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GENERAL NUTRITION PRINCIPLES FOR THE MENTAL AND PHYSICAL HEALTH OF CHILDREN

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ABSTRACT

According to the theory of Hipocrates (3rd century BC) "all diseases begin in the intestines". It is now known that intestinal microorganisms participate in physiological processes such as: immune system functioning, detoxification, inflammation, neurotransmitter and vitamin production, nutrient absorption, hunger, and satiety signaling, carbohydrate and fat burning. Thus, a beneficial microbial flora is maintained by proper nutrition. Also, in the literature, there are microbiome-specific associations with different pathologies: attention deficit hyperactivity disorder (ADHD), asthma, autism, allergies, chronic fatigue, depression, anxiety, and diabetes. To prevent these pathologies, in the children's growth and development it must be considered multiple factors: the type of birth (natural or caesarean), genetics, general health, physical activity, sedentarism, sleep quality, and appropriate nutrition.

Keywords: nutrition, health, child, ADHD, autism

BACKGROUND

According to Hippocrates' theory (3rd century BC), "**all diseases begin in the intestines**." Also, Russian biologist Ilia Mecinikov (19th century) also claimed that "death begins in the colon". The human body is colonized by many microbes such as bacteria, fungi, viruses, or protozoa. The largest number of microbes is found at the gastrointestinal level. These microbes form the intestinal microbiota (Falup-Pecurariu et al., 2017). The intestinal microbiota works in a symbiotic way with the host, being also beneficial. (Zeng et al., 2016; van den Elsen et al. 2017). Microorganisms of the human body are about 10 times more numerous than own cells. Intestinal microorganisms participate in physiological processes: immune system functioning, detoxification, inflammation, neurotransmitters and vitamin production, nutrient absorption, hunger and satiety signalling, carbohydrate, and fat use (Sekirov et al., 2010; Lupu, Ignat, Ciubotariu, et al., 2016; Lupu, Ignat, Paduraru, et al., 2016). A beneficial microbial flora is maintained by proper nutrition. Also, there are specific associations between the microbiome and certain pathologies in the literature: Attention Deficit Hyperkinetic Disorder (ADHD), asthma, autism, allergies, chronic fatigue, depression, anxiety, and diabetes.

PATHOPHYSIOLOGY

The intestinal-brain axis is a two way communication between the gastrointestinal tract and the nervous

system. The bowel-brain axis is able to regulate pain, energy behaviour and metabolism (Cai et al., 2018). The three main ways in which intestinal microbes reduce the risk of brain damage are by controlling inflammation, protecting intestinal wall integrity, and producing important substances (Lupu et al., 2019). By controlling inflammation, the production of inflammatory compounds in the body and the brain is limited. It is known that inflammation is the origin of various degenerative diseases of the human body: diabetes, cancer, coronary artery disease and Alzheimer's disease. By protecting the integrity of the intestinal wall and preventing intestinal permeability, the passage of proteins, which puts the immune system in difficulty and, implicitly, causes the inflammation, is prevented. The production of important brain health substances (vitamin B12, glutamate neurotransmitters and GABA) together with the fermentation of substances (polyphenols) that turn into smaller anti-inflammatory compounds contributes to brain protection (Chirita et al., 2017; Russo et al., 2018). There are studies that have shown that changes in the intestinal microbiota can control inflammation, endogenous production of GLP-2 that can cause associated metabolic disorders, thus highlighting the mechanism of microbiota and the occurrence of metabolic diseases (Cani et al., 2008; Cani et al., 2009; Jiaxing et al., 2017).

DYSBIOSIS ASSOCIATED WITH AUTISM DISORDERS

Autism disorders are a group of diseases including autism and Asperger syndrome that manifest early in childhood and are have qualitative abnormalities in communication skills, social interactions, and abnormal behaviours, restricted activities and repetitive interests (Mayer 2011). Behavioural and developmental factors that may imply autism also include regressive development, abnormal responses to environmental stimuli, abnormal social interactions, absence of smile in interaction with parents or other known people, absence of typical responses to pain and bodily injuries, speech abnormalities, susceptibility to infections and fever, absence of symbolic play, stereotype behaviour (Burlea et al., 2012).

