Effects of Omega-3 Intake on Adolescent Health

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Abstract. The phrase "omega-3" refers to a group of polyunsaturated fatty acids that are essential for both physical growth and illness prevention. According to relevant scientific research, Omega-3 has a certain effect on puberty, its role is very important, and it may cover most of the characteristics of puberty. Through research, omega-3 intake has a profound impact on all aspects of adolescents, and most adolescents are deficient in omega-3. This article compares the various impacts of omega-3 on the human body and analyzes the physiological and psychological functions of omega-3 intake about adolescents, and the possible effects of insufficient intake on adolescents' bodies, so as to summarize the diseases that may be caused by omega-3 deficiency and its harmful effects on physical health. In general, Omega-3 has huge potential nutritional value, and its potential academic value has also received high attention from all walks of life. Its popularity is likely to continue to rise in the future, and it will have a broader market in the field of youth health care products.

Keywords: Fatty Acid Omega-3, Teenagers, Good Health, Polyunsaturated Fatty Acids.

1. Introduction

Omega-3 series polyunsaturated fatty acids, which have linolenic acid as their precursor, and Omega-6 series unsaturated fatty acids, which have linoleic acid as their precursor, are the two different types of significant fatty acids that are present in the human body. Omega-3 polyunsaturated fatty acid is an essential fatty acid. Because body cannot create vital fatty acids on its own, the body must get them from the diet in order for it to function effectively. Our brain cells, retina, heart tissue, semen, and breast milk all contain a significant amount of omega-3 unsaturated fatty acids (around 30% of the total fatty acid concentration).

Lengthy polyunsaturated fatty acids like omega-3 are made up of one lengthy chain of carbon atoms., with hydrogen and oxygen atoms on it [1]. This long chain has a head and tail, and has 3-6 unsaturated bonds (double bonds) arranged at intervals. Fatty acid molecules generally have two ends, and the carboxyl end (-COOH) is considered to be the beginning of the fatty acid chain, also known as α End (alpha end); The methyl end (CH_3) is considered to be the end of the fatty acid chain, also known as ω End (omega end). These double bonds determine the activity of fatty acids. The last double bond has three carbon atoms at the end of the long chain. And Ω/ω this Greek letter is expressing the meaning of "end", so this nutrient is called omega-3 unsaturated fatty acid, abbreviated as n-3.

It is always affecting the health of young people, to a certain extent, related to young people's growth and advancement. In terms of protecting physical health, three different Omega-3 fatty acids can play more than 60 roles, covering almost all health problems of adolescent growth and development. Super health care function, known as "golden nutritional supplement" by the nutrition industry. Omega-3 plays a decisive role in our life and health.

By comparing and analyzing the possible physiological phenomena and characteristics related to Omega-3 in adolescence, the possible effects of different intake on the body were discussed. The effects of different intake of omega-3 were analyzed and the mechanism of Omega-3 affecting the body was summarized. Thus, it can be seen, Omega-3 is still a lot of room for relevant theories and future research and development.

2. Classification of Omega-3

At present, omega-3 fatty acids, which are most beneficial and common to human body, can be divided into three types in the nutrition circle (Fig. 1, Fig. 2).

2.1. ALA

α-Linolenic acid, whose chemical formula is octadecotrienic acid, mainly exists in plant foods. ALA can be metabolized by the body into EPA/DHA and then absorbed by the body, but the conversion rate is very low, generally less than 10%, and the conversion speed is slow, which is difficult to meet our body's needs [2].

2.2. EPA

The chemical formula is eicosapentaenoic acid, which mainly exists in marine food and is also the main component of fish oil. Generally, it depends on external food intake, and it can hardly be obtained by the transformation of ALA.

2.3. DHA

The chemical formula name is docosahexaenoic acid, and the main source is also fish, shrimp, seafood and deep-sea fish, but the content of freshwater fish is very low. Compared with the above two fatty acids, DHA has more functions and is more important to the human body [3]. It is an indispensable unsaturated fatty acid in teenagers.

Among the three, ALA is also different from DHA and EPA. ALA must be converted into DHA and EPA in the body before it can be used by the human body. However, the conversion speed is relatively slow, and the conversion rate is not high. By eating vegetables, vegetable oil or flax, it is impossible to produce enough EPA and DHA for the body.

