Moderate iron deficiency anemia in the treatment of metabolic syndrome

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ABSTRACT

Background: Body mass index (BMI), weight, and height may be due to various hereditary and environmental factors.

Material and methods: Age and sex-matched cases with a hematocrit value of less than 30% were collected into the first, less than 36% into the second, less than 40% into the third, and 40% or greater into the fourth groups of patients.

Results: The study included 108 anemia patients (101 females) with a mean age of 34.7 years (range 15-68). The anemia cases were mainly iron deficiency anemia and/or thalassemia minors. When we compared the first group with the second, the BMI and weight were significantly retarded in the first group (23.6 versus 26.9 kg/m2, p= 0.005 and 61.3 versus 69.9 kg, p= 0.008), whereas there were nonsignificant differences between the second, third, and fourth groups for both (p>0.05 for all). Although there was significantly retarded BMI and weight in the first group, body heights were similar in the four groups (p>0.05 for all).

Conclusion: Although the BMI and weight can be affected by moderate anemia, the height may strongly be determined by heredity. Since the excess weight may be a significant underlying cause of the metabolic syndrome, and the metabolic syndrome shortens human lifespan significantly, and there is no case with shortened survival due to iron deficiency anemia and/or thalassemia minors, an iatrogenic and moderate iron deficiency anemia with frequent blood donation may prolong human survival by decreasing the BMI and weight in the overweight and obese individuals.

Key words: Iron deficiency anemia, thalassemia minor, metabolic syndrome, weight, height

Introduction

Body mass index (BMI), weight, and height may be due to effects of various hereditary and environmental factors. Many studies assume that genes may be importantin these factors, and there is a common agreement that parents' heights affect the stature of the children (1, 2). External factors may also play a role on the body weight and height. It was shown in a previous study that rural and urban living conditions may cause up to a 30% of difference in weight and a 12% of difference in height (3). But there is still little known about genetic and environmental control of the BMI, weight, and height. On the other hand, anemia is defined as a reduction of hemoglobin in the red blood cells (RBCs), and millions of people suffer from it in the world. Iron deficiency anemia and alpha and/or beta thalassemia minors are the most common types of anemia seen in the world. Hemoglobin is the iron-rich protein of the RBCs that carries oxygen from the lungs to the body. The final consequence is a decrease in the blood's ability to carry oxygen to the body and supply it with the energy that it needs. So the important body processes including cell building, tissue repair, and muscular activity slow down in case of iron deficiency anemia. Dizziness and a decrease in mental acuity may result due to the lack of oxygen to the brain and heart failure due to the increased work of heart. Loss of appetite, palpitation, difficulty in concentration, depression, fatigue, coldness of extremities, pallor (reduced amount of oxyhemoglobin in the skin and mucous membranes), brittle nails, cessation of menstruation, breathlessness on exertion, glossitis (inflammation of the tongue), and angular cheilitis (inflammation of mouth corners) are the other common symptoms and signs seen with the iron deficiency anemia. All of the above symptoms are related to the decreased cell turnover and increased work of heart due either to the decreased oxygen supply or to the decreased iron supplement of tissues. We tried to understand possible effects of various hematocrit values on the BMI, weight, and height

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Material and Methods

The study was performed in the Hematology Polyclinics of the Mustafa Kemal University and Diskapi Yildirim Beyazit Education and Research Hospital on routine check up patients between August 2009 and August 2010. The medical history of all cases including already used medications was learnt, and a routine check up procedure was performed. Insulin using diabetics and patients with devastating illnesses including malignancies, chronic renal diseases, cirrhosis, hyper- or hypothyroidism, heart failure, thalassemia intermedia and major, sickle cell diseases (SCDs), and autoimmune hemolytic anemias were excluded to avoid their possible effects on the BMI, weight, height, or hematocrit values. Body weights and heights were measured, and the BMI of each case was calculated by the physicians instead of verbal expressions, since there is evidence that heavier individuals systematically underreport their weight relatively to the lighter ones (4). Weight in kilograms is divided by height in meters squared (5). Iron deficiency anemia and thalassemia minors were diagnosed with serum iron, iron binding capacity, ferritin, and hemoglobin electrophoresis performed via high performance liquid chromatography. Age and sex-matched cases with a hematocrit value of less than 30% were collected into the first, less than 36% into the second, less than 40% into the third, and 40% or greater into the fourth group. Finally, the four groups were compared in between according to the mean BMI, weight, and height. Mann-Whitney U Test, Independent-Samples T Test, and comparison of proportions were used as the methods of statistical analyses.

