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RESEARCH ARTICLE

Serum Zinc and Copper Levels in Obese Adolescents

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Abstract

Background: Childhood obesity has been called one of the most serious public health challenges of the 21st century. Zinc is one of the essential trace elements. Zinc plays a role in immunity, wound healing, cell growth and division, carbohydrate breakdown, and function of many enzymes and transcription factors. Copper is a component of antioxidant enzymes that acts to protect the body against the action of free radicals. It especially has a role in cardiovascular disease. An increase or decreased in the levels on copper deleterious effect on metabolism.

Objective: To estimate serum zinc and copper levels in obese adolescents.

Methods: A cross-sectional study was carried out on JSS Hospital in Mysuru among obese adolescents from 11 year to 18 years visiting the pediatric department as an inpatient or outpatient basis from November 2019to December 2021. The subjects with BMI<95th percentile were enrolled in the study.

Results: 51 individual with BMI<95th percentile were enrolled in the study. There is a relation between trace elements and obesity. 30 out of 51 (58.8%) of them have Deficit Zinc levels. The correlation between serum zinc and obesity was established by Pearson's correlation (0.2) . But difference is not statistically significant. [*p-value*>0.05] 31 out of 51 (60.7%) of study subjects had excess copper . Obese adolescents of age group 13-16 years have excess copper with male predominance, the correlation between serum copper with obesity was established by in the adolescent's population by Pearson's correlation (0.1), of Mysuru district, Karnataka, India.. Our study was not statistically significant. (p-value >0.05).

Conclusions: Our study concluded that 58.8% of study subjects had zinc deficiency and 60.7% of study subjects had excess copper, co-relation was established between serum zinc and copper with obesity in the adolescents population of Mysuru district, but the study was not statistically significant.

Keywords: Serum zinc, Copper levels, Obese adolescents.

Introduction

Childhood obesity is one of the major public health problems of the 21st century. WHO[2019] As per world obesity federation, 'Obesity is a chronic relapsing disease process'. Obesity, a chronic disease, is one of the important risk factors for th poor health and early death worldwide. Due to both behavioral and psychological factors,
India has the highest number of diabetics in the world, rapid rise of obesity in children is one of the prime reasons for increased insulin resistance, and metabolic syndrome and later may lead to disability in adulthood.

According to WHO, over 340 million children and adolescents aged 5-19 were overweight or obese in 2016. Dramatic rise is seen from 4% in 1975 to 18% in the year of 2016. While just 1% of adolescents and children aged 5 to 11 years were obese in 1975, to > 124 million adolescents and children and were obese in (Obesity and overweight) [2016]. Overweight and obesity are linked with more mortality and morbidity worldwide then undernutrition. Obesity is a preventable non communicable disease which can be death with proper diet, calorie restriction and physical activity.

Zinc is an important trace elements. Zinc plays a role in immunity, wound healing, cell growth and division, carbohydrate breakdown and function of many enzymes and transcription factors. Zinc plays an important role in insulin receptor tyrosine kinase activity, Insulin activity, and the hormone storage in the pancreas. Zn-a2-glycoprotein (ZAG gene), an adipokine that rouses energy expenditure, is found to be altered. Through leptin, Zinc has an influence

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on adipocytes, and promotes glucose uptake and free fatty acid release, which is found to be altered in zinc deficiency states. Smidt K *et al.* [2007]

Copper is an antioxidant that protects the body from against the free radicals. It specially has a role in cardiovascular disease. Increase or decrease in the levels on copper deleterious effect on metabolism. Either increase or decrease in copper levels might trigger hypercholesterolemia and other illnesses of oxidative stress. Klevay, L. [2000].

In trace element metabolism, the finest known antagonism is seen between copper and zinc. Increased zinc in diet leads to increased mucosal absorption of copper in small intestine, leading to decreased serum copper levels. Copper levels are found to be elevated in obese children and adolescents Abdel et al., [2019].

Not many studies have been carried out in India regarding the importance of serum zinc and copper levels in childhood obesity and their significance in the pathogenesis of obesity. Hence, this study estimated serum zinc and copper levels in obese adolescents.

Materials and Methods

This Observational cross-sectional study was conducted among adolescents between the age of Child between 11-18 years of age attending the inpatient/outpatient of the pediatric department at JSS Hospital, a tertiary care centre in Mysuru, Karnataka,India will be included in the study. The duration of study was 18 Month. A convenience sampling technique was used. Permission for conducting the study was taken from JSS UniversityEthical Committee. Written and informed consent was taken from the parents of the children involved in the study.