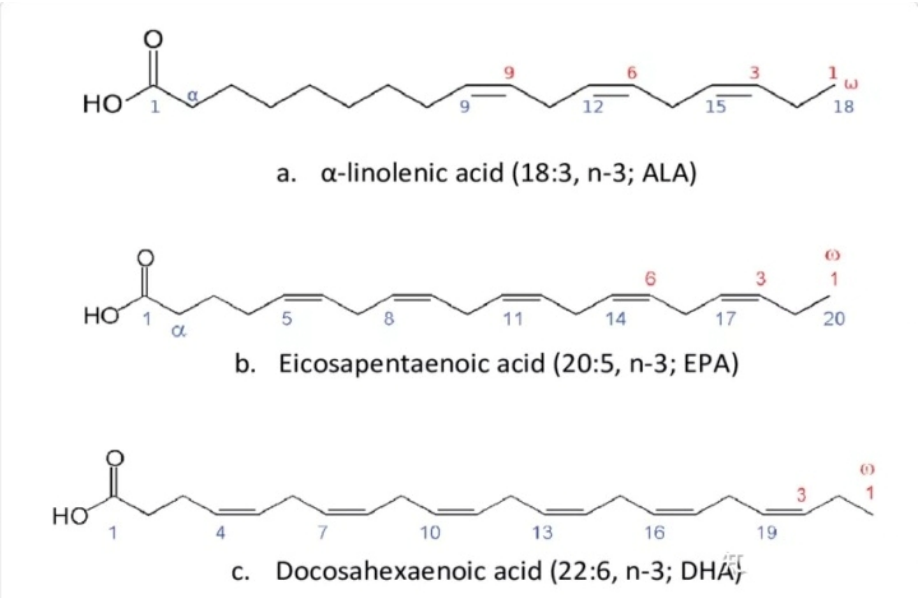

Fig. 1 Structure of three Omega

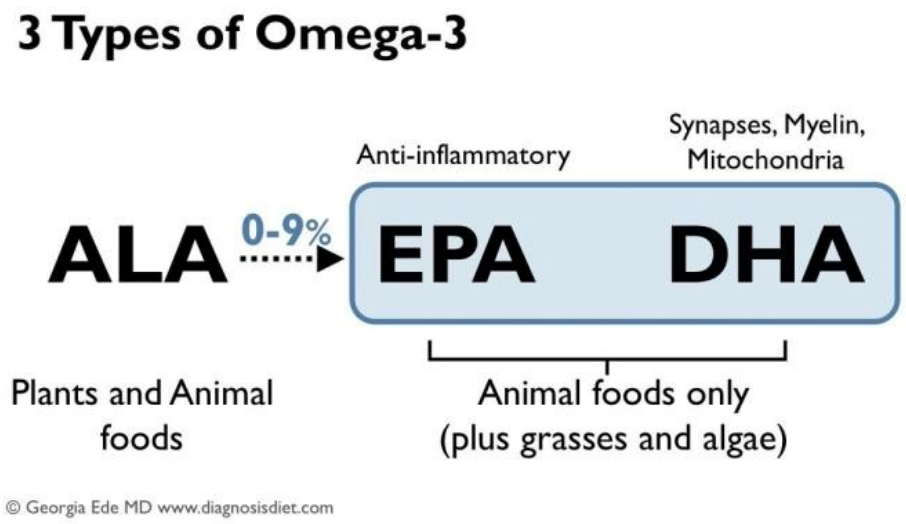

Fig. 2 Transformation between three Omega

2.4. Omega-3 Efficacy

In addition to different origins of Omega-3, they also have different effects on human body. ALA helps to prevent cholesterol deposition in blood vessels, reduce arterial inflammation and inhibit tumor growth; EPA is mainly anti-inflammatory, which can reduce chronic damage, three peaks, and cardiovascular problems; DHA plays a role in neuroprotection and helps with focus, memory, and cognitive performance.

