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Original research

Impact of zinc: Early prevention of obesity and fatty in children

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ABSTRACT

Objective: Get the effect of zinc supplementation on the fat profile consisting of blood glucose levels, total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides in obese and fatty children.

Methods: Primary data are anthropometric, nutritional intake and blood sugar levels at the time, total cholesterol, glycerides, HDL and LDL collected before and after intervention, namely in March to April 2018. Zinc supplements in the form of 1 teaspoon (20 mg) syrup used one day. The researcher got a sample, namely by criteria of obese and fatty children age 6–12 years, Bugis-Makassar tribes, physically healthy, received parental approval. Finally, there were 12 samples based on sample size calculations. Blood serum was examined using Roche Cobas C111 to in the Tajuddin Chalik General Hospital Laboratory Makassar, Indonesia. Anthropometric data consists of weight and 24-h intake.

Results: Latest, obese and fatty students who received zinc supplements caused blood sugar levels, total cholesterol and HDL to decrease significantly while triglyceride and LDL levels dropped not significantly.

Conclusions: Zinc supplements can be used as substances that can maintain the balance of blood fats and blood sugar levels for obese and fatty students.

1. Introduction

The rate of obesity and fatty in children in Indonesia has tripled, according to a global study released in the New England Journal of Medicine. They have the potential to suffer from various types of diseases as adults, including diabetes, heart disease and cancer. These findings are in line with the 2016 National Health Indicator Survey Data which revealed that 20.7% of Indonesia's adult population are overweight. This figure increased from 15.4% in 2013. The Global Burden of Diseases study published in the scientific journal, Lancet, in 2014 placed Indonesia at number 10 in the list of countries with the highest obesity rates in the world. While research by the University of Washington in 195 countries found that 107 million children and 603 million adults worldwide were obese and fatty (Hokansan and Austin, 1996; Hooper, Visconti, Garry, Johnson, 1980; Katier et al., 2008). Besides that, the impact of obesity contributed to four million deaths in 2015 with not a small economic loss. Ironically, obesity cases have also increased in countries that are threatened with food insecurity such as in Africa (Gunasekara, Hettiarachchi, liyanage, 2008).

According to experts obesity continues to increase, due to unhealthy consumption patterns. In Indonesia, children from families with middle to upper economic conditions experience this, because of the ease of accessing various types of food. Parents tend to want their children to eat a lot, and choose the types of high-calorie foods. This type of fast food is also popular and popular with children, including menus that contain high sugar. At the same time, children, especially in urban areas, began to lack physical activity, due to the increasing hobby of playing games. About 30 percent are obese in the adult group. Children and adolescents are in the top ten percent who are obese. However, in this group of adolescents this is not only a problem of obesity, because blood pressure also starts to rise (Aggoun, 2007; Jenifer, 2019; Nurrahman, 2018). In several studies found evidence also that the symptoms of high blood pressure among adolescents, as a follow-up impact of obesity, excessive salt consumption, high stress levels and lack of physical activity. Not surprisingly, now, various diseases such as sugar and heart have been found in the age group of 30 years. This phenomenon occurs because the actual trigger factors have been initiated and saved since the age of the children. Indonesia ranks 10th as the country with the highest

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number of obese people in the world. Even so, obesity has not become a health problem that has received enough attention in Indonesia. In fact, the impact on health in the future will be very worrying (Nurrahman, 2018).