The real cause of autism is not known. It may be due to obstetric complications, infections, genetic factors, and exposure to toxins (Constantino et al., 2010; Lawler et al., 2004). There are studies demonstrating the implications of intestinal dysbiosis in the role of pathogenesis of autism spectrum disorders. The microbiome and its metabolites influence the central nervous system through endocrine, neural and immune pathways of the gut-brain axis, influencing brain function and causing aberrant behaviour (Mayer et al., 2014). Studies performed on mice have shown that alteration of the intestinal microbiota can result in the neurotoxins' synthesis that may interfere with non-development, determining changes in brain chemistry and implicitly in behaviour. Characteristics of autism spectrum disorders such as anxiety, depression and cognitive dysfunction are determined by neuronal changes associated with bowel dysbiosis (DeGruttola et al., 2016; Mayer 2011). The important role of the microbiota in the development of autism spectrum disorders is also underlined by probiotics considered to contribute to the normalization of intestinal microflora, thereby reducing anxiety and improving cognitive behaviours (Bruce-Keller et al., 2015).

Almost all people with autism face gastrointestinal problems: abdominal pain, diarrhoea, meteorism, intestinal dysbiosis, and increased intestinal membrane permeability (Buie et al., 2010). Species of intestinal bacteria found in people with autism create compounds that affect the immune system and the brain. Children have a rapidly developing brain and are the main ones that are affected. Multiple studies have found a decline in *Firmicutes* and in other "good" bacteria like *Bifidobacteria* and *Prevotella,* with a raise in *Bacteroidetes* and other "bad" bacteria like *Proteobacteria* and *Clostridiales* (Bruce-Keller et al., 2015). The development of these bacteria seems to have an important place in the development of autism.

DYSBIOSIS ASSOCIATED WITH OTHER PATHOLOGIES

The gastrointestinal tract has to not respond to food antigens and intestinal microbiota, but has to respond rapidly to the invading pathogens. The intestinal microbiota must be able to limit access of pathological bacteria to the intestinal epithelium through competitive exclusion. Also, intestinal microbiome helps maintain immune homeostasis by stimulating different T-cell response arms (van den Elsen et al., 2017).

Inflammatory intestinal diseases (Crohn's disease and ulcerative colitis) have unknown aetiologies and a marked incidence in many developed countries. Numerous studies have suggested the important role of intestinal microbiota in the pathogenesis of inflammatory bowel disease (Bozomitu et al., 2022; Chen et al., 2014). The intestinal dysbiosis in patients with inflammatory bowel disease involve a decrease in the intestinal microflora of *Firmicutes* and *Bacteroides.* Also, dysbiosis in Crohn's disease was also linked to a relative raise of the *Enterobacteriaceae* family (Bien et al., 2013).

Obesity is the most common nutritional disease in children and adolescents in the United States. About 21-24% of children and adolescents in US are overweight, while 16-18% suffer from obesity. Obesity represents a metabolic disease due to an excessive body fat storage, being a more complicated disease associated with intestinal dysbiosis in both mice and humans (Arslan 2014).

Diabetes mellitus is an autoimmune disease and it is a carbohydrate metabolism disorder characterized by the inappropriate production or use of insulin, that has to transform sugars and starches into energy needed

by the body in order to function. In insulin-dependent diabetes mellitus associated with dysbiosis there is a cut down of degrading bacteria of mucin, *Lactobacillus, Bifidobacteria* and *Prevotella* and a raise of *Bacteroides* and *Clostridium* (McLean et al., 2014). In contrast, dysbiosis associated with non-insulin dependent diabetes mellitus is with a cut down of *Clostridium,* a raise of *Lactobacillus* and a raise of *Bacteroides* in case of non-insulin-dependent diabetes that is not associated with obesity (Larsen et al., 2010).

In Colorectal Cancer patients a general pattern of dysbiosis has been found which has a cut down of butyrate-producing bacteria associated with a raise of other pathogenic bacteria (*Akkermansia muciniphila* and *Fusobacterium nucleatum*) (Castellarin et al., 2012).

