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The Association Between Iron Deficiency Anemia and Obesity in Children

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Abstract

Background: Obesity is a growing health problem all over the world. Approximately 18–38% of under 5 years old children have iron deficiency anemia. Obese people are more likely to be have iron deficiency. Studies that dealt with the relationship between iron deficiency and obesity are not homogeneous.

Aim: To examine the association between obesity and iron status and the presence of iron deficiency anemia in children.

Methods: This case-control study included 100 children between 2–14 years of age who were divided into two age- and sex-matched equal groups of 50 children each. Children with a body mass index (BMI) greater than or equal to 95th centile were categorized as obese while the other 50 children with a BMI greater than or equal to 5th centile but less than 95th centile were considered the normal weight group. Children with cardiac disease, liver disease, chronic gastrointestinal disease and chronic hematologic disorders except iron deficiency (with or without anemia) and those taking Vitamin or mineral supplements regularly during the previous year were excluded. Each participant was sent for serum iron, ferritin, total iron binding capacity (TIBC), transferrin saturation TS and complete blood count. Iron deficiency is defined as Transferrin Saturation (TS) lower than 16% and IDA is defined as TS lower than 16% and hemoglobin (Hb) concentration lower than 120 g/l or 12 mg/dl for children. The data were analyzed using SPSS-23 software and for all data normal distribution was tested so that *P*-value <0.05 is the level of threshold for statistical significance.

Results: The gender distribution between the both group is reversed with male being more common in obese group but no statistical difference. The age distribution shows dominance of the age group 5–10 years in the both group with some differences which are of no statistical significance ($P = 0.294$). The values of Hemoglobin, serum iron, serum ferritin, total iron binding capacity and transferrin saturation are obviously similar between the both genders of the whole study population with no statistically significant differences ($P = 0.084$, 0.469, 0.48, 0.4, 0.571 respectively). Obese children have higher level of Hemoglobin ($P = 0.069$), Ferritin ($P = 0.5$) and total iron binding capacity ($P = 0.449$) but lower levels of serum iron ($P = 0.234$) and transferrin saturation($P = 0.45$) but with no statistical significance.

Conclusion: There is no significant association between obesity and iron status and the presence of iron deficiency anemia despite a lower level of serum iron and lower transferrin saturation in obese than normal weight children.

Introduction

Obesity is a growing health problem all over the world. Its prevalence has increased apparently in recent years.[1,2] Up to 16–31% of children suffer from obesity nowadays.[2,3] According to the World Health Organization (WHO) classification, the prevalence of iron deficiency anemia (IDA) is in the medium level.[4] Approximately 18–38% of under 5 years old children have iron deficiency anemia.[5] The rapid changes in lifestyles and dietary patterns with large amounts of fat, sugar and oil are of the most important causes of obesity.[6-8]

It has been found that obese people are more likely to be have iron deficiency. Iron deficiency anemia is significantly more prevalent among obese than normal weight people.[9-11]

Foods high in calorie are low in nutrients leading to poor diet. Obese children are susceptible to a variety of micronutrient deficiencies.[12]

Obesity is considered a low-grade inflammatory disease. Adipose tissue is considered an endocrine organ that secret pro-inflammatory cytokines named adipokines that contribute to the inflammatory process that may have an important pathogenic role in some obesity-related comorbidities.[13]

It has been suggested that expansion of tissue mass and adipocyte size in obesity makes white adipose tissue hypoxic leading to inflammation and cellular dysfunction.[14] Moreover, when hypertrophied adipose tissue is unable to satisfy its storage function, there will be excess free fatty acids exposed to organs which are lipid intolerant leading to lipotoxicity and thereby low-grade inflammation in the adipose tissue. Therefore, hypertrophy of adipocytes and local tissue hypoxia, triggers overproduction of adipokine that enhances macrophage infiltration in obesity.[15]

This inflammation can cause transformation of iron metabolism leading to overload of iron in tissues with decreased mobility and as a result reduction of the breakdown of myoglobin. This will decrease the serum iron needed for hematopoiesis.[16]

Studies that dealt with the relationship between iron deficiency and obesity are not homogeneous.[17-20] They are generally case/control or cross-sectional studies, in many cases, not population-based, but rather they considered many variables related to iron deficiency and obesity[21,22] and used different criteria for defining iron deficiency. A frequently used iron parameter is serum ferritin[23-25] which is an acute-phase reactant that is positively related to adiposity and thus reducing its sensitivity.

To the best of our knowledge, no studies have been done locally to study the relation between obesity and each of iron status and the presence of iron deficiency anemia. The aim of study is to examine the association between obesity and iron status and the presence of iron deficiency anemia in children.

Methods

This case-control study was out at Zakho General Hospital in the period from May 1st 2021 to May 1st 2022. A total of 100

children between 2–14 years of age were included in the study. The participants were divided into two equal groups of 50 children each. Both groups were age- and sex- matched. Children with a body mass index (BMI) greater than or equal to 95th centile were categorized as obese and termed as cases while the other 50 children with a BMI greater than or equal to 5th centile but less than 95th centile (as per the World Health Organization [WHO] standards) were the normal weight group and termed controls.