Zinc is a mineral that plays an important role in many biological processes and plays an important role in the workings of insulin and carbohydrate metabolism (Ranasinghe et al., 2015). Some human studies have shown that zinc supplementation reduces total cholesterol, LDL cholesterol and triglycerides, in addition to increasing HDL cholesterol levels (Foster et al., 2010). However, these results have contradicted other studies. Even under the most rigorous study design conditions, a single planned study rarely gives definite results (Xiao et al., 2013). Therefore, changing clinical practices that depend on a high-profile clinical trial can endanger the health of the patient. Systematic reviews and meta-analyzes on the other hand often have increased power and decreased bias compared to individual studies they include, and careful collection of treatment effects can provide the most accurate overall assessment of an intervention (Jenifer, 2019). In 2008 conducted a meta-analysis of controlled clinical trials to determine the effect of zinc supplementation on serum lipids in humans (Xiao et al., 2013). They did not observe the beneficial effects of zinc supplementation on plasma lipoprotein in the overall analysis, while in the analysis of healthy subgroup subjects zinc supplementation was associated with a decrease in HDL cholesterol concentration (Foster et al., 2010). However, since then several recent studies have evaluated the effects of zinc supplementation on serum lipids in humans and have shown mixed results (Jayawardena et al., 2012). Therefore this study aims to re-explore the area being discussed, by systematically evaluating the literature and conducting a recent meta-analysis of the effects of zinc supplementation on serum lipids: total cholesterol (TC); LDL cholesterol (LDL-c); HDL cholesterol (HDL-c); and triglycerides (TG) in humans.

1.1. Subjects

The subjects in this study were elementary school children aged 6–12 years.

2. Materials & methods

2.1. Location and time of research

This study was an experiment with the design of interventions before and after. The location of this study was conducted at the Primary Schools in the Work Area of the Kassi-Kassi Community Health Center in Makassar City.

Supplementation zinc was carried out for one month by controlling nutritional status and nutritional intake through 24-h recall.

2.2. Sampling

The population studied was all elementary school students in the working area of Kassi-Kassi Community Health Center, Makassar City.

The sample used was elementary school students aged 6–12 years in the working area of the Kassi-Kassi Community Health Center in Makassar City. Sample inclusion criteria: active, obese and fatty students, get approval from parents, Bugis and Makassar tribes.

The sample size is the number of members of the population to be sampled. The sample size of the treatment group was calculated using a large sample formula to produce a number of 9 samples by adding 20% so that there were 12 students (The population studied was all elementary school students in the work area of Kassi-Kassi Health Center, Makassar City, Indonesia.

The sample used was elementary school students aged 6–12 years in the working area of Kassi-Kassi Community Health Center, Makassar City, Indonesia. Data Collection Primary data are anthropometric data, nutritional intake and blood sugar levels at the time, total cholesterol, glycerides, HDL and LDL will be collected before and after intervention, namely in March to April 2018. Secondary data in the form of sample characteristics are collected at the same time. Taking blood as much as ± 3 cc in the sample. After that centrifuge to get the serum.

The serum was examined using Roche Cobas C111 to determine the levels of blood sugar levels at the time, Total cholesterol, Glycerides, HDL and LDL each in mg/dl units at the Tajuddin Chalik Hospital Laboratory Makassar, Indonesia.

2.3. Data analysis

Analysis of normality and homogeneity to determine parametric or non parametric statistical tests with the Shapiro-Wilk test. Furthermore, if it meets parametric requirements, the analysis used in this study is to use before after *t*-test to see the effect of each intervention group (pre post test).

2.4. Data presentation

Data is presented in table form accompanied by narration.

2.5. Ethical aspects

This study has obtained research ethics from the Makassar Health Polytechnic Research Ethics Committee with number: 467/KEPK-PTKMKS/VII/2018.

3. Results

The number of samples obtained was 12 obese and fatty students. They obtained zinc sulfate (20 mg elementari) patent products obtained from a pharmacy located in Makassar City, Indonesia. Each student gets 1 teaspoon which contains 20 mg of zinc every day, which is given during recess. Supervision is carried out by enumerators and class teachers who handle school health efforts. Sunday is not done because students do not attend school (holiday), with the reason that it is difficult to control student activities.

Measurement of body weight and nutrient intake was carried out 3 times during the research process.

Based on the table above shows that sex male as much as 75,00% while female samples amounted to 25,00% with ages 6–8 years dominating which amounted to 66,67%. The status of the most obese nutrition is 66,67%. The sample characteristics based on religion indicate that all samples are Muslim.

