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The Main Role of the Microelement Zinc in Human Organism (Literature Review)

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Abstract This literature review analyses the available scientific research on the role of zinc in the body, as well as the mechanisms of action and its significance in the pathogenesis of obesity. In experimental studies, it was found that the content of zinc decreases in adipose tissue with obesity and affects the activity and differentiation of adipocyte cells. Considering zinc as one of the regulators of adiposeness, disturbance of its metabolism is observed along with dysfunction of adipose tissue. By correcting the exchange of zinc in adipose tissue, it is possible to achieve normalization of the exchange of the lipid spectrum. At the same time, since its excessive accumulation in adipocytes also leads to their dysfunction, it is important to conduct additional studies to study the mechanisms of action of deficiency and excess of zinc in adipose tissue.

Keywords Zinc, Adipose tissue, Adiposeness, Atherosclerosis, Zinc-α2-glycoprotein

1. Relevance of the Topic

Zinc is the second most important element after iron in the human body. Zinc performs a catalytic function in 70% of the existing enzymes. In addition, it enters proteins and acts as a substrate or regulator of enzymatic activity. This explains why the need for zinc is high for DNA, RNA, protein and lipid synthesis. Also, zinc is considered necessary for the stabilization of the genome, its antioxidant properties ensure the recovery of DNA after damage, and it participates in the synthesis of methionine from biologically active molecules. Zinc is involved in neurotransmission and is accumulated and released in vesicles at the synaptic terminals of glutamatergic neurons [19]. Zinc is considered an essential metal involved in the regulation of nervous, endocrine, immune, reproductive and other systems, zinc-storing metalloproteinase and leases, ligases, isomerases, hydrolases, transferases and oxidoreductases, and more than 7000 enzymes in the composition of signal, cofactor, systemic, etc. participates in the implementation of functions in mutual cooperation [1]. Modulation of the activity of zinc transporters leads to changes in its level in cells. Despite the role of zinc-holding metalloproteinase, its main effect depends on low molecular weight zinc compounds or Zn2+ cation [23]. Zinc finger (zinc finger) is a type of protein structure containing about 20 amino acids stabilized by one or two zinc ions, and its amount in the human body is 1.5-2 grams. 63% of zinc is mainly found in skeletal muscles.

In fact, zinc trace element is a pre-, post-, and transitory element present in the body, and it has been proven that it is non-toxic even in bio doses slightly above the norm [13].

As a result of the disturbance of zinc metabolism, the development of a wide spectrum of pathologies, such as diabetes and atherosclerosis [10]. In the pathogenesis of diabetes-related obesity, zinc metabolism disorders are characteristic [5]. The results of a meta-analysis conducted in recent years showed a significant decrease in zinc levels in overweight patients. [6]. Given the role of insulin-dependent adipose tissue in the regulation of carbohydrate metabolism, the involvement or lack of zinc in insulin signalling in adipocytes plays an important role in the pathogenesis of obesity and obesity-related metabolic diseases [20]. Alternatively, the use of zinc-containing drugs in obesity leads to weight loss, insulin sensitivity [3] and normalization of blood plasma lipid spectrum [17].

However, unlike diabetes, the importance of zinc metabolism disorder in the pathogenesis of atherosclerosis, as well as its mechanisms and potential to protect the vascular walls, have not been thoroughly studied.

Taking into account the role of oxidative stress and inflammatory response in the pathogenesis of obesity [4], it has been noted that the positive results observed when zinc is used in this situation are due to its anti-inflammatory and antioxidant effects [11].

In addition, as the main hormone of adipose tissue, leptin, which is involved in the control of metabolism, is closely related to zinc metabolism [2].

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Taking into account that the effect of zinc is carried out at the level of adipocytes, it is known that its deficiency is hypertrophy of adipose tissue as a morphological and functional substrate or unit of obesity. However, its local effect on adipose tissue, its role in the pathogenesis of obesity has not been sufficiently studied and systematized.

Therefore, the aim of this literature review was to review and systematize the data on the role of zinc metabolism in the pathogenesis of obesity.

As a result of research, it was found that zinc deficiency has a negative effect on the activity of many enzymes related to it, and it has been proven that the detection of changes in the activity of three main enzymes, such as alkaline phosphatase, carboxypeptidase and thymidine kinase, has high sensitivity in diagnosing diseases related to zinc deficiency. Significant changes were observed in experimental animals on 3-6 days of Zn-deficient diet [16].