3. Characteristics of Adolescence Associated With Omega-3

For every normal development person, they will experience five growth and development stages: fetal period, infancy period, childhood period, school age period and adolescence. Among them, adolescence is a very important period in life. Whether all aspects of the human body can develop normally in adolescence is directly related to the human quality and mental health of adults. During this period, physiology, psychology and society developed rapidly, and showed its unique phased physiological, psychological and social characteristics [4]. The approximate range of this age is from 12-14 years old to 17-19 years old. Adolescents who belong to adolescence will experience a series of subtle and significant changes physically and psychologically.

In various countries, Omega-3 dietary products are almost always the sales champion on any shopping website selling health products. Surprisingly, without any exaggerated effect and false propaganda, it does have a huge impact on the growth and development of teenagers, and really interferes with the characteristics of each adolescent period.

3.1. Correlation Between Omega-3 and Physiological Characteristics of Adolescents

3.1.1 Gland development

Under the action and stimulation of hormones in the body, the endocrine function of the human body has changed, and great changes have taken place in the function and shape of the human body in adolescence. During adolescence, the glands develop rapidly, and the hormones secreted by hypothalamus and pituitary gland continue to increase in the body, and finally close to adults; The secretion of auxin, adrenocorticotropin, thyrotropin, gonadotropin and so on has also reached a new level [5]. Auxin acts directly on the tissue cells of the whole body and promotes the growth of the body; Thyrotropin promotes thyroid growth; Gonadotropins promote the development and maturation of reproductive system; Adrenocorticotropin stimulates the activity of adrenal cortex, which produces glucocorticoids and sex hormones. These hormones are catalysts for human development and accelerate physiological mutations in adolescents .

Omega-3 can significantly promote the secretion of various hormones, thus helping the development of glands in adolescence to a certain extent. For example, DHA and EPA have three, five and six double bonds on the carbon chain respectively, so as to achieve three "unsaturated states" [6], which become the main carrier of hormones according to their fluidity and unsaturation. Moreover, it can provide raw materials for a variety of special prostaglandins that are very important to the human body and promote their rapid secretion.

3.1.2 Brain development

In theory, the cell division of brain nerve will not stop until about 10 years old, that is to say, the number will not increase. This means that the brain stops growing physically, but the intelligence level of teenagers will still be fully developed during adolescence [7]. Adolescence is an important period of intellectual development. The number of gray matters in human brain will decrease and more white matter will be generated at the same time [8], which indicates that the high-level brain center of adolescents is still in the process of development.

As the most important branch of Omega-3,DHA is crucial for the brain and mental development of adolescents. DHA is a crucial part of the membrane of brain cells. It contributes to the growth and development of brain cells, is crucial for the extension of nerve cell axons and the creation of new processes, can maintain the physiologically normal functions of nerve cells, and plays a role in the development of thinking and memory in the brain [9]. It might have something to do with encouraging nerve cell proliferation and protein synthesis.

3.1.3 Promote the development of heart and blood vessels

The functions of various organs in adolescents also began to be enhanced in adolescence, the most obvious being the cardiovascular system, which developed rapidly in adolescence and approached adults [10]. The most obvious feature is the thickening of myocardium, the enhancement of cardiac contraction, and the significant improvement of cardiac function. By the age of 17~18, the cardiac stroke output is 60~70ml, which is close to the adult level.

Additionally, omega-3 is essential for enhancing cardiovascular health.Omega-3 can simultaneously enhance blood levels of HDL ("good") cholesterol and lower levels of LDL ("bad") cholesterol and triglycerides [11]. It can also make blood vessels more unobstructed, healthier and more elastic. At the same time, it can also reduce platelets crowded with cholesterol and prevent the formation of clots that can block blood vessels. And can effectively prevent the occurrence of juvenile stroke symptoms [12].

3.2. Omega-3 and Adolescents' Psychological Characteristics

Teenagers are emotional, but extremely unstable and irrational. In addition, teenagers' psychological pressure is also increasing, negative emotions are increasing, and even loneliness and depression will occur, which is harmful to the development of mental health for a long time [13]. Omega-3 can relieve psychological pressure and stabilize emotions in many ways. For example, Omega-3 can improve the permeability of cell membrane and regulate the endocrine function of human body. Secondly, it can provide nutrition for brain development. Thus, rapid and stable metabolism can relieve pressure and reduce tension. In addition, Omega-3 can prevent myopia and eye fatigue to a certain extent, and the relief of eye fatigue can relieve mood and pressure to a certain extent [14]. To sum up,Omega-3 indirectly contributes to adolescent mental development.