Table 2 Above Shows that Carbohydrates and Triglycerides have $p < 0.05$, meaning that data is not normally distributed, so that in further analysis using nonparametric statistics.

Table 1
Distribution of characteristics research samples in work areas makassar city of health center kassi-kassi in 2018.

Characteristics	n	%
Gender		
Male	9	75,00
Female	3	25,00
Total	12	100,00
Age (Year)		
6–8	8	66,67
9–11	4	33,33
Total	12	100,00
Nutritional Status		
Fatty	4	33,33
Obese	8	66,67
Total	12	100,00
Religion		
Islam	12	100,00
Total	12	100,00

Table 2
Distribution of normality of intake, anthropometry data and variable.

Intake/anthropometry/Variable	Intervention	Shapiro Wilk	p
When blood sugar	Before	0,921	0437
	After	0,882	0195
Cholesterol	Before	0,913	0378
	After	0,845	0086
Trigliceride	Before	0,800	0029
	After	0,811	0038
LDL	Before	0,851	0097
	After	0,953	0745
HDL	Before	0,967	0878
	After	0,921	0438

Based on the results of Table 3, it shows that the blood sugar levels at any time, total cholesterol and LDL decreased significantly ($p < 0.05$). Triglyceride and HDL levels decreased but not statistically significant ($p < 0.05$).

4. Discussion

Nutritional problems in children faced by society today are no longer about malnutrition or poor nutrition, but the excess of nutrients or called obesity. Obesity from year to year is increasing in various countries including in Indonesia, especially in big cities. Obesity in children occurs due to heredity and environment. Children who are obese will easily become infected, hypertension, diabetes mellitus and metabolic syndrome. Some of the consequences associated with obesity will trigger the emergence of cardiovascular disease. As it is known that some functions of zinc are regulating approximately 300 hormonal activities in the body, besides that it can also increase the glycemic index in the body. As it is known that some functions of zinc are regulating approximately 300 hormonal activities in the body, besides that it can also increase the glycemic index in the body.

The work of zinc also synergistically reduces GDS levels in obese and obese children so that it can be used as a preventive measure in increasing the body's resistance in counteracting free radicals. Some of the latest research results show that zinc is an important nutrient in the incidence of obesity. Recent research reports that adults with a history of "yo-yo" syndrome (gradually decreasing, then increasing) zinc suplementation is significantly helpful (Khan et al., 2013).

In one study, zinc levels in obese and obese subjects were inversely proportional to their body mass index, indicating that the important role of zinc in the development of obesity. In general, the higher the body mass index, the lower the zinc (Xiao et al., 2013).

The highest reduction in HDL levels was in the group of obese and obese children who received zinc supplementation. The results of the Hashemipour et al., 2009 study showed similar results that with zinc administration in obese children would significantly reduce HDL levels. Children with excess weight aka obesity face health risks that are not mild and have long-term effects, including also having high cholesterol levels. Overweight children are often found to have high levels of bad cholesterol (LDL), low good cholesterol (HDL), and high triglycerides. Therefore children who have a high body mass index before the age of 5–7 years must be checked for cholesterol levels.

Apart from high cholesterol, obese children can also experience high blood pressure. These are all risk factors for coronary heart disease. When the child is still a child, the effect is not yet visible, but his heart aches later when he is 30–40 years old. Another complication of obesity is insulin resistance which makes it at risk of developing diabetes mellitus, sleep apnea (stopping breathing during sleep), joint problems, and gallstones.

In other words, obesity is the cause of various chronic diseases. To manage child obesity is not easy so prevention is better done as early as possible. Almost 90 percent of cases of obesity in children are caused by environmental factors, such as a high-calorie diet, lack of movement, or a history of obesity in the family. Prevention of obesity is done by getting a balanced healthy diet in the family. Usually obese children have an unbalanced diet.