In the offspring of zinc-deficient animals, the proliferative response of T-lymphocytes to a mitogen is impaired, and in the case of mice, prenatal zinc deficiency caused the absence of antibodies after vaccination. In this case, the formation of V-cell receptors in plasma membranes is associated with their saturation with zinc. In addition to negative effects of zinc deficiency on the specific immune response of animals, anomalous innate immune responses such as chemotaxis and phagocytosis have been reported [15].

During clinical studies, it was noted that with a decrease in the amount of zinc in bio substrates in the body, which is an indicator of alimentary obesity, its level in adipose tissue has a significant inverse relationship with the concentration of leptin, insulin resistance, and inflammatory markers [21].

In addition, against the background of a high-fat diet, there was a decrease in the amount of zinc in adipose tissue and a violation of the expression of zinc transporting transporters against the background of unchanged concentration in blood plasma. Interestingly, these changes were associated with increased circulating leptin concentrations as well as increased adipose tissue infiltration by macrophages [9].

A decrease in zinc levels in adipose tissue during obesity indicates that this tissue is one of the physiological targets of zinc.

Thus, changes in the amount of zinc in adipocytes have a significant effect on their differentiation. In particular, Sivero J.S. together with co-authors (2020) were able to prove that zinc has a positive effect on adiposeness in vitro [18].

These observations are consistent with the results of subsequent studies, which showed that mRNA PPARγ (Peroxisome Proliferator-Activated Receptors γ), FABP4 (Fatty-Acid-Binding Proteins 4), C/EBPa (CCAAT-Enhancer-Binding Proteins α), SREBP1 (Sterol Regulatory Element-Binding It shows a significant increase in the expression of proteins 1), as well as an increase in the intensification of the accumulation of lipids in adipocytes in response to zinc oxide (II) [12].

2. Conclusions

Relying on a large number of literature, concluding that zinc is one of the most functional elements in the human body, it is urgent to develop and study measures to eliminate problems in its metabolism.

Modulation of zinc level is considered as one of the regulators of adiposeness, and the disturbance of its metabolism leads to the dysfunction of adipose tissue and becomes important as the main factor in the development of obesity and related metabolic diseases [8].

Alternatively, zinc deficiency [12], or an excess of zinc leads to a violation of adipose tissue physiology [7].

According to the results of in vivo and in vitro studies, zinc plays an important role in adipose tissue physiology, which is carried out by zinc transporters that control its intracellular concentration and compartmentalization.

When treating socially important diseases such as chronic heart failure, metabolic syndrome, diabetes and atherosclerosis, it is necessary to take into account the state of zinc homeostasis, hypokinaemia can be an indicator not only as a sign of zinc metabolism disorders, but also as an indicator of carbohydrate and lipid metabolism disorders.

In conclusion, the correction of zinc metabolism in adipose tissue can be considered as one of the ways to normalize the metabolism of adipose tissue in cases of excess body weight.

REFERENCES

[1] Andreini C.A. Bioinformatics view of zinc enzymes // J. Inorg. Biochem. -2012. -Vol. 111. -P. 150-156.

[2] Baldacci A.K., Mogulkoc R. Leptin and zinc relation: in regulation of food intake and immunity // Indian J. Endocrinol. Metab. -2012. –Vol.16 (Suppl. 3). –P. 611-606. DOI: 10.4103/2230-8210.105579.

[3] Cruz K.J.C., Morais J.B.S., de Oliveira A.R.S. et al The effect of zinc supplementation on insulin resistance in obese subjects: a systematic review // Biol. Trace Elem. Res. -2017. –Vol. 176(2). -P. 239-243. DOI: 10.1007/s12011-016-0835-8.

[4] Fernandez-Sanchez A., Madrigal-Santillan E., Bautista M. et al Inflammation, oxidative stress, and obesity // Int. J. Mol. Sci. -2011. –Vol. 12(5). -P. 3117-3132. DOI: 10.3390/ijms12053117.

[5] Fukunaka A., Fujitani Y. Role of zinc homeostasis in the pathogenesis of diabetes and obesity // Int. J. Mol. Sci. -2018. –Vol. 19(2). –P. 476. DOI: 10.3390/ijms19020476.

[6] Gu K., Xiang W., Zhang Y. et al. The association between serum zinc level and overweight/obesity: a meta-analysis // Eur. J. Nutr. -2019. –Vol. 58(8). –P. 2971-2982. DOI: 10.1007/s00394-018-1876-x.