4. Effects of Different Intake of Omega-3 on The Body

At present, in most western developed countries, some experts or organizations, such as the WHO, FDA and the European Union and the international Heart Association, will have certain recommended intake of Omega-3 [15]. However, according to the authoritative FAO expert committee, it is recommended that ordinary minors consume 250mg~2000mg of Omega-3 per person per day. Studies have shown that the daily intake of 0.25 grams of EPA and DHA by adult men and

women is sufficient. For ALA, according to the National Institutes of Health, the adequate intake dose recommended by 1.6 g per day for adult men and 1.1 g per day for adult women. However, too much or too little Omega-3 intake will pose a certain threat to health.

4.1. Impact on Body Obesity Indicators

Omega-3, as a special fatty acid, belongs to the category of lipids and is inextricably related to adolescent development. With the rapid development of teenagers' bodies, adolescent obesity, as the most concerned problem today, is very worthy of discussion.

BM index and body fat rate are the commonly used international standards to evaluate the level of fitness and obesity. It primarily serves statistical needs. BMI is a trustworthy and neutral metric when comparing and analyzing the health effects of a person's weight on people of different heights, and body fat ratio is the percentage of fat in your body weight. Taking the current WHO standard as an example, the BM index of adolescents is normal between 18.5 and 24.9, less than 18.5 is lean, and more than 25 is obese. For young men, obesity is identified when the body weight rate is higher than 25%; Women with a body fat rate of more than 30% are judged to be obese [16]. BMI and body fat ratio are important indicators to judge personal obesity.

According to the current research literature, intake of a certain standard amount of Omega-3 can indeed make the changes of balanced BM index of obese patients or young people with severe lean constitution tend to the standard value. Its Omega-3 is an important mechanism for regulating obesity [17]. In terms of regulating metabolic syndrome, metabolic syndrome in adolescence has a variety of physiological abnormalities, mainly including abdominal obesity, hypertension, insulin resistance, malnutrition, high triglyceride and low high-density cholesterol (HDL). People with metabolic syndrome have different body size and obesity degree from normal people [18]. For the above symptoms, Omega-3 can improve metabolic syndrome mainly from the following aspects.

First of all, Omega-3 can enhance the metabolic capacity of digestive organs, accelerate the digestion of food and the absorption of nutrients, and then prevent the occurrence of dyspepsia symptoms, leading to weight loss and physical weakness; In addition, it also has the ability to resist depression, anxiety and other negative emotions. Negative emotions are easy to cause loss of appetite, so it is also the main reason for people to be thin; Omega-3 can also significantly improve the quality of sleep. High quality sleep can promote the secretion of hormones by the liver, and the sleeping state can reduce the consumption of body nutrients at night, so that nutrients can be transformed into human components. Therefore, promoting the body's absorption of food nutrients can cure malnutrition in some cases, and play a certain role in health treatment for those who are thin due to malnutrition.

In addition to the function of preventing weight loss, Omega-3 has obvious health care and treatment effects for obese patients. First of all, Omega-3 intake will significantly reduce the level of triglycerides, which is extremely effective in reducing abdominal and facial obesity; In addition, Omega-3 can increase the level of HDL and reduce the level of LDL, that is to say, high-density lipoprotein can absorb substances such as cholesterol, low-density lipoprotein and triglyceride immersed in the intima of blood vessel wall, which can not only improve blood circulation, but also prevent fat accumulation in the body, thus reducing obesity [19].

4.2. Mechanism of Omega-3 Affecting The Body

Omega-3 is very important to the body. It can regulate various organs and systems in the body through different mechanisms.

