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Ecoimmunonutrition: Contemporary Approaches to Optimal Nutrition

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Abstract

Nutrition, appropriate in composition and in amount, is one of the basic elements for determining human health. Adequate nutrition plays an important role in well-being, including aiding in the prevention and therapy of diseases. Therefore, for more than 50 years, there is intense research devoted to optimalization of the diet to fulfil nutritional needs at various circumstances of human life. In the current review, we are discussing the basic principles of immuno- and ecoimmunonutrition.

Keywords: Nutrition; Evolution; Immunity; Microflora

Introduction

The term immunonutrition usually refers to a special diet for seriously ill patients, designed to support their recovery and to prevent metabolic and inflammatory complications. It is thought to work by balancing immune system functions. The extended meaning of the term immunonutrition is a diet based on the knowledge of principles of the immune system and its functions, intended to help both its proper development in childhood and its maintenance up to elderly. Targets of immunonutritional programs are age-based or disease-based groups of people, according to the WHO guidance.

Econutrition reflects the nutritional needs of

Table 1: Terminology

Term	Explanation	Effect	Consequences
Malnutrition	Nutrition insufficient in amount or inadequate in composition	Disorders of the IS* Cachexy	Developmental retardation Enhanced morbidity NAIDS** Tumors
Immunonutrition	Fortified and supplemented well balanced diet	1: Support of the IS in patient care 2: Enhancement of population health	Optimalization of recovery and prevention of complications Cutdown of morbidity of the population
Econutrition		Support and regulation of GIT*** microflora	Inhibition of pathogens including ones causing septic complications Prevention of tumours
Ecoimmunonutrition		Support of both the IS and GIT microflora	Enhancement of the population health, restriction of drug consumption, finantial saving

* Immune system

** Nutritionaly Acquired Immunodeficiency Syndrome

*** Gastrointestinal Tract

tissues lining the digestive tract and of a gastrointestinal microflora. Econutrition is going to be replaced by ecoimmunonutrition, a diet enriched with supplements supporting the immune system and the gastrointestinal microecological equilibrium. Ecoimmunonutrition is the aim of the WHO program "Nutrition for the 21st Century," designed to enhance the health state of populations by promoting the improved diet. Basic terms used are listed in Table 1.

Historical background

Over the last century, the life span in industrial countries prolongated due to many improvements, e.g. introduction of hygiene precautions, more effective treatment including an optimalization of patient care, discovery of new drugs such as chemotherapeutics and antibiotics, vaccination and consequently erradication of some lethal diseases. Apart from these causes, there is another more fundamental cause, and that is: better nutrition.

On the other hand, the resistance to contagious diseases, especially those caused by air-borne pathogens, decreased within the last 30 – 50 years [1]. This may be attributed to the modern life style which includes social stress and reduced physical activity, intake of industrialy processed food, chemicals used as preservatives, nutritional additives, and, last but not least, the over-usage of drugs.

Changes in feeding habits during human evolution and the rigidity of a genome

For about 100,000 generations of hunter-gatherers, followed by 500 generations living on agriculture, our ancestors kept the same feeding habits. Moreover, they were exposed to environmental and climatic conditions heavily different from the recent ones, that are artificially transformed and often damaged by industrial abiotic immision load. Since the advent of a modern industrial society, no more than 10 generations could be counted. The last period is even shorter: People take modern nutrients, processed by the contemporary high-technology food industry, for just about 2 generations – lets say 50 years.

Eaton and Konner say that human genes, controlling metabolisms of food components, could hardly reflect recent changes in life style, particularly in nutrition habits [2]. Genes, adapted through millennia under the selective pressure, cannot change within decades. Therefore, the gene pool of people nowadays is in fact almost the same as the one of our forefathers, adjusted to the conditions they lived in, and to the food they consume.

One of the most dramatic changes started in the 18th century, when refined sugar became part of daily nutrition. Since then, the average consumption of refined sugar has steadily increased, up to approximately 45 kg (55 kg in the USA) per person and a year nowadays [3]. This elevation represents an amount of energy equivalent to three marathon races weekly year around.

Besides the elevation of the energy intake, there are enormous changes in the composition of the diet. Fat consumption has risen from 20% of energy intake in 1950 up to 50% in recent years. Simultaneously, the consumption of food of plant origin has dropped to one half. The diet of our ancestors contained 5-10 times as much fiber, n-3 fatty acids, antioxidants, vitamins and other nutritionally valuable substances, whereas there was 3 times as much proteins as in modern food. On the other hand, the contemporary diet contains 4 times as much saturated fat and twice as much monosaturated fat as our ancestors used to consume [4].