Table 3
Distribution of Changes in Blood Sugar Profile, Total cholesterol, Triglycerides, LDL, HDL in Obese and Obese Children in the Work Area of Kassi-Kassi Makassar Health Center in 2018.

Group	n	When Blood Sugar	Total Cholesterol	Trygliceride	LDL	HDL
Before	12	97,08 ± 9,76	180,67 ± 18,38	206,58 ± 82,41	96,83 ± 18,43	47,75 ± 11,39
After	12	90,5 ± 6,56	165,16 ± 16,58	163,25 ± 80,61	94,83 ± 18,69	42,67 ± 10,77
t		2,463[b]	3,717[a]	−1,412[a]	0,436[b]	3,827[b]
p		0,032[b]	0,003[a]	0,158[a]	0,672[b]	0,003[b]

[a] Wilcoxon Signed Ranks Test.
[b] Paired *t*-Test.

4.1. Obesity and Children's lifestyle

There are food rules that must be obeyed, namely to comply with the schedule of three meals and two snacks. Obese children generally consume too much milk and eat too much. Although overweight, children are not advised to go on any diet. "It is feared that it can affect the growth and development of children. Diets are still given according to their ideal needs. In addition to regulating diet and physical activity, parents are also advised to routinely measure a child's body mass index, which is the division of body weight in kilograms with their height in meters squared (Foster et al., 2010).

Research conducted in fourteen major cities in Indonesia, the incidence of obesity in children is relatively high, between 10 and 20% with a value that continues to increase until now.

Child nutrition education for parents continues to be intensified, considering that Indonesia still has a unique phenomenon of the pediatric paradox, millions of children are malnourished, while on the other hand millions of children are obese. The factor of snacks other than home food (snacks) is thought to be a scapegoat.

Obesity is a condition of a child's body mass index (BMI) which is above the 95th percentile in the child's growth chart according to his gender. This definition is relatively similar to the Institute of Medicine (IOM) in the US, while the US Center for Disease Control (CDC) categorizes these children as "overweight". The CDC argues that a child is categorized as obese if he is overweight above the 95th percentile with a greater proportion of body fat than other body components (Andra, 2009). According to (2003), a child who has excess body fat or has a BMI of more than 30. This excess is due to the amount of food that comes in compared to the energy released.

Scientifically, obesity results from consuming more calories than is needed by the body. The cause of this imbalance between calorie intake and burning is still unclear. The occurrence of obesity involves several factors: Genetic factors. Obesity tends to be lowered, so it is thought to have genetic causes. But family members not only share genes, but also food and lifestyle habits, which can encourage obesity. It is often difficult to separate lifestyle factors from genetic factors. Recent research shows that the average genetic factor has an effect of 33% on a person's body weight. Environmental factor. Gene is an important factor in various cases of obesity, but one's environment also plays a significant role. This environment includes behavior/lifestyle patterns (such as what is eaten and how many times a person eats and how it works). Someone of course cannot change his genetic pattern, but he can change his diet and activities (Hendrix et al., 2020).

According to Campana et al. (2019), the pathogenesis of obesity can be divided into two types. The first type of disorder is regulatory obesity related to the center that regulates food input. The second type is metabolic obesity, there are abnormalities in the metabolism of fats and

carbohydrates.

Energy balance can be set at the level of food intake and energy released. The experts found the energy storage regulator component, namely leptin. Leptin is a cytokine like a polypeptide produced by genes in adipose tissue that control food intake through hypothalamic receptors. Leptin is produced in proportion to the weight of adipose. Leptin also decreases the expression of neuropeptides Y, and hormones associated with energy intakes include ghrelin, insulin and cholecytokinin. The presence of leptin at the hypothalamic receptor can inhibit food intake. Mutagenesis of this gene will eliminate the regulator factor from food intake (Gunasekara et al., 2011).

