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Assessment of the Serum Levels of Hemoglobin, Ferritin, and Vitamin B12 in a Sample of Iranian Population With Morbid Obesity

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Abstract

Background: Considering the importance of providing vitamins and minerals in body health, it obviously seems to be necessary to assess the deficiencies of these nutrients in obese patients.
Objectives: The present study aimed to evaluate the level of hemoglobin, ferritin, and vitamin B12 in a sample of Iranian population with morbid obesity.
Patients and Methods: This cross-sectional study was conducted on 1252 consecutive patients with morbid obesity referred to obesity clinic at Rasoul-e-Akram hospital from 2009 to 2015 in Tehran, IR Iran. Morbid obesity was defined as body mass index (BMI) equal to or higher than 40 kg/m^2. Serum hemoglobin level (gr/dL) was measured using the cyan methemoglobin method. Serum ferritin level (ng/mL) can be measured by the human ferritin enzyme immunoassay test. Also, serum vitamin B12 concentration (pg/mL) was measured using the solid-phase, competitive chemiluminescent enzyme immunoassay method.
Results: Overall, 1252 patients with morbid obesity were included in the study. The mean age of participants was 39.77 $\pm$ 10.84 years (ranged 10 to 70 years) and 80.3% of them were female. The mean body weight was 126.75 $\pm$ 21.58 kg and the mean BMI was also 46.99 $\pm$ 5.87 kg/m^2. In result, 9.8% were anemic according to the low value of hemoglobin level, 46.6% had ferritin lower than the normal range and the average serum level of vitamin B12 was lower than the normal value in 21.1%. By applying the Pearson's correlation test, a positive association was found between BMI value and the level of hemoglobin (r = 0.074, P = 0.009).
Conclusions: Morbid obesity may result in two important hematologic and metabolic changes including increased hemoglobin level and reduced vitamin B12 level. Since, vitamin B12 has vital role in the body, providing adequate vitamin B12 is essential in these patients even by using vitamin supplements. Also, regular screening of the level of hematologic markers in these patients is strongly recommended.

Keywords: Hemoglobin, Ferritin, Vitamin B12, Morbid Obesity

1. Background

Morbid obesity is a health problem having socioeconomic burden with an increasing global trend particularly in industrialized countries. Based on recent reports by the world health organization (WHO), the overall prevalence of overweight and obesity have estimated to be 1.9 billion and 600 million (1). In Lipid and Glucose study on Iranian population resident in Tehran it was shown that about 40% of patients were overweight and 23.1% were obese (2). The upward trend of morbid obesity seems to be important due to its pathological effects leading to serious metabolic disturbances such as type 2 diabetes, cardiovascular mortality and morbidity, and even cancers (3, 4). In this regard, the evaluation of health risks associated with obesity emphasizes the importance of preventive measures for the obesity and its serious complications as well. One of the main sequels in morbid obese individuals is micronutrient deficiencies including iron, hemoglobin, and vitamin deficiencies. Regarding iron deficiency, it has been found that obesity can promote iron deficiency by inhibition of dietary iron uptake from the duodenum (5). In line with iron deficit in the obese people, some investigations on micro-nutritional status could show low ferritin serum concentrations in about 6% to 9% of the patients, respectively (6, 7). Some studies on association between obesity and anemia could demonstrate that the main reason for iron deficiency anemia in obese individuals was increased level of hepcidin and subclinical inflammation leading iron metabolism impairment in these patients (8-10). Other study showed that Vitamin B12 level was significantly lower in patients with obesity and overweight compared with healthy individuals. A significant nega-

tive correlation was observed between vitamin B12 and BMI (Baltaci et al. (11)). In total, nutritional deficiencies are not unexpected with regard to regulations adopted in patients with morbid obesity. Few studies have been done in this area but the association between anemia and morbid obesity has still remained unclear. Considering the importance of providing vitamins and minerals such as iron and folic acid, ferritin and vitamin B12 in the body health, it is obviously necessary to assess deficiencies of these nutrients in obese patients. On the other hand, there is no data about our study in Iran.

2. Objectives

The present study aimed to assess the level of hemoglobin, ferritin, and vitamin B12 in a sample of Iranian population with morbid obesity.