Adolescents from age 11-18 years, with BMI >95TH percentile, satisfying both inclusion and exclusion criteria will be included in the study

Inclusion Criteria

- Adolescents from age 11-18years
- BMI above >95th percentile

Exclusion Criteria

- Children with syndromic obesity
- Endocrine disorders
- History of use of chronic medication use like steroids and the medications which will have an impact on the weight
- Use of minerals and vitamin supplement for >1 week

Sample size calculation-

n = z2pqd2
z - standardized normal deviation
p - prevalence or proportion of interest
q-(100-p)
d-clinically expected variation
with prevalence of 6% (9),
Sample size yields 90.

All subjects in the study will be subjected to the following: Detailed history taking and clinical examination will be conducted. Height is measured using a stadiometer. Weight is measured using a weighing machine. BMI is calculated using the formula weight/(height)^2.

Children with BMI>95TH percentile are selected using IAP growth charts

Under aseptic precaution, 3ml of venous sample will be taken in plain vacutainer and sent for serum zinc and copper levels.

Serum Zinc levels > 65 µg/dl (128)
Normal Serum Copper levels for age (128):

- 11-12 years - 64-148 µg/dl
- 13-14 years- 63-135 µg/dl
- 15-16 years - 52-128 µg/dl
- 17-18 years- 49-133 µg/dl

The blood sample is centrifuged , 5000RPM for 10-15minutes, following which the serum is separated and subjected to the estimation of ROCHE full automated CUPAS 6000 integrated system. Method used is calorimetry.

Statistical Analysis

Data collected was entered in Microsoft Excel and was analysed using SPSS 22 version software. The association between BMI serum zinc and copper levels was done by chi-square test , and Pearson's correlation co-efficient indicated the strength correlation. p-value of more then 0.05 was taken as statistically non-significant.

Results

After data collection, a total of 51 participants data was taken for analysis. The results of the study are presented as follows. Initially, demographic details of the study participants are presented, followed by classification of the BMI for age according to IAP classification for obesity. Serum copper and levels among the study participants are depicted. Table 1 Later the correlation and association between obesity and the serum copper and zinc levels are presented.

The mean age of the study participants is 13.70 years and the standard deviation of 1.78 years. The mean age of the female and the males in the study is almost same. 56.86% of the study participants were males while 43.13% were females.

Table 1: Classes of obesity in adolescents according to ACOG (Obesity in Adolescents, https://www.acog.org/)

Class 1	Greater than or equal to 95th percentile to 120$^{\%}$ of the 95th percentile
Class 2	More than or equal to 120% of the 95th percentile to 140% of the 95th percentile
Class3	More than or equal to 140th of 95th percentile

The mean height of the study participants measured in centimetres is 150.76 cms and standard deviation of 10.15 cms. Boys are relatively taller than the girls. The mean weight of them is 62.54 kgs and 8.91 kg as standard deviation. Weight of the males is higher compared to that of the females. Mean BMI of them is 27.4 kg/m^2 (Table 2).

SD- Standard Deviation, µg/dl- microgram per decilitreMean serum Zinc levels of the study participants measured in micrograms per decilitre is 67.94 µg/dl and standard deviation of 15.28 µg/dl. The mean serum copper levels of them are 142.0 µg/dl and 28.98 µg/dl as standard deviation (Table 3).

Serum Zinc levels of the study participants were classified into normal levels and deficiency of zinc based on the standard reference normal values. Accordingly, 58.82% of the study participants had deficiency in the zinc levels. 41.17% of them had normal zinc levels (Table 4).

Serum Copper levels of the study participants were classified into normal levels and excess of copper based on the standard reference normal values. Accordingly, 60.78% of the study participants had excess in copper levels. 39.21% of them had normal copper levels (Table 5).

Males have excess of copper is seen more frequently in age 13 to 16 years then other groups with male predominance then females (Table 6).

Correlation between Serum Copper levels and BMI for the age among the study participants. The scatter plot shows no slope indicating no correlation between the variables, The strength of correlation is indicated by Pearson's correlation co-efficient denoted by r. Pearson's correlation is 0.1 which indicates correlation between Serum Copper levels and BMI for age (Figure 1).