Finally, the general fat intake rose due to the boom of n-6 fatty acids, including precursors of prostaglandins and leukotriens, whereas the fraction of n-3 fatty acids dropped.The changed n-6: n-3 ratio results in diseases based on atherosclerosis, e.g. myocardial infarction or stroke [5,6]. Changes in proportion of dietary fatty acids in relation to mortality on cardiovascular and cerebrovascular diseases are demonstrated in Table 2.

Although a number of people think that the vegetarian manner of feeding is healthier than meat-based, the general problem is much more complicated. Recently, the long-term influence of the different feeding habits on morbidity was exemplified on two African tribes, pastoralists-hunters and farmers (Table 3). Apart from the composition of the nutrition, the absolute volumes of its parts are also important. Proteins and fibers are especially essential components of nutrition.

Population	Prevailing nutrition	n-6 : n-3	Mortality (%)
Hunters-gatherers (paleolithic)	molluscs, fish	2 : 1	?
Fishermen-hunters (Greenland)	fish, game	1 : 1	7
Fishermen, farmers (Japan, Portugal)	fish, plants	10 : 1	12
Modern (Europe, North America, Japan)	industrialized food	50 : 1	45

Table 2: Mortality on cardiovascular and cerebrovascular diseases related to prevailing nutrition in different populations. Role of nutritional fatty acids.

Population	Energy intake (kJ/day)	Saccharides (g/day)	Fat (g/day)	Proteins (g/day)	Caries (%)	Bone deformations (%)	Airway diseases (%)
"Masai pastoralists"	12 500	390	160	300	8	13	4
Kikuyu farmers	8 800	100	20	100	35	53	28

Table 3: Feeding habits in relation to morbidity, studied in two African tribes, the pastoralists-hunters and farmers, in the first half of the last century [7].

GIT microenvironment

The gastrointestinal tract is the second largest internal surface of the human body, covering a total area of 300 - 400 m^2. It represents the place where nutrients are absorbed and utilized by both the body and by GIT microflora, whereas potentially dangerous components of the food, such as toxins and pathogens, are eliminated together with dead cells. The turnover of mucosal cells is roughly 8.10^{10} of cells in every 3 - 4 days. This material, approximately 0.33 kg daily, is degraded by microbes and reutilized.

The GIT microflora is a balanced array of bacterial species. The intestine harbors 10 times the amount of bacteria as is the body contents of cells (Table 4) [8,9]. The microflora is metabolically and digestive active, produces a lot of substances (to name at least one of them, the vitamin K produced by intestinal bacteria) and forms the microenvironment of the GIT, inhibiting the propagation of pathogens and supporting the regeneration of the intestinal epithelium.

GIT (mainly mouth and large intestine)	1000 g
Skin	200 g
Lungs	20 g
Vagina	20 g
Airways (nose)	10 g
Eyes	1 g

Table 4: Presence of bacteria in the human body

Connection to the immune system

Besides the GIT microflora, the microbial contamination of the food and its antigen load is one of the strongest cues to the immune system. Antigens that escaped digestion stimulate a defense response in the intestinal walls. Therefore, the GIT-associated lymphoid tissue (GALT) developed in a highly effective immune tissue forming the largest immune organ of an endothermic vertebrate body. In humans, about 80% of the total immunoglobulin producing cells of the body are located in lamina propria of the GIT [10].

Nutritional antigen stimulation is crucial for the postnatal development of the immune system, however, childhood is also a time when inadequate reactions could be easily settled, e.g. overshoot activity such as allergies. In adults, the immunomodulative effect of nutrition is aimed more on antitumor immunity. All things considered, GALT is a strategically very important tissue throughout all human life.

In the past, paleolithic food was heavily contaminated and naturally fermented by microbes. Our ancestors ingested a million times moremicroorganims beneficial for health as people living today [11,12]. Over the paleolithic transition from vegetarian to omnivorous feeding habit, the GIT microflora changed. Furthermore, nowadays it is strongly inhibited by chemicals present in the food and by antibiotics.