3. Patients and Methods

This cross-sectional study was conducted on 1252 consecutive patients with morbid obesity that were referred to the obesity clinic at Rasoul-e-Akram hospital from 2009 to 2015 in Tehran, IR Iran. Morbid obesity was defined according to guideline from the consensus statement of Asia-Pacific Bariatric surgeons group, as a body mass index (BMI) equal to or higher than 40 kg/m^2. In this regard, BMI was calculated by the Quetelet index as the ratio of subject's body weight (in kg) to square of the height (in meters). The subjects were selected based on simple random sampling method. Baseline characteristics and clinical data of the study subjects were collected by reviewing the patients' files and then recorded at study checklist. In this study, various laboratory parameters including these serum levels of hemoglobin, iron, ferritin, and vitamin B12 were assessed with the use of standard laboratory techniques. In this regard, serum hemoglobin level (gr/dL) was measured with use of the cyan methemoglobin method considering the range of 12 to16 gr/dL for women and 14 to 17gr/dL for men as normal reference. Serum iron concentration (μg/dL) was assessed with the use of the spectrophotometric method (Zist chemistry) with the normal range of 50 to150 μg/dL. Serum ferritin level (ng/mL) was also measured using the human ferritin enzyme immunoassay test with the normal value of 50 to 200ng/mL, as well as serum vitamin B12 concentration (pg/mL) with using the solid-phase, competitive chemiluminescent enzyme immunoassay method with the reference normal value of 200 to 1000 pg/mL.

In the present study, results were presented as mean $\pm$ standard deviation (SD) for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Normality of data was analyzed using the Kolmogorov-Smirnoff test. The categorical variables were compared with the use of chi-square test or Fisher's exact test when more than 20% of cells with expected count of less than 5 were observed. Quantitative variables were also compared with t test or Mann-Whitney U test. Changes in quantitative variables were also assessed using the paired t-test. Data were analyzed using software SPSS version 16.0 for windows (SPSS Inc., Chicago, IL). P values of 0.05 or less were considered statistically significant.

4. Results

Overall, 1252 patients with morbid obesity were included in the study. The mean age of participants was 39.77 $\pm$ 10.84 years (ranged 10 to 70 years) and 80.3% of them were female. The mean body weight was 126.75 $\pm$ 21.58 kg and the mean BMI was also 46.99 $\pm$ 5.87 kg/m^2. The mean serum hemoglobin level was calculated 13.63 $\pm$ 1.61 gr/dL and 9.8% were anemic according to the low value of hemoglobin level. The mean serum level of ferritin was 76.00 $\pm$ 80.30 ng/mL and 46.6% had ferritin lower than the normal range. Also, the average serum level of vitamin B12 was 326.20 $\pm$ 186.65 pg/mL that was lower than the normal value in 21.1%.

Due to the Pearson's correlation test, it was found that there is a positive association between BMI value and the level of the hemoglobin (r = 0.074, P = 0.009, (Table 1). In other words, patients with higher weight had high level of hemoglobin. No significant difference was seen in anemic status based on serum hemoglobin concentration between men and women (9.7% versus 10.1%, P = 0.857) and between the patients aged less than 50 years and the elderly ones (10.3% versus 9.3%, P = 0.674) as well (Table 2).

Table 1. The Correlation Between BMI and Level of Hemoglobin, Ferritin, and Vitamin B12

	HB	Ferritin	VitB12
BMI	Significant	No significant	Significant
	P = 0.009	P = 0.062	P = 0.004
	r = 0.074	r = 0.054	r = -0.081

However, there was not any significant relation between serum ferritin level and the patients' BMI value (r = 0.054, P = 0.062) (Abnormal Abnormal serum ferritin level was considerably more prevalent in women than in men (16.9% versus 55.7%, P < 0.001). However, there was no difference in prevalence of low serum ferritin level between the young people and those who with older than 50 years

Table 2. The Frequency of Low Level of Hemoglobin, Ferritin, and Vitamin B12 (Based on Sex and Age and Total Amount of Them)[a]

	Male	Female	Age < 50	Age > 50	Total
HB					
Normal	90.30	89.90	89.70	90.70	90.20
Low	9.70	10.10	10.30	9.30	9.80
Ferritin					
Normal	83.10	44.30	51.40	52.60	53.40
Low	16.90	55.70	48.60	47.40	46.60
Vit B12					
Normal	79.40	79	78.40	80.90	78.9
Low	20.60	21	21.60	19.10	21.1

[a]Values are presented as %.

(48.6% versus 47.4%, P = 0.750). No correlation was revealed between age and serum ferritin level (r = -0.028, P = 0.334) (Table 2).

It was shown that there was a reverse association between patients' BMI and vitamin B12 concentration (r = -0.081, P = 0.004), (Table 1). The mean BMI level in those with and without vitamin B12 insufficiency was 47.86 $\pm$ 6.55 kg/m^2 and 46.77 $\pm$ 5.66 kg/m^2 that was significantly higher in the former group (P = 0.008). Insufficient vitamin B12 concentration was revealed in 20.6% of men and 21.0% of women with no difference (P = 0.904) as well as the low level of serum concentration of this vitamin in 21.6% of young patients and 19.1% of the older ones with no difference (P = 0.385) (Table 2).