[7] Huang X., Jiang D., Zhu Y. et al Chronic high dose zinc supplementation induces visceral adipose tissue hypertrophy without altering body weight in mice // Nutrients. -2017.

–Vol. 9(10). –P. 1138. DOI: 10.3390/nu9101138.

[8] Klöting N., Blüher M. Adipocyte dysfunction, inflammation and metabolic syndrome // Rev. Endocarp. Metal. Dis. -2014. –Vol. 15(4). –P. 277-287. DOI: 10.1007/s11154-014-9301-0.

[9] Liu M.J., Bao S., Bolin E.R. et al Zinc deficiency augments leptin production and exacerbates macrophage infiltration into adipose tissue in mice fed a high-fat diet // J. Nutr. -2013. –Vol.143 (7). -P.1036-1045. DOI: 10.3945/jn.113.175158.

[10] Maret W. Regulation of Cellular Zinc Ions and Their Signaling Functions. In: Zinc Signaling // Singapore. Springer. -2019. –Vol. 5. –P. 22. DOI: 10.3390/ijms18112285.

[11] Olechnowicz J., Tinkov A., Skalny A., Suliburska J. Zinc status is associated with inflammation, oxidative stress, lipid, and glucose metabolism // J. Physiol. Sci. -2018. –Vol. 68(1). –P.19-31. DOI: 10.1007/s12576-017-0571-7.

[12] Pandurangan M., Veerappan M., Kim D.H. Cytotoxicity of zinc oxide nanoparticles on antioxidant enzyme activities and mRNA expression in the cocultured C2C12 and 3T3-L1 cells // Appl. Biochem. Biotechnol. -2015. –Vol. 175(3). –P.1270-1280. DOI: 10.1007/s12010-014-1351-y.

[13] Pathak A. Supplementation of zinc mitigates the altered uptake and turnover of 65Zn in liver and whole body of diabetic rats // Biometals. -2011. -Vol. 24. -P. 1027-1034.

[14] Pelletier C.C., Koppe L., Croze M.L. et al White adipose tissue overproduces the lipid-mobilizing factor zinc α2-glycoprotein in chronic kidney disease // Kidney Int. -2013. –Vol. 83(5). –P.878-886. DOI: 10.1038/ki.2013.9.

[15] Prasad A.S. Impact of the discovery of human zinc deficiency on health // J. Trace Elem. Med. Biol. -2014. -Vol.28. № 4. -P.357-363.

[16] Severo J.S., Morais J., Beserra J.B. et al. Effect of Zinc Supplementation on Lipid Profile in Obese People: A Systematic Review // Curr. Nutr. Food Sci. -2019. –Vol. 15(6). –P. 551-556. DOI: 10.2174/1573401314666180420094522.

[17] Severo J.S., Morais J.B.S., Beserra J.B. Role of zinc in zinc-α2-glycoprotein metabolism in obesity: a review of literature // Biol. Trace Elem. Res. -2020. –Vol. 193(1). –P.81-88. DOI: 10.1007/s12011-019-01702-w.

[18] Sharif R. The role of zinc in genomic stability // Mutat Res. -2012. -Vol. 733. -P. 111-121.

[19] Smith U., Kahn B.B. Adipose tissue regulates insulin sensitivity: role of adipogenesis, de novo lipogenesis and novel lipids // J. Int. Med. -2016. –Vol. 280(5). –P. 465-475. DOI: 10.1111/joim.12540.

[20] Tinkov A.A., Popova E.V., Gatiatulina E.R. et al Decreased adipose tissue zinc content is associated with metabolic parameters in high fat fed Wistar rats // Acta Sci. Pol. Technol. Aliment. -2016. –Vol. 15(1). –P. 99-105. DOI: 10.17306/J.AFS.2016.1.10.

[21] Zahid H., Miah L., Lau A.M. et al Zinc-induced oligomerization of zinc α2 glycoprotein reveals multiple fatty acid-binding sites // Biochem. J. -2016. –Vol. 473(1). –P. 43-54. DOI: 10.1042/BJ20150836.

[22] Тиньков А.А. Механизмы адипотропного действия цинка и их роль в патогенезе ожирения // Патогенез. -2020. -№ 18(2). –С. 20-26. DOI: 10.25557/2310-0435.2020.02.20-26.

[23] Шейбак В.М. Транспортная функция сывороточного альбумина: цинк и жирные кислоты // Вестник Витебского государственного медицинского университета. -2015. - Т.14. -№ 2. -С.17 – 23.