Results

The study included 108 anemia patients (101 females) with a mean age of 34.7 years (range 15-68). The anemia cases were mainly iron deficiency anemia and/or thalassemia minors. The female predominance of the anemia cases (93.5%) is due to the menorrhagia induced iron deficiency anemia in this age group. The mean hematocrit values were 23.4, 32.6, 37.7, and 41.6%, respectively, in the groups. The mean corpuscular volume (MCV) values were 58.3, 71.4, 83.3, and 85.5 fL, respectively, in them. When we compared the first group with the second according to the mean BMI and weight, both of them were significantly retarded in the first group (23.6 versus 26.9 kg/m2, p= 0.005 and 61.3 versus 69.9 kg, p= 0.008, respectively), whereas there were nonsignificant differences between the second, third, and fourth groups for both (25.1, 26.6 kg/m2 and 66.6, 71.8 kg, respectively, p>0.05 for all). Interestingly, although the significantly retarded values of the mean BMI and weight in the first group, the mean heights were similar in the four groups (161.0, 160.7, 162.1, and 163.1 cm, respectively, p>0.05 for all) (Table 1 - next page).

Discussion

Iron deficiency anemia is the most common type of anemia in the world, and mostly seen in children due to the increased iron requirement in growth and in women due to the increased iron requirement in pregnancy, lactation, and menstruation. For instance, nine to 11% of adolescent girls and women in childbearing age have iron deficiency, compared with less than 1% of young men in the United States (6). Similarly, the significantly lower MCV values of the anemia patients in the present study also indicate that the majority of cases with anemia are secondary to iron deficiency and/or thalassemias because both are the most common causes of microcytic anemias in the world. The female predominance (93.5%) and young mean age of the anemia patients (34.7 years) of the present study is due to the menorrhagia induced iron deficiency anemia since iron deficiency anemia can be caused by insufficent dietary intake of iron, insufficient absorption of iron, or blood loss which is often caused by menstruation. Iron deficiency anemia induced sign and symptoms may be due to the tissue hypoxia and/or iron deficiency alone since iron takes additional roles in the various tissues and enzymes in the body. Glossitis, angular cheilitis, koilonychia (spoon-shaped nails), and dysphagia due to formation of esophageal webs in the Plummer-Vinson syndrome may be some of the indicators of various roles of iron other than the hemoglobin in the body. Thus moderate anemia induced retarded BMI and weight in the present study may also be secondary to the various roles of iron in tissues and enzymes other than the hemoglobin alone. Thalassemias are the other most common causes of microcytic anemia in the world, particularly in the Mediterranean region. They are autosomal recessively inherited disorders. Normal hemoglobin is composed of two