In addition to their suppressive effect on GIT microflora, these substances also suppress the immune system and some of them are even toxic. Trying to avoid preservatives and artificial flavorings when buying goods is not up to the mark, and the majority of people do not have such a choice. Therefore,more pressure should be put on the food industry to decrease the usage of chemical additives. A complementary task is to enrich food with essential compounds beneficial for health.

Fortification of nutrition and nutritional supplements

Fortification of nutrition is an addition of essential nutrients to the food that contains them naturally, but originally in smaller amounts. For example, the concentration of vitamin E has been leveled up in cooking oil. To supplement the food, means to add the micronutrients such as vitamins in pharmaceutical preparations, usually in situations of augmented needs that could not be satisfied by a common food. Nutritional additives and supplements support the immune system and protect it from impairment caused by chemicals.

For example, fortification of the diet with soluble fibers promotes a production of mucus in the gastrointestinal tract. Mucus, covering the luminal walls, supports the regeneration of enterocytes and represents a barrier to pathogens, inhibiting their adhesion and penetrance. Moreover, fibers, causing a volumetric swelling of intestinal content, accelerate its passage and inhibit the effect of toxins, both by lowering the time of exposure and by trapping them chemically. Therefore, besides other beneficial effects, the fibers are one of the most potent protectors to colorectal cancer. It is important to note, however, that the subject of fibers and colorectal cancer is still not fully understood and some doubts remain. Readers seeking more details should read a comprehensive review [13.]. Some ecoimmunonutrients used in fortification and supplementation of food, are listed in Table 5.

Furthermore, the combination of ecoimmunonutrients brings better results than if they are used separately.For example, soluble fibers taken together with membrane lipids have excellent gastroprotective effects.

Nutrient	Effect	Consequences
Prebiotics – soluble fibers Polysaccharides (pectin and oat gum containing β-glucans) Fructooligosaccharides (inulin, phlein) Glucomannan, algal fibers	Modulation of absorption of nutrients Antioxidative effect Promotion of mucus secretion Support to GIT microflora, especially for bifidobacteria Source for bacterial fermentation and synthese of vitamins (members of group B, folic acid, nicotinic acid)	Protective effect in GIT Stimulation of regeneration of enterocytes Therapy of ulcerosis, diabetes, hypercholesterolemia and hypertension Prevention of colorectal cancer
n-3 fatty acids essential nutrients such as linolenic acid, EPA, DHA	Downregulation of acute inflammatory response Modulation of immune signal network	Therapy of IS disorders Protective effect on cardiovascular system, Prevention of tumours Preoperative care
Membrane lipids (phospholipids, gangliosides, galactolipids, phosphatidylcholine)	Prevention of inflammation in GIT Inhibition of bacterial translocation Positive effect on cellular immunity	Prevention and therapy of ulcerosis, toxic and inflammatory liver impairment, sepsis
Polyamines, Amino acids arginine, glutamine, taurine	Protein synthesis enhancement Urate metabolism modulation	Wound healing Support of thymic functions
Nucleotids	Cell proliferation support Immune signal induction	Regeneration and growth of all tissues, IS, hematopoiesis
Antioxidants Zn, Se vitamins A, B, C, E lycopen, lutein	Inhibition of reactive oxigen species Stimulation of B-cell and T-cell linked immunity and cytotoxicity	Support of thymic functions Role in ill health, elderly and starvation

Table 5: Ecoimmunonutrients and their effects.

Conclusion

A worldwide rise of bacterial strains resistant to antibiotics directs the WHO to demand a cutback of drug consumption and the development of new therapeutic strategies.

Moreover, regarding human life prolongation, patient care extends intothe elderly population and becomes more and more expensive. On the other hand, an age connected deterioration of immune system functions, caused by a physiological involution of thymus and by a cummulative effect of exposition to antigens during life, could be partially compensated by the specially designed diet.

The enhancement of health to the population by ecoimmunonutrition is cheaper in comparison to pharmaceutical industry, and fits more to the metabolic demands of human body. Ecoimmunonutrition respects the feeding habits settled through ages of human evolution and help us to sustain the recent change of life conditions, including a different pattern of contagious pathogens.

Given the proven beneficial effect of nutrition on immunity, nutrition starts to play an important role in prevention and therapy not just of metabolic diseases, but also of the contagious ones, especially in the Third World. In western countries, the key role of nutrition in therapy of the most widespread death causing diseases, i.e. metabolically based cardiovascular and cerebrovascular ones, is already well known.

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