Association between the BMI for age and serum copper levels were seen. Serum copper levels are classified as normal copper levels and Excess Copper levels. Since both the variables were described as categorical variables. A chi-square test for association was used to test the hypothesis.

Although there is a difference in the proportion of the participants with normal and Excess Copper levels amongst who are obese. 20 out of 51 of those who are obese have normal copper levels, 31 out of 51 of them have Excess Copper levels. But the difference is not statistically significant. [p-value=0.74] Hence there is no significant association between the BMI for age and serum copper levels.

Figure 2 shows the correlation between Serum Zinc levels and BMI for age among the study participants.

Table 2: Anthropometric measures of the study participants. [n=51]

Sl No	*Anthropometric measures*	*Male*	*Female*	*Total*
		Mean [SD]		
1	Height in cms	152.55 [10.65]	148.40 [9.14]	150.76 [10.15]
2	Weight in Kgs	64.58 [9.08]	59.85 [8.27]	62.54 [8.91]
3	BMI in kg/m^2	27.65 [1.80]	27.07 [1.82]	27.4 [1.81]

BMI- Body Mass Index, SD- Standard Deviation

Table 3: Trace elements of the study participants. [n=51]

Sl No	*Trace Elements*	*Male*	*Female*	*Total*
		Mean [SD]		
1	Serum Zinc in µg/dl	66.83 [14.00]	69.42 [17.06]	67.94 [15.28]
2	Serum Copper in µg/dl	149.43 [29.41]	132.36 [25.94]	142.0 [28.98]

Table 4: Serum Zinc levels [µg/dl] of the study participants. [n=51]

Serum Zinc levels	*Frequencies*	*Percentages*
Normal [> 65 µg/dl]	21	41.17
Deficient [<65 µg/dl]	30	58.82
Total	51	100

Table 5: Serum copper levels [µg/dl] of the study participants. [n=51]

Serum Copper levels	*Frequencies*	*Percentages*
Normal*	20	39.21
Excess	31	60.78
Total	51	100

*Normal values for the serum copper levels are as follows (): Age 11-12 years - 64-148 µg/dl, age 13-14 years- 63-135 µg/dl, age 15-16 years - 52-128 µg/dl, age 17-18 years- 49-133 µg/dl.

Table 6: Distribution of Copper levels classified according to the age groups

Serum Copper levels	*Normal*	*Excess*		
		Total	*Female*	*Male*
		Frequencies [Percentages]*		
Age 11–12 years	10 [50]	5 [16.12]	2 [20]	3 [14.28]
Age 13–14 years	08 [40]	11 [35.48]	4 [40]	7 [33.33]
Age 15–16 years	01 [05]	12 [38.70]	2 [20]	10 [47.61]
Age 17–18 years	01 [05]	03 [9.67]	2 [20]	1 [4.76]
Total	20 [100]	31 [100]	10 [100]	21 [100]

*Percentages in the parenthesis indicate column percentages.

The scatter plot shows no slope indicating no correlation between the variables, The strength of correlation is indicated by Pearson's correlation co-efficient denoted by r. the Pearson's correlation is 0.2 which indicates correlation between BMI for age and Serum Zinc levels.

Association between the BMI for age and serum Zinc levels were seen. Serum Zinc levels are classified as normal Zinc levels and Deficit Zinc levels. Since both the variables were described as the categorical variables. Chi-square test for association was used to test the hypothesis.

Although there is difference in the proportion of the participants with normal and Deficit Zinc levels amongst who are obese. 21 out of 51 of those who are obese have normal Zinc levels, 30 out of 51 of them have Deficit Zinc levels. But difference is not statistically significant. [p-value=0.79] Hence there is no significant association between the BMI for age and serum zinc levels.

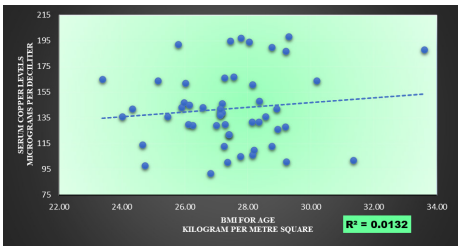

Figure 1 : Correlation between Serum Copper and BMI for age among the study population