The exclusion criteria were: 1- Any disorder, such as cardiac disease, liver disease, chronic gastrointestinal disease and chronic hematologic disorders except iron deficiency (with or without anemia). 2- Vitamin or mineral supplements taken regularly during the previous year.

From each participant, about 5 cc of fasting blood were taken to evaluate the serum iron, ferritin, total iron binding capacity (TIBC) and transferrin saturation TS, and about 2 cc citrated fasting blood sample were evaluated for complete blood count (CBC) and analyzed according to standard protocols.

Iron deficiency is defined as Transferrin Saturation (TS) lower than 16% and IDA is defined as TS lower than 16% and hemoglobin (Hb) concentration lower than 120 g/l or 12 mg/dl for children.

The data were analyzed using SPSS-23 software and for all data normal distribution was tested so that *P*-value <0.05 is the level of threshold for statistical significance.

Results

As shown in Table 1, the gender distribution between the both group is reversed but no statistical difference has been found. The age distribution shows dominance of the age group 5–10 years in the both group with some differences which are of no statistical significance. So, the obese and normal weight children are age and gender matched.

The laboratory findings of the whole participants are shown in Table 2. The values of Hemoglobin, serum iron, serum ferritin, total iron binding capacity and transferrin saturation are obviously similar between the both genders of the whole study population with no statistically significant differences.

Comparison between obese and normal weight children laboratory values shows the obese children have higher level of Hemoglobin, Ferritin and TIBC but lower levels of serum iron and transferrin saturation but with no statistical significance as shown in Table 3.

Discussion

The sociodemographic characteristics show males are more commonly obese and that age group of 5–10 years are the most prevalent but no significant differences were noticed between the both groups.

Numerous previous studies have found higher prevalence of iron deficiency in obese children.[28-35] Our findings show a lower level of serum iron and lower transferrin saturation in obese children than normal weight but do not reveal a significant deficiency of iron in obese children.

These results corroborate the results of Perez et al.[29] that found the prevalence of iron deficiency in otherwise healthy obese was not higher than in normal weight children so the effect of obesity on iron status was low. They suggested that

Table 1. **The sociodemographic characteristics of cases and controls**

	Normal	Obese	*P*-value
Gender			
Male	24 (48%)	26 (52%)	0.689
Female	26 (52%)	24 (48%)	
Age			
Under 5 years	12 (24%)	6 (12%)	
5–10 years	22 (44%)	25 (50%)	0.294
Above 10 years	16 (32%)	19 (38%)	

Table 2. **Laboratory values of the study population**

Mean ± SD	Male	Female	Total	*P*-value
Hb	12.5380 ± .94694	12.5180 ± 1.07489	12.5280 ± 1.00786	0.084
Iron	62.9948 ± 30.31192	59.0934 ± 28.53107	61.0441 ± 29.35148	0.469
Ferritin	35.7664 ± 26.75804	30.3876 ± 23.27093	33.0770 ± 25.09420	0.480
TIBC	378.0280 ± 82.31149	390.4890 ± 81.36954	384.2585 ± 81.66790	0.541
TS	19.6440 ± 22.87591	16.9146 ± 9.8158	18.2793 ± 17.566	0.571

Table 3. **Relation between weight status and laboratory values**

	Normal	Obese	*P*-value
Hb	12.4960 ± 1.12847	12.5600 ± .88133	0.069
Iron	63.1104 ± 35.55115	58.9778 ± 21.63337	0.234
Ferritin	30.0546 ± 21.68217	36.0994 ± 27.99161	0.5
TIBC	368.0170 ± 72.77616	400.5000 ± 87.41108	0.449
TS	18.7760 ± 10.94805	17.7826 ± 22.42977	0.450

specific cutoff values for iron deficiency in overweight adolescents need to be defined.

This is in agreement with Ferrari et al.[36] who revealed that adiposity of the European adolescents was sufficient to cause chronic inflammation but not sufficient to impair iron status and cause iron deficiency.

In line with our findings, Demircioglu et al.[37] found that serum iron and ferritin level were comparable between obese and normal weight children and stressed a significant role of hepcidin in obesity.

Cheng et al.[38] did a study on obese adult women and found that obesity alone may not be sufficient to cause disturbances to iron metabolism which are clinically significant as previously described and Qin[39] [IDA similar 9] found anemia to be even less prevalent in obese women and this is in agreement with our study on pediatric population.

Gajewska[40] found that in obese children with sufficient iron intake, the altered ferroportin-hepcidin axis may occur without signs of iron deficiency or iron deficiency anemia. They suggested that the role of other micronutrients, besides dietary iron, may also be considered in the iron status of obese children while Huang[22] concluded that being overweight or obese would not be a risk factor of iron deficiency in adolescents, if it were defined by ferritin rather than iron level.

In total, the paradoxical results of the studies regarding association between obesity and iron deficiency might be attributed to the differences in the definition of obesity or using different techniques to assess laboratory parameters.[41]

One of the limitations of this study is that we did not include the dietary intake of iron which if sufficient can overcome the effects of obesity on causing iron deficiency and anemia. Also, it would have been much better if we studied the role of hepcidin in iron status in obesity as proved in many studies.[37]

Conclusion

There is no significant association between obesity and iron status and the presence of iron deficiency anemia despite a lower level of serum iron and lower transferrin saturation in obese than normal weight children.

Conflict of Interest

None.

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