Apart from leptin, adipose tissue also secretes other factors that regulate energy balance and carbohydrate metabolism, such as cytokines, angiogenic factors, immune-related factors, prostaglandins, angiotensinogen and protein. These factors are produced proportionally according to the adipose tissue mass (Kang Cheah et al., 2019).

4.2. Health factor

Some diseases can cause obesity, including: hypothyroidism, Cushing's syndrome, Prader-Willi syndrome, and some neurological disorders that can cause a person to eat a lot. Certain medications (such as steroids and some anti-depressants) can cause weight gain.

The addition of size or number of fat cells (or both) causes an increase in the amount of fat stored in the body. Obese people, especially those who become obese in childhood, can have fat cells up to 5 times more than people who are of normal weight. The number of fat cells cannot be reduced, because weight loss can only be done by reducing the amount of fat in each cell. According to Kriemler et al. (1999) and Warner et al. (1998), lack of physical activity is probably one of the main causes of the increasing incidence of obesity in a prosperous society. Inactive children need fewer calories (lower energy released). A child who tends to consume fat-rich foods and not engage in balanced physical activity will be obese (Franssen et al., 2011).

4.3. Obesity in children and cardiovascular disease

The circulatory system or cardiovascular system is an organ system that functions to move substances to and from cells. This system also helps stabilize the body's temperature and pH (part of homeostasis). There are three types of circulatory system: no circulatory system, open circulatory system, and closed circulatory system. Components of organs that play a role in the cardiovascular system include the heart, arteries, veins, lungs and blood.

Cardiovascular disease is a health disorder that occurs in parts related to the cardiovascular system. Sightings of cardiovascular diseases include stroke, artherioschlerosis, coronary heart disease, heart failure, inflammation and hemorrhoids. Some of the causes of cardiovascular disease include hypertension, diabetes mellitus, oxidized LDL, infection and obesity.

Cardiovascular disease that was suffered by many adults and older people for various reasons, now also occurs in children and adolescents. According to Atabek et al. (2007), recent studies show the process of atherosclerosis in the vascular wall in children and there is an increasing tendency. Other diseases found in children are hypercholesterolemia, hypertension and type 2 diabetes mellitus, which was also dominated by adults and the elderly (Xiao et, 2013).

Of the various diseases that appear above if traced begins obesity in children. Obesity is associated with metabolic abnormalities (dyslipidemia, insulin resistance and hyperglycemia) and hypertension which increases the risk of cardiovascular disease (Katier et al., 2008). Atabek et al., 2007 and Aggoun (2007) argue that there is a relationship between obesity and the occurrence of artherosclerosis.

Because of the high prevalence of obesity in children from day to day, scientists are increasingly serious about the adverse consequences of these conditions, namely the occurrence of the metabolic syndrome. The definition of the entity of the metabolic syndrome is the presence of insulin resistance followed by at least three of the following symptoms, hypertension, changes in glucose metabolism, dyslipidemia, and obesity. Therefore, it is possible for a child to be obese but not necessarily in the category of metabolic syndrome (Seet et al., 2011).

Although the definition of the metabolic syndrome has been relatively clearly described in adults, to determine in children is another story. Based on Cook's definition in Andra (2007) a child is categorized as having metabolic syndrome if it meets the following components, abdominal circumference which is greater than the 90th percentile on the age, gender, and ethnic curves; fasting blood sugar higher than 110 mg/dl; higher blood pressure from the 90th percentile on the age and height curves; fasting triglycerides greater than 110 mg/dl; and HDL cholesterol which is lower than 40 mg/dl. Of course all these examinations are highly tertiary and are not easy to do in all hospitals in Indonesia.

The prevalence of the metabolic syndrome itself is strongly associated with obesity in children. Weiss in Andra (2007) states that 30% of obese children are suffering from metabolic syndrome. While the number increased to 50% in children with severe obesity. In addition to this study conducted by Weiss, there is another conclusion that complements the incidence of metabolic syndrome, namely the main problem in the occurrence of metabolic syndrome is insulin resistance in tissues, and the second problem is obese children will experience increased levels of C-reactive protein (CRP).