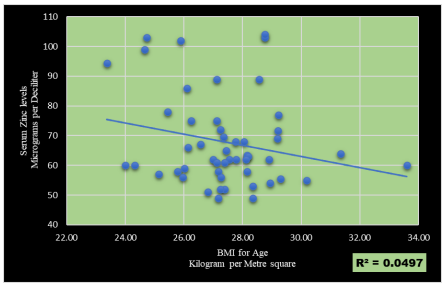

Figure 2: Correlation between Serum Zinc and BMI for age levels among the study population

Discussion

Adolescent Obesity is one major health problem that today's generation are facing. It can be due to sedentary lifestyle, unhealthy diet, easy accessibility to high calorie food substances. Lockdown due to COVID-19 pandemic has lead to increase in obesity among the adolescents, which subsequently can predispose to multiple health issues in adulthood. Adolescent population is rapidly increasing, hence more focus is needed in the area of adolescent medicine. Trace elements play major role in metabolism like growth, fertility, immunity, reducing oxidiative stress and free radical injury .This study concentrates on serum copper and zinc levels in obese adolescents.

Very few Indian studies on trace elements in obese adolescents are present. Either excess deficiency of trace elements can play a role in the disease process in paediatric population. This study throws light regarding the importance of trace elements in obese adolescents in Mysuru, Karnataka, South India.

In our study, the mean age of the study participants is 13.70 years and standard deviation of 1.78 years. 56.86% of the study participants were males while 43.13% were females.

Gaber HAA et al[6]. in their case control study aimed to assess, evaluate and compare serum copper, magnesium and zinc in obese, overweight and normal weight children. The mean age of their participants was 10.8 years and around 55% of them females**.**

Malik V S et al [2020]. studied the association between the serum copper and zinc among children with obesity. The mean age of the study subject was 10.97 years among the obese group and 9.88 years among the non-obese participants.

Azab SFA et al [2014]. conducted a case control study to assess the trace element status selenium, iron , copper chromium and zinc in obese Egyptian children and their relationship with serum leptin , insulin resistance and lipid profile The mean age of the study participants among the obese children was 7.8 years and among the controls was 8.1 years.

In the present study, the mean serum Zinc and Copper levels of the study participants were 67.94 µg/dl (SD 15.28) and 142.0 µg/dl (SD 28.98). Serum Zinc levels of the study participants were classified into normal levels and deficiency of zinc based on the standard reference normal values. Accordingly, 58.82% of the study participants had deficiency in the zinc levels. 41.17% of them had normal zinc levels. Whereas Serum Copper levels of the study participants were classified into normal levels and excess of copper based on the standard reference normal values. Accordingly, 60.78% of the study participants had excess in the copper levels. 39.21% of them had normal copper levels.

Azab SFA et al in their study presented that, the mean serum zinc level in ug per decilitre among obese children was 57 and it was 75 among the controls. Whereas the mean serum Copper level in ug per decilitre among obese children was 123.7 and it was 96.4 among the controls. It is shown in this study that the zinc level is lower in case of obese children and the copper level is high in case of obese children. This is in in comparison with our study which showed 58.8% of the study subjects have decreased zinc and 60.7% have excess copper levels.

Gaber HAA et al[6] in their case control study presented that serum copper levels and serum zinc levels among the obese were 39.7 µg/dl and 124.4 µg/dl respectively. It is comparable to our study as there is decreasing levels of zinc levels and excess of the copper levels among the obese individuals. The values in our study is higher compared to this study probably as our study population included only the adolescents unlike here in this study where in children aged 8 years were included in the study .

Malik V S et al the mean zinc and copper levels were 85.1 µg/dl and 109.9 µg/dl among the obese respectively. This study is similar to our study which also shows the deficiency of the zinc among the obese adolescents. In contrast, our study shows excess of copper among the obese adolescents .

Our study shows the difference in the proportion of the participants with normal and Deficit Zinc levels amongst these obese subjects . 20 out of 49(41%) of those who are obese have normal Zinc levels, 29 out of 49 (58.8%)of them have deficit zinc levels. But difference is not statistically significant. [p-value=0.79] Hence there is no significant association between the BMI for age and serum zinc levels. Gaber HAA et al shows the statistically significant correlation between the zinc levels and BMI. Our study has also shown the difference but not satistically significant . This could be because of the smaller sample size of our study which fell short in ascertaining the significance.

Malik V S et al has demonstrated the significant difference in the zinc levels between the obese and non-obese. With deficiency in the zinc among the obese set. This finding is in consistent with the present study.