The intestinal microbiota can also play an important part in the evolution of allergic diseases. The limited microbial diversity of the intestine in infants has been linked with an increased risk of developing food allergies at this age. The authors of a study have shown that a smaller number of bacteria like *Akkermansia, Bifidobacterium* and *Faecalibacterium* together with a greater number of specific fungi, like *Rhodotorula, Candida* in neonates, can through influence over the T cell differentiation, predispose to allergy sensitivity (Fujimura et al., 2016).

GENERAL PRINCIPLES OF NUTRITION FOR A NORMAL INTESTINAL MICROBIOTA

When the child is born, all the digestive tract is sterile. Initially, the intestine is colonized by maternal bacteria at birth and continues to be subsequently populated by means of diet (Sekirov et al., 2010). Factors that may influence colonization include gestational age, birth pattern (vaginal birth or caesarean delivery), health level, and exposure to antibiotics (Popazu et al., 2022). Vaginal born babies have much higher levels of bifidobacteria, a group of beneficial intestinal bacteria that contribute to the faster maturation of the intestinal mucosa. The disadvantages of caesarean delivery are multiple: a five-fold increase in the risk of allergies, tripling the risk of ADHD, doubling the risk of autism, increasing the risk of celiac disease by 80%, increasing the risk of obesity in adulthood by 50% and 70% increase in the risk of diabetes (Fouhy et al., 2012; Marques et al., 2010).

The intestinal microbial of new-borns has a low diversity and is dominated by bacteria such as *Actinobacteria, Proteobacteria.* Subsequently, the microbiome diversifies along with the development of *Bacteroidetes, Firmicutes* domination, characteristic to the adult microbiome (Backhed, 2011).

The composition of the intestinal microbiota is influenced by age, socioeconomic and nutritional status. Undigested dietary components can contribute substantially to microbial metabolism. Food fibres increase the volume of the stool and are correlated with an increase in the bacterial mass. Antibiotics or meat consumption from animals that have received antibiotics have the potential to deeply influence microbiota (Ley et al., 2008). Microbiota quality is also affected using non-steroidal anti-inflammatories, environmental chemicals, or genetically modified foods (Lupu et al., 2015; Lupu et al., 2017).

Children learn behaviours through observation and participation in activities (Vendemmia et al., 2019). The model of parents and carers is an ideal opportunity to promote positive eating behaviours. Studies have shown nutritional similarities in mothers and daughters: drinking, eating fruits and vegetables, eating vitamins, minerals and fats. Meals together with the family are recommended and children are stimulated to eat the same healthy diet as their parents (Government of Canada, 2014; Ignat et al., 2017). A diet based primarily on fruits and vegetables, whole grains, skimmed milk and dairy products low in fat, fish and lean meat is recommended. It is recommended to balance your caloric intake with physical activity to ensure normal growth. It is encouraged to consume fruit and vegetables, to limit the consumption of juices, to use vegetable oils containing low saturated fats, to consume whole grain bakery products, to the detriment of the refined ones (white flour), to consume fish, especially of fish oils and reducing salt intake, including that of processed foods (Dragan et al., 2017; Goossens et al., 2006; Rebegea et al., 2019).

Changing nutrition results in alteration of intestinal bacteria, thus contributing to microbial transformation.

Probiotics are living bacteria, most of them gram-positive (*Bifidobacteria* spp., *Lactobacillus* spp., *Lactococcus* spp., *Pediococcus* spp.). Generally, they promote the integrity of the intestinal barrier, prevent bacterial movement in the intestine, and diminish the inflammatory response. The effects of probiotics it is believed to be transient because it has been shown that administering *Lactobacillus plantarum* may lead to a raise of this bacteria in the faeces, and not in intestinal biopsy (Government of Canada, 2014; Lupu, Ignat, Paduraru, et al., 2019).

CONCLUSIONS

The intestinal microbiota changes throughout life and plays an important part both in physical and mental health as well as in the occurrence of diseases. Progress has been made in a short time, but in-depth

studies on the composition and function of intestinal microbiota are still needed to strengthen this subject. Changes in intestinal microbiota should be considered in case of diseases such as intestinal inflammatory diseases, autism spectrum disorders, obesity and diabetes mellitus, colorectal cancer, or allergies. It should be considered that the alteration of the intestinal flora can have a significant therapeutic benefit.

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