Among those with evidenced CRP result (n = 211), 55.5% had positive CRP. In this context, the positive CRP was found in 66.7% of the anemic patients according to the low value of hemoglobin level and in 54.6% of those who with normal hemoglobin condition (P = 0.364). No significant difference was seen in the prevalence of positive CRP between the anemic patients and patients with normal hemoglobin condition (all results are presented in Tables 1 and 2).

5. Discussion

In the present study, we found that morbid obesity, assessed by BMI higher than 40 kg/m^2, can be associated with changes in two hematologic indices including elevated level of the hemoglobin and also reduced level of the vitamin B12. To the best of our knowledge; our study was the first study obtaining the pointed results. In a study by Ghadiri-Anari et al. (12), there was no difference in hemoglobin concentrations, MCV, serum iron, TIBC, transferrin saturation index, and ferritin between normal weight, overweight, and the obese persons. These results confirm the findings of Dallman et al. (13), 1978, who reported that exclusion of obese individuals virtually had no effect on the ranges or midpoints of hemoglobin concentrations in black, white, or oriental children. Similar to our study, Rao et al. (14) could show that levels of erythrocyte count and hemoglobin of the obese patients were higher than those counterparts who were non-obese. Similarly, Scheer et al. (15) indicated that median hemoglobin concentrations of average 0.125 g/dL, were higher in obese individuals than the ones with or without exclusion of iron-deficiency. In another study conducted by Bagni et al. (16), it was revealed that overweight was associated with low hemoglobin levels in adolescent girls. Thus, the effect of overweight and obesity on serum hemoglobin level still remained controversial and this may be due to differences in design of the study and the characteristics of population especially the presence of underlying comorbidities such as diabetes or insulin resistance. Therefore, in those studies that reverse association was observed between the hemoglobin concentration and body weight, high insulin resistance was the prominent finding (17). The mechanism underlying this relationship is not established. However, it has been suggested that while excessive food intake contributes to the obesity, inadequate quality of diets may be accounted for this finding (18).

In another aspect, inverse relationship was revealed between the level of vitamin B12 and BMI in morbid obese patients. Also, no agreement exists between the reports on this association. As shown by Baltaci et al. 2013 (11), low Vitamin B12 level was associated with obesity and overweight but not with other baseline indices such as insulin resistance, metabolic syndrome or even gender. While vitamin B12 levels were normal in some indices, they were low in others. Uehara et al. (19) reported that the cobalamin lev-

els were normal in their study. Guven et al. (20) also found that vitamin B12 levels were normal. However, Karatela et al. (21) conducted a study on vitamin B12 and homocysteine levels in hypertensive patients who were obese and overweight compared to normal-weight hypertensive patients, reporting a high homocysteine level and reduced vitamin B level. Vitamin B12 deficiency results from an inadequate intake of nutrition, abnormal nutrient absorption, and rare inborn errors of vitamin B12 metabolism. It seems that inappropriate sedentary lifestyle, malnutrition status as the intake of imbalanced nutrition leading low vitamin B12 intake and vitamin B12 metabolic impairment, may be responsible for vitamin B12 deficiency in morbid obese patients.

5.1. Conclusion

Morbid obesity may result in two important hematologic and metabolic changes including increased hemoglobin level and reduced vitamin B12 level. Since, vitamin B12 has vital role in the body, providing adequate vitamin B12 even by using vitamin supplements is essential in these patients. Also, regular screening of hematologic markers level in these patients is strongly recommended.