The latest opinion states that in obese children there is found vascular endothelial dysfunction, especially if it is found that obese children also have hypertension. Through Doppler ultrasound examination in the carotid artery, Sorof in Andra (2007) shows that obese children will experience thickening of the intima-media. It is not known why this area thickens, but it is thought that everything is related to insulin resistance, obesity, metabolic syndrome, atherosclerosis, and of course it causes hypertension (Payahoo et al., 2013).

Research from Rocchini in Andra (2007) gives results that obese children who experience weight loss also will experience a decrease in vascular resistance along with a decrease in insulin resistance. Thus insulin resistance and vascular resistance are actually very closely related, although it is not known what the relationship is (Khan et al., 2013).

Insulin resistance and vascular resistance are indeed the main causes of the metabolic syndrome. But actually there are still many other factors that can cause endothelial dysfunction, including changes in the renin-angiotensin-aldosterone system, changes in the sympathetic nervous system, dyslipidemia, increased levels of endothelin, and even chronic inflammation. Even future studies might find ways to isolate inflammatory pathways that can help prevent vascular abnormalities found in the metabolic syndrome (Jayawardena et al., 2012).

Comparing blood pressure between obese and non-obese children, getting systolic and diastolic blood pressure in obese children higher than non-obese children. Koba and Hirano (2011), in the same study found children and adolescents who were obese had enlargement of the left ventricular wall (posterior wall, septum and left ventricular mass index) and abnormalities in diastolic filling. Atabek et al., 2007 also get total cholesterol, triglycerides, LDL cholesterol and carotid artery BMI (early signs of artherosclerosis) in obese children higher than non-obese children. Aggoun (2007), also stated that in obese children in Korea found a high concentration of total cholesterol, LDL cholesterol, triglycerides and low concentrations of HDL cholesterol. And also associated with the occurrence of micro-albuminuria and insulin resistance or increased blood glucose levels (Foster et al., 2010).

Aggoun (2007) argues that obesity in individuals is the appearance of metabolic syndrome associated with increased cardiovascular risk. While resistant insulin is expressed as the center of syndrome and explains the link between obesity and vascular dysfunction. Obesity also promotes preclinical artherosclerosis by changing the direct influence on vascular physiology. The amount of adipose deposits in children and

adolescents is associated with high cardiovascular disease.

Some reports indicate damage to vascular function, namely damage to endothelial-mediated vasodilators that respond to increased blood flow and insulin. In obese children there is more carotid artery BMI and a tendency for hypertension. Obesity in children is also associated with a decrease in arterial elasticity, this is similar to the case of type 2 diabetes mellitus which can reduce blood vessel elasticity. This decrease in elasticity can cause disruption of blood flow (Franssen et al., 2011; Hendrix et al., 2020).

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There is a positive correlation between the level of obesity and the incidence of various diseases (infections). Campana et al., 2019 showed that obesity was found to be impaired in cell-mediated immune responses both in vivo and in vitro, a decrease in bacteriocidal activity of polymorphonuclear leukocytes (PMN) and levels of iron (Fe) and zinc (Zn) low. They estimate that the disruption of the immunologic mechanism in obesity is caused by subclinical iron and zinc deficiency.

5. Conclusion

Zinc supplementation in obese and fatty children can reduce blood sugar, total cholesterol, triglycerides, LDL and HDL.

CRediT authorship contribution statement

Rudy Hartono: Conceptualization, Methodology, Software, Formal analysis. **Agustian Ipa:** Data curation, Writing - original draft. **Aswita Amir:** sample selection, Investigation, Intervention. **Rusli:** Analysis sample in laboratorium, Supervision, Writing - review & editing.

Declaration of competing interest

In this study there were no conflicts of interest between researchers and research subjects.

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