4.2.1 Anticancer mechanism

Firstly, linolenic acid can promote tumor growth, and its effect is partially mediated by arachidonic acid analogues. Omega-3 fatty acids can impede linolenic acid synthesis, absorption, and transportation, arachidonic acid or their analogues and prostaglandin E2 in the body, thereby inhibiting tumor growth. In MDA-MB-231 human breast cancer cells, certain studies have demonstrated that n-3 polyunsaturated fatty acids and Genistein can suppress the production of COX-

2, so as to reduce the production of PGE2 and inhibit tumor growth. Monoacylglycerol analogues were found in MCF-7 cells to induce these cells to activate TRPC3. TRPC3 mediated ca2+ entry can inhibit AA, La, etc. [20]. These studies show that polyunsaturated fatty acids inhibit breast cancer in part by inhibiting TRPC3 channels.

Omega-3 fatty acids, meantime, can stop the growth of breast cancer cells by controlling the expression of genes linked to tumors. Omega-3 fatty acids have been discovered to have a specific impact on the tumour cell genes BRCA1 and BRCA2.According to new research. DHA and EPA can increase their expression in tumor cells, thus inhibiting the growth of tumor cells, while omega-6 fatty acids do not. Some researchers applied dietary fish oil (MaxEPA) and corn oil to female SD rats induced by DMBA and found that DNA strand breaks were dramatically reduced in the fish oil group, Ki-67 index, her2/neu gene and c-myc immune marker index than the corn oil group ($p<0.05$). In further studies, it was found that DHA could induce apoptosis by blocking MEK (extracellular signal-regulated kinase) and MAPK/ERK kinase (MEK) (ERK). At the same time, it was also found that DHA could up regulate sdc-1 gene, and the phosphorylation of sdc-1 gene could also inhibit the phosphorylation pathway of MAPK/ERK [21].

In addition, Omega-3 can also enhance the effect of anticancer drugs on tumor cells, including a-linolenic acid, y-linolenic acid and Polyunsaturated fatty acids. Beside EPA and DHA can promote the absorption and retention of anticancer drugs, enhance the concentration of anticancer drugs in tumor cells, enhance their efficacy, and enhance the cytotoxicity of anticancer drugs (such as doxorubicin), without reducing its sensitivity to tumor cells (such as malignant glioma cells-a-172 and u-87mg, a-427 and sk-lu-1 bronchial cancer cells, breast cancer cell MDA-MB-231, etc.), Its effect may be the effect of lipid peroxidation products, which changes the activity of cell membrane, such as Na-K ATPase activity, 5'- nucleotidyl glycase activity, various antioxidant levels or improves antioxidant enzymes. Such as the activity of SOD and cat, the concentration of protein kinase C and the promotion of p53 expression. Therefore, experts think that fish oil can be utilized as an additional nutritional therapy for those who have malignancies including colorectal, breast, pancreatic, prostate, and other cancers [22].

4.2.2 Mechanism of eye protection

Adolescence is one of the most frequent periods of eye use, and excessive eye use is likely to lead to vision loss and other eye diseases. DHA is the main structural component in the retina of human eyes, accounting for 60% of polyunsaturated fatty acids.

The retina is a translucent film that is found in the inner layer of the eyeball wall. The pigment epithelium and retinal sensory layer make up the retina. The sensory layer on the retina is composed of three neurons. The first neuron is the optic cell layer, which is specialized in light sensitivity. It includes cone cells and rod cells. There are about 110 ~ 130 million rod cells and 6 ~ 7million cone cells in human retina. Rod cells are mainly located in the retina far from the fovea, while cone cells are most located in the fovea. The second layer is called Double ganglion cells. About 10 to hundreds of visual cells are connected with a ganglion cell through double ganglion cells, which are responsible for communication. The third layer is called ganglion cell layer, which specializes in conduction. Nerve fibers excited by retinal receptors cross the surface of the retina and reach the exit through the optic nerve. The resolution of the retina is uneven, and its resolution is the strongest in the macular region. The thickness of the retina is equivalent to a thin piece of paper. From the optical point of view, the retina is the imaging screen of the optical system of the eye, which is a concave spherical surface. Pigment epithelium, photoreceptor, bipolar and ganglion cells make up the organizational framework. In retinal photoreceptors, omega-3 fatty acid is the most prevalent long-chain polyunsaturated fatty acid. It is an important component of the retina, accounting for 50% of the total retinal lipids, and is necessary to maintain the normal function of rhodopsin [23]. It is crucial for promoting the development of retinal tissue, improving the function of hippocampus and maintaining normal cognitive function.