Azab SFA et al shows the negative correction between the serum zinc levels and BMI. This correlation was significant statistically. Our study also established the presence of deficiency of the zinc among the obese subjects.

In the present study, there is difference in the proportion of the participants with normal and Excess Copper levels amongst who are obese. 19 out of 49(39.2%) of those who are obese have normal copper levels, 30 out of 49(60.7%) of them have Excess Copper levels. But difference is not statistically significant. [p-value=0.74] Hence there is no significant association between the BMI for age and serum copper levels.

Azab SFA et al shows correction between the serum copper levels and BMI. Our study also has similar findings of the copper among the obese .

Gaber HAA et al shows the statistically significant correlation between the BMI and copper levels. Our study has also shown the difference but are not statitstically significant . This could be because of the smaller sample size of our study which fell short in ascertaining the significance.

Malik V S et al has demonstrated the significant difference in the copper levels between the obese and non-obese. In this study there deficiency in the copper among the obese group which is in contrast to our study where we found higher levels of copper in obese adolescents.(60.7%).

Yun Fan et al [2017] studied the relationships between the serum metallic elements and obesity among the US adolescents. They showed that there is a relationship between serum metals and obesity but there is no confirmatory evidence on the skewness of the relationship, i.e., whether it is the deficiency or the excess of the zinc, copper or any other metallic elements which is related to the obesity. Here in this study many trace elements were evaluated along with biochemical parameter like lipid profile, and insulin resistance. It only concluded that there is relationship between the disturbance in the zinc and copper levels and the obesity.

On observing the following comparisons of various studies, it can be summarized that, there is definitive relationship between the serum metals namely zinc and copper and the BMI i.e., the obesity of the individual. However, there is wide variation in the direction of the relationship viz. deficiency or excess. This skewness of the relationship needs further evaluation with larger sample size for confirmation.

Hence, it can be concluded that,variation of trace element levels exsits in obese adolescents which can have an impact on the heath of the individual . Our study has inferred that there is decreased zinc levels and elevated copper levels in obese adolescents. Hence any abnormalities in the levels of trace elements should be treated in order to counteract the impact of these abnormal levels of trace elements on the health of the adolescents . Zinc plays a role in immunity, growth, fertility and insulin activity where as copper play a role as an antioxidant and in cholesterol metabolism implying the vital importance of these two trace elements in obese adolescents .

Conclusion

Trace elements like Zinc and copper play a major role in metabolism .Our study concluded that 58.8% of study subjects had zinc deficiency Co-relation between serum zinc and obesity was established in adolescents population of Mysuru district (by Pearson's correlation 0.2). However in our study it was not statistically significant (p value >0.05)

60.7% of study subjects had excess copper . Obese adolescents of age group 13-16years have excess copper , co-relation between serum copper with obesity was established in adolescents population, of Mysuru district(by Pearson's correlation 0.1) However in our study it was not statistically significant. (p-value >0.05)

References

Childhood overweight and obesity [Internet]. World Health Organization. 2019 [cited 8 October 2019]. Available from: https://www.who.int/dietphysicalactivity/childhood/en/

Obesity and overweight https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

Smidt K, Pedersen S, Brock B, Schmitz O, Fisker S, Bendix J et al. Zinc-transporter genes in human visceral and subcutaneous adipocytes: Lean versus obese. Molecular and Cellular Endocrinology. 2007;264(1-2):68-73.

Klevay, L. (2000). Cardiovascular Disease from Copper Deficiency—A History. *The Journal of Nutrition*, 130(2), pp.489S-492S.

Obesity in Adolescents. https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2017/09/obesity-in-adolescents

Abdel H, Gaber A, Abdel T, Eldahshan K, Ghanem SM. Value of Serum Zinc, Magnesium and Copper in Obese and Normal Weight Children. 2019;76(July):3254–9.

Malik VS, Dayal D, Khaiwal R, Bharti B, Bhalla A, Singh S, et al. Low serum copper and zinc concentrations in North Indian children with overweight and obesity Niskie stężenie miedzi i cynku w surowicy u dzieci z północnej Indii z nadwagą i otyłością. 2020;26(2):79–83.

Azab SFA, Saleh SH, Elsaeed WF, Elshafie MA, Sherief LM, Esh AMH. OF PEDIATRICS Serum trace elements in obese Egyptian children: a case – control study. 2014;1–7.

Fan Y, Zhang C, Bu J. Elements and Obesity in Children and. 2017;1–12.