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References

1. World Health Organization Media Center . Obesity and overweight; Fact sheet N 311 Geneva: WHO; 2015. Available from: http://www.who.int/mediacentre/factsheets/fs311/en/.
2. Myint PK, Kwok CS, Luben RN, Wareham NJ, Khaw KT. Body fat percentage, body mass index and waist-to-hip ratio as predictors of mortality and cardiovascular disease. *Heart.* 2014;**100**(20):1613–9. doi: 10.1136/heartjnl-2014-305816. [PubMed: 24966306].
3. Noto H, Goto A, Tsujimoto T, Osame K, Noda M. Latest insights into the risk of cancer in diabetes. *J Diabetes Investig.* 2013;**4**(3):225–32. doi: 10.1111/jdi.12068. [PubMed: 24843658].
4. Mirmiran P, Mohammadi F, Sarbazi N, Allahverdian S, Azizi F. Gender differences in dietary intakes, anthropometrical measurements and biochemical indices in an urban adult population: the Tehran Lipid and Glucose Study. *Nutr Metab Cardiovasc Dis.* 2003;**13**(2):64–71. [PubMed: 12929618].
5. Flancbaum L, Belsley S, Drake V, Colarusso T, Tayler E. Preoperative nutritional status of patients undergoing Roux-en-Y gastric bypass for morbid obesity. *J Gastrointest Surg.* 2006;**10**(7):1033–7. doi: 10.1016/j.gassur.2006.03.004. [PubMed: 16843874].
6. Damms-Machado A, Friedrich A, Kramer KM, Stingel K, Meile T, Kuper MA, et al. Pre- and postoperative nutritional deficiencies in obese patients undergoing laparoscopic sleeve gastrectomy. *Obes Surg.* 2012;**22**(6):881–9. doi: 10.1007/s11695-012-0609-0. [PubMed: 22403000].
7. Ernst B, Thurnheer M, Schmid SM, Schultes B. Evidence for the necessity to systematically assess micronutrient status prior to bariatric surgery. *Obes Surg.* 2009;**19**(1):66–73. doi: 10.1007/s11695-008-9545-4. [PubMed: 18491197].
8. Cepeda-Lopez AC, Aeberli I, Zimmermann MB. Does obesity increase risk for iron deficiency? A review of the literature and the potential mechanisms. *Int J Vitam Nutr Res.* 2010;**80**(4-5):263–70. doi: 10.1024/0300-9831/a000033. [PubMed: 21462109].
9. Hamza RT, Hamed AI, Kharshoum RR. Iron homeostasis and serum hepcidin-25 levels in obese children and adolescents: relation to body mass index. *Horm Res Paediatr.* 2013;**80**(1):11–7. doi: 10.1159/000351941. [PubMed: 23817203].
10. Sonnweber T, Ress C, Nairz M, Theurl I, Schroll A, Murphy AT, et al. High-fat diet causes iron deficiency via hepcidin-independent reduction of duodenal iron absorption. *J Nutr Biochem.* 2012;**23**(12):1600–8. doi: 10.1016/j.jnutbio.2011.10.013. [PubMed: 22444869].
11. Baltaci D, Kutlucan A, Turker Y, Yilmaz A, Karacam S, Deler H, et al. Association of vitamin B12 with obesity, overweight, insulin resistance and metabolic syndrome, and body fat composition; primary care-based study. *Med Glas (Zenica).* 2013;**10**(2):203–10. [PubMed: 23892832].
12. Ghadiri-Anari A, Nazemian N, Vahedian-Ardakani HA. Association of body mass index with hemoglobin concentration and iron parameters in Iranian population. *ISRN Hematol.* 2014;**2014**:525312. doi: 10.1155/2014/525312. [PubMed: 24665367].
13. Dallman PR, Barr GD, Allen CM, Shinefield HR. Hemoglobin concentration in white, black, and Oriental children: is there a need for separate criteria in screening for anemia?. *Am J Clin Nutr.* 1978;**31**(3):377–80. [PubMed: 629213].
14. Rao GM, Morghom LO. Effect of obesity on erythrocyte count and hemoglobin levels in Libyan diabetic patients. *Clin Physiol Biochem.* 1986;**4**(4):277–80. [PubMed: 3757413].
15. Scheer JC, Guthrie HA. Hemoglobin criteria with respect to obesity. *Am J Clin Nutr.* 1981;**34**(12):2748–51. [PubMed: 7315776].
16. Bagni UV, Luiz RR, Veiga GV. Overweight is associated with low hemoglobin levels in adolescent girls. *Obes Res Clin Pract.* 2013;**7**(3):218–29. doi: 10.1016/j.orcp.2011.12.004. [PubMed: 23697591].
17. Altunoglu E, Muderrisoglu C, Erdenen F, Ulgen E, Ar MC. The impact of obesity and insulin resistance on iron and red blood cell parameters: a single center, cross-sectional study. *Turk J Haematol.* 2014;**31**(1):61–7. doi: 10.4274/Tjh.2012.0187. [PubMed: 24764731].
18. Camitta BM, Nathan DG. Anemia in adolescence. 2. Hemoglobinopathies and other causes. *Postgrad Med.* 1975;**57**(2):151–5. [PubMed: 1109736].
19. Uehara SK, Rosa G. Association of homocysteinemia with high concentrations of serum insulin and uric acid in Brazilian subjects with metabolic syndrome genotyped for C677T polymorphism in the methylenetetrahydrofolate reductase gene. *Nutr Res.* 2008;**28**(11):760–6. doi: 10.1016/j.nutres.2008.09.006. [PubMed: 19083485].
20. Guven A, Inanc F, Kilinc M, Ekerbicer H. Plasma homocysteine and lipoprotein (a) levels in Turkish patients with metabolic syndrome. *Heart Vessels.* 2005;**20**(6):290–5. doi: 10.1007/s00380-004-0822-4. [PubMed: 16314912].
21. Karatela RA, Sainani GS. Plasma homocysteine in obese, overweight and normal weight hypertensives and normotensives. *Indian Heart J.* 2009;**61**(2):156–9. [PubMed: 20039500].