In addition, glaucoma is also a high incidence of eye disease in adolescence. According to the experimental study of Downie research team, 105 subjects who had no glaucoma and other eye

diseases, normal blood pressure and intraocular pressure <21 mmHg were randomly assigned to the treatment group (oral PUFA 600 mg/d) and the placebo group (oral olive oil 1500 mg/D for 90 days). The results showed that the intraocular pressure decreased significantly in the treatment group. In another neuroprotective study on the mouse model of hereditary glaucoma, according to different intervention methods, the mice were randomly divided into PUFA combined with timolol group (group A), PUFA only group (group B), timolol only group (Group C) and untreated group (Group D). Among them, the ratio of eicosapentaenoic acid and EPA in PUFA by intragastric administration of 0.5% timolol should reach 1~1.5 times of the treatment range. Groups A, B, and C had considerably larger retinal ganglion cell densities after 4 weeks of therapy than Group. Furthermore, both groups A and B of mice had considerably lower levels of interleukin-18 as well as tumor necrosis factor-A expression in their retinas, while group C had no effect on the expression levels of the above-mentioned mediators. According to experiments, Omega-3 has the effect of protecting retinal ganglion cells.

4.2.3 Improve sleep

Omega-3 can regulate the central nervous function of the brain, normalize the excitatory and inhibitory functions of the cerebral cortex, and improve the sleep state. Increase gastrointestinal peristalsis and strengthen metabolic function.

4.2.4 Regulating blood lipids and blood pressure

In terms of reducing blood lipids, Omega-3 can effectively reduce the level of triacylglycerol by 20%-30%, slightly reduce low-density lipoprotein cholesterol, but has a weak impact on high-density lipoprotein cholesterol, and does not influence how much cholesterol is regulated. Studies have shown that EPA and DHA can lessen the transfer of unesterified fatty acids to the liver and enhance theβoxidation of fatty acids while inhibiting the activity of enzymes involved in TG esterification., increase liver phospholipid synthesis and other mechanisms inhibit TG synthesis. Clinical studies have confirmed that Omega-3 PUFAs combined with statins can further reduce TG and increase HDL cholesterol; High dose W-3 PUFAs can be used as an adjuvant treatment for hypertriglyceridemia [24].

In terms of lowering blood pressure, Omega-3pufas can reduce systolic blood pressure, and high-dose EPA+DHA (22g/d) can slightly reduce diastolic blood pressure [25]. EPA and DHA can change vascular endothelial function by inhibiting inflammation and oxidative stress, improve arterial compliance, reduce systemic vascular resistance, and then reduce blood pressure. The latest research shows that EPA improves the fluidity of cell membrane through fatty acid metabolism and increases the number of vanillin receptor 4 channels of microvascular endothelial cell transient receptor potential, so as to reduce the calcium sensitivity of cell membrane and reduce systolic blood pressure.

Increasing Omega-3 PUFA consumption has also been shown in clinical trials to slow bleeding and minimize platelet aggregation. Under the influence of lipid/cyclooxygenase, EPA is a 3-Series prostaglandin precursor that creates PG inhibitor, thromboxane A3, and other active compounds. Omega-3pufas compete with arachidonic acid to bind cyclooxygenase and reduce the transformation of arachidonic acid to 2-line PG (TXA2). Txa3 is weaker than TXA2 in promoting platelet aggregation, while PGIS has the same antithrombotic effect as PGI2. Therefore, the increase of EPA concentration reduces the synthesis of PG in line 2 and increases the synthesis of PG in line 3, resulting in the shift of the balance between promoting and inhibiting platelet aggregation, thus playing the role of inhibiting platelet aggregation and prolonging bleeding time.

According to the current research literature, the other mechanism of Omega-3 is not clear, and it needs to be studied.