Table 1: Characteristics of the study cases

Variables	Hematocrit value <30%	*p*-value	Hematocrit value <36%	*p*-value	Hematocrit value <40%	*p*-value	Hematocrit value ≥40%
Number	45		63		60		48
Mean age (year)	34.7 ± 12.0 (15-55)	ns*	34.8 ± 12.0 (16-68)	ns	34.8 ± 11.3 (16-68)	ns	34.6 ± 10.3 (18-54)
Female ratio	91.1% (41)	ns	95.2% (60)	ns	95.0% (57)	ns	93.7% (45)
Mean hematocrit value (%)	23.4 ± 3.9 (14-29)	***0.000***	32.6 ± 1.5 (30-35)	***0.000***	37.7 ± 1.0 (36-39)	***0.000***	41.6 ± 1.9 (40-48)
Mean MCV† value (fL)	58.3 ± 6.4 (46-77)	***0.000***	71.4 ± 5.5 (57-81)	***0.000***	83.3 ± 6.0 (64-92)	ns	85.0 ± 3.9 (78-93)
Mean body weight (kg)	61.3 ± 16.0 (38-104)	***0.008***	69.9 ± 18.1 (40-118)	ns	66.6 ± 12.6 (41-104)	ns	71.8 ± 16.1 (45-107)
Mean body height (cm)	161.0 ± 6.7 (145-179)	ns	160.7 ± 6.7 (147-179)	ns	162.1 ± 7.0 (149-182)	ns	163.1 ± 6.6 (151-180)
Mean BMI‡ (kg/m2)	23.6 ± 6.7 (15.0-47.5)	***0.005***	26.9 ± 6.8 (15.8-46.6)	ns	25.1 ± 5.0 (16.7-36.7)	ns	26.6 ± 5.6 (18.0-39.6)

*Nonsignificant (p>0.05) †Mean corpuscular volume ‡Body mass index

pairs of alpha and beta globin chains. Alpha thalassemias result in a decreased alpha globin synthesis, causing an excess of beta chains in adults. The excess beta chains form unstable tetramers (called hemoglobin H) which have abnormal oxygen dissociation curves. Whereas in beta thalassemias, excess alpha chains bind to the RBC membranes causing membrane damage and they form toxic aggregates at high concentrations. Generally, thalassemias are prevalent in populations that evolved in humid climates where malaria is endemic since thalassemias protect these people from malaria due to the easy degradation of the RBCs. Alpha and beta thalassemias are also frequent in Turkey, especially in the Mediterranean region, and most of the cases with anemia in the present study have alpha thalassemias and/or beta thalassemias and/or iron deficiency anemia. Pathophysiologic mechanisms of the lower BMI and weight in the thalassemia cases may include anemia induced tissue hypoxia, increased cardiac activity, increased bone marrow activity, and increased splenic activity. In this field, iron deficiency anemia and thalassemia cases must be researched separately with increased number of cases in further studies. But it is obvious that neither the iron deficiency anemia nor the alpha and/or beta thalassemia minors do not shorten lifespan of the human being.

Normally the BMI and weight may be determined by a complex network of hormonal, nutritional, physical, and genetic factors. For instance, approximately 70 genes may take role in the regulation of bone mass (7), and some genes were shown to affect both the BMI and bone geometric parameters (8). The same results were also shown in animals that the results indicate substantial additive genetic control of Brahman body weight to hip height ratio (9). Leptin is a hormone produced mainly by adipocytes and it acts centrally to control the body weight (10). Leptin is also expressed on osteoblasts and acts as a skeletal growth factor and promotes bone mineralization (11, 12). The pleiotropic effect of leptin on the BMI and bone geometry may also be supported by the evidence of genetic correlation of leptin with the BMI and bone geometry (13). On the other hand, the body length growth velocity was found not to be affected by genes in some studies (14). Whereas we detected in the present study that although the significantly retarded BMI and weight in the moderate anemia ($p< 0.05$ for both), the heights were similar in all groups without any effect of anemia ($p>0.05$ for all). Similarly, in a previous study (15) performed on 122 patients (58 females) with the SCDs with a mean age of 28.6 years, although the BMI and weight were significantly retarded in the SCDs cases (24.9 versus 20.7 kg/m2 and 71.6 versus 57.8 kg, $p= 0.000$ for both) probably due to the accelerated vascular endothelial damaging process initiated at birth; the heights were similar in the SCDs and control groups (166.1 versus 168.5 cm, respectively, $p>0.05$) probably due to its hereditary nature.

