

Problem & Objectives

Why do children brought up in a pathogen-saturated environment have less allergies and a healthier immune system, resulting in fewer autoimmune diseases, compared to those brought up in sterile environments?

The objective for this project is to learn as much detail as possible about the immune system, and to formulate explanations in answer to the problem that have not yet been formulated by other researchers.
Hypothesis

If a child raised in a pathogen free environment has more allergies and is worse at dealing with autoimmune diseases, then the primary factor is experience at fighting diseases and ignoring more minor problems, because the immune system is so complex. It is likely that many parts of the immune system are activated as pathogens arrive in the system (such as suppressor T-cells), and these may not be able to function as well without regular “practice”, which is given by minor pathogens.

Procedure

Data and studies pertaining to the topic were collected and examined for possible causes of the higher rate of autoimmune diseases in those who grew up in cleaner environments. The theories of other researchers were also examined.

Background Information

There are three major lines of defence that the human body uses in order to defend and protect itself from harmful foreign matter, known as pathogens.

The first defence encountered, physical barriers, protects against most pathogens that the human body will encounter. The skin covering the body, the acid in the stomach, the conjunctiva of the eye, and the mucus lining the lungs are all physical barriers. Physical barriers try to stop pathogens before they enter the body.

The second defence encountered by a pathogen is the line of non-specific defence, which employs most leukocytes (white blood cells). Complement proteins, interferons, and the inflammatory response are also part of this non-specific defence.

Leukocytes are found throughout the bloodstream and lymphatic system of the body. They are nucleated cells that are able to swim against the current of the blood flow, and can squeeze out of capillaries in some areas. Neutrophils, eosinophils, basophils, and monocytes
are all non-specific leukocytes. Non-specific leukocytes engulf most pathogens that they encounter in the body. Lymphocytes are the only class of leukocytes that target specific cells.

The third defence is the adaptive immune response. The adaptive immune response is the only component of the immune system that confers any immunity against pathogens. It also enhances some effects of the innate immune system, such as inflammation and complement protein responses. The adaptive immune system protects the body from invading pathogens and even infected or cancerous cells, which are usually identified to be foreign.

In an adaptive immune response, a macrophage (a specific type of monocyte) engulfs a pathogen and presents the pathogen’s foreign proteins (called antigens – which are anything that triggers an immune response) on its own cell membrane. The macrophage then releases chemicals, which are responded to by two different types of lymphocytes.

When B-lymphocytes receive these chemicals, they divide and specialize to become immunocompetent B-lymphocytes. These B-lymphocytes take part in plasma-mediated immunity, whereby they produce antibodies that attach to the antigens and make the pathogen harmless. The antibodies may force many pathogens to clump together, in which case they cannot function and become an easy target for macrophages, or by the antibodies blocking vital active sites on the pathogen, whereby the pathogen is unable to function. After the pathogen has been fought off, most immunocompetent B-lymphocytes die. However, some will specialize and become memory B-cells, which contain all the information about the specific antibody-antigen combination. If that particular pathogen is encountered again in the future, the body will be able to respond to that pathogen more efficiently by rapidly cloning the memory B-cells from the previous infection.

T-lymphocytes also respond to the chemicals released by the macrophages. In their case, they divide and specialize into Cytotoxic T-cells, Helper T-cells, Memory T-cells, and Suppressor T-cells. T-cells deal primarily with cells found in the body, such as cancerous
cells or cells harbouring viruses. Cytotoxic T-cells puncture any cells in the body that are infected with viruses or are cancerous. Helper T-cells connect to macrophages via a Major Histocompatibility Complex, and greatly increase the rate of cell division of all lymphocytes, helping the defence system cope with more pathogens. Memory T-cells store the chemical composition of pathogens and the attacks against them. Suppressor T-cells shut down the immune response in case the attack is against the body itself (an autoimmune response), or when the immune response is over.

The adaptive immune response can remember the antigens (and hence, the pathogens) it has encountered before, and attack them more vigorously than it did previously. Thus, exposure to a certain pathogen or foreign molecule improves future responses to that pathogen or molecule.

It is failure of part of the adaptive immune system combined with the over-zealousness of another that results in an autoimmune disease. Immune cells attacking the body are part of the T-lymphocytes’ jurisdiction – particularly the Suppressor T-cells, which normally contain any out-of-control responses where the body is attacking itself.

**Discussion**

Studies done by many researchers, such as Duke University’s Dr. William Parker\(^1\), establish that growing up in a sterile environment results in a higher rate of autoimmune diseases than growing up with constant exposure to pathogens. What such studies have not discovered is *why* this happens.

Researchers such as Graham Rook\(^2\), a professor at the Centre for Infectious Diseases and International Health in London, UK, have their own theories. Dr. Rook, for example, suggests that what we lack are “old acquaintances” – pathogens that may have primed the immune system early in life upon exposure. Dr. Rook brings up the example of a helminth – once a pathogen that size entered the body, the only recourse of the immune system is to
tolerate it by controlling itself (through massive immunoregulation). This may have helped the body adjust to and ignore minor irritants and antigens found internally.

Although a definitive cause for the higher rate of autoimmune diseases and allergies in those people that have grown up in sterile environments has not been isolated, there are certainly possible causes that we can test. The theories that were hypothesized based on the information studied in the course of this project include: a lack of activation of suppressor t-cells; a larger variety of antibodies found in the body; a quicker defence carried out against the antigens that the body has primarily encountered, i.e. those in itself; the presence of more professional APC’s; and the possible presence of more immune cells.

**Conclusion**

The hypothesis was correct in stating that there are several factors involved in causing the increase in autoimmune diseases and allergies. It was also correct in that the immune system may ignore minor problems while fighting diseases, and that more suppressor T-cells will be activated as pathogens attack the body. These facts have either been proven in studies\(^1\&2\), or are supported through ongoing research.

However, in stating that experience and practice had anything to do with the immune system, the hypothesis was incorrect. The immune system does not function in a manner where experience and practice have a significant role to play.

This project has serious societal implications. If the cause for a higher rate of autoimmune diseases and allergies is isolated, then we can formulate a vaccine for children. This vaccine would then prevent autoimmune disorders and allergies, saving many lives as well as considerable resources.

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Bibliography