5. Potential Crisis Caused by Lack of Omega-3

Lack of Omega-3 may affect the intelligence of teenagers. During junior high school and senior high school, the development of the brain has been completed, but it is the time to strengthen the stimulation of brain cells. When brain cells are stimulated, the neurites of nerve cells will be prolonged, and DHA is an indispensable material to promote the neurites to sprout and prolong. The connection between nerve cells will be strengthened, and the transmission of information will be rapid and smooth. For students, the brain must get enough DHA to have good intelligence and memory ability, otherwise even if they study hard, the brain cells will not get good stimulation and growth and development, so they must take enough DHA every day α- Linolenic acid, so as to effectively improve academic performance.

Secondly, adolescence is a period of vigorous metabolism and physical growth. Omega-3 can improve the endocrine function of human body, so as to reduce obesity through the control of hormone secretion. In addition, in terms of asthma and eye health, the lack of a certain amount of Omega-3 will also be affected. Relevant studies have shown that children and young people who consume sufficient Omega-3 fatty acids (consuming fish or supplementing with Omega-3 fatty acids) have a lower risk of asthma, and the two are significantly negatively correlated. As for eye health, lack of sufficient DHA will affect the synthesis of retina, and retinal cells cannot be quickly supplemented after decay, resulting in vision loss and other eye diseases.

Finally, Omega-3 is also a good antidepressant. Adolescents who regularly consume Omega-3 have a lower risk of depression. Moreover, Omega-3 can significantly alleviate the symptoms of patients with mild depression and anxiety. Among them, EPA has a more obvious effect, which can effectively alleviate the related symptoms caused by depression [26].

6. Foods With High Omega-3 Content

With the change of agricultural production mode and dietary structure, the dietary source of omega-3 is more and more limited, so how to absorb enough omega-3 to achieve the nutritional goal is very worth exploring. Through the analysis of nutritional components of the foods listed below, several foods with the highest content of Omega-3 were selected (Table 1).

Table 1. Omega-3 rich foods Comparing [27]

Species	Name	The radio pf Omega-3 to Omega-6	Omega-3(mg) per 100g	% of daily intake
vegetable and fruit	Persimmon pepper	1：6	775	48
	avocado	1：15	111	7
Animal food	Oysters	25：1	1584	99
	salmon	4：1	2501	156
	deep-sea fish	N/A	N/A	N/A
Beans and bean products	Bean curd	1：7	582	36
	kidney bean	1.57：1	170	10.6
Seeds and nuts	flaxseed	4：1	22813	1426
	Chia seed	3：1	17830	1114
	Walnut	1：4	9080	568

7. Conclusion

In conclusion, Omega-3 intake has an extremely important impact on the growth and development of adolescents. The current scientific research on Omega-3 shows that the amount of Omega-3 (especially DHA) consumed during adolescence will have a critical impact on the level of intelligence

(that is, brain development). Secondly, Omega-3 can promote the gland development of adolescents and prevent physiological diseases caused by endocrine disorders caused by vigorous metabolism of adolescents. Third, Omega-3 can to a certain extent curb the occurrence of obesity caused by overeating for the needs of physical growth and development. Fourth, Omega-3 can protect the eyes and prevent the occurrence of eye diseases caused by excessive use of eyes due to learning and other reasons. Fifth, DHA in Omega-3 can also significantly improve sleep and improve sleep quality. In addition, Omega-3 also has health care functions such as improving immune function, improving bone and joint health, reducing female physiological pain and reducing asthma.

The whole medical community has studied and found that omega-3 has significant effects on more than 60 diseases. With the continuous deepening of relevant scientific research, the powerful health care function and nutritional value of Omega-3 have also received high attention in the medical and nutrition circles. Various teams, research institutes and even the government have begun to increase their efforts to invest in the development of Omega-3. Omega-3 not only has high nutritional value, but also shows high economic value. Nowadays, Chinese teenagers are still seriously lacking in Omega-3. Animals and plants rich in Omega 3 will still be the main source of intake of Omega-3 in the future. Omega-3 supplements have been popular for more than decades, but these products still have a series of problems such as high price, single effect and poor raw material quality. Many citizens of third world countries have not realized its importance, Therefore, there is still enough room for improvement and market scale to be expanded for Omega-3 dietary supplement products. Omega-3 health food with broad market prospects and sales trends will certainly shine brilliantly in the future health product market.

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