Chronic endothelial damage may be the major cause of aging, morbidity, and mortality by causing disseminated tissue

hypoxia all over the body. Some of the well-known accelerators of the inflammatory process are physical inactivity induced excess weight, smoking, and alcohol for the development of irreversible consequences including obesity, hypertension (HT), diabetes mellitus (DM), cirrhosis, peripheric artery disease (PAD), chronic obstructive pulmonary disease (COPD), chronic renal disease (CRD), coronary artery disease (CAD), mesenteric ischemia, osteoporosis, and stroke, all of which terminate with early aging and death. They were researched under the title of metabolic syndrome in the literature, extensively (16, 17). The metabolic syndrome may be the most common type of vasculitis in the world, and leading cause of aging, morbidity, and mortality in human beings. Much higher blood pressure (BP) of the afferent vasculature may be the major underlying cause by inducing recurrent injuries on endothelium. Thus the term of venosclerosis is not as famous as atherosclerosis in the literature. Secondary to the chronic endothelial inflammation, edema, and fibrosis, vascular walls become thickened, their lumens are narrowed, and they lose their elastic natures that reduce blood flow and increase systolic BP further. Although early withdrawal of causative factors may prevent final consequences, after development of obesity, HT, DM, cirrhosis, PAD, COPD, CRD, CAD, mesenteric ischemia, osteoporosis, or stroke, endothelial changes cannot be reversed completely due to their fibrotic natures (18, 19). Other chronic inflammatory processes including SCDs, rheumatologic disorders, prolonged infections, and cancers may accelerate the process. Finally it is obvious that the metabolic syndrome terminates with a significantly shortened survival in human being (20).

As a conclusion, although the BMI and weight can be affected by moderate anemia, the height may strongly be determined by heredity. Since the excess weight may be a significant underlying cause of metabolic syndrome, and the metabolic syndrome shortens human lifespan significantly, and there is no case with shortened survival due to the iron deficiency anemia and/or thalassemia minors, an iatrogenic and moderate iron deficiency anemia with frequent blood donation may prolong human survival by decreasing the BMI and weight in the overweight and obese individuals.

References

1. Rona RJ, Chinn S. Genetic and environmental influences on growth. J Med Screen 1995; 2: 133-139.

2. Preece MA. The genetic contribution to stature. Horm Res 1996; 45: 56-58.

3. Habicht JP, Martorell R, Yarbrough C, Malina RM, Klein RE. Height and weight standards for preschool children. How relevant are ethnic differences in growth potential? Lancet 1974; 1: 611-614.

4. Bowman RL, DeLucia JL. Accuracy of self reported weight: a meta-analysis. Behav Ther 1992; 23: 637-635.

5. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002; 17:106: 3143-3421.

6. Looker AC, Dallman PR, Carroll MD, Gunter EW, Johnson CL. Prevalence of iron deficiency in the United States. JAMA 1997; 277: 973-976.

7. Khoury MJ. Genetic epidemiology and the future of disease prevention and public health. Epidemiol Rev 1997; 19: 175-180.

8. Xu H, Xiong DH, Xu FH, Zhang YY, Lei SF, Deng HW. Association between VDR Apal polymorphism and hip bone mineral density can be modified by body mass index: a study on postmenopausal Chinese women. Acta Biochim Biophys Sin (Shanghai) 2005; 37: 61-67.

9. Riley DG, Coleman SW, Chase CC Jr, Oslon TA, Hammond AC. Genetic parameters of body weight, hip height, and the ratio of weight to hip height from random regression analyses of Brahman feedlot cattle. J Anim Sci 2007; 85: 42-52.

10. Considine RV, Sinha MK, Heiman ML, Kriauciunas A, Stephens TW, Nyce MR, et al. Serum immunoreactive-leptin concentrations in normal-weight and obese humans. New Engl J Med 1996; 334: 292-295.

11. Reseland JE, Syversen U, Bakke I, Qvigstad G, Eide LG, Hjertner O, et al. Leptin is expressed in and secreted from primary cultures of human osteoblasts and promotes bone mineralization. J Bone Miner Res 2001; 16: 1426-1433.

12. Ducy P, Amling M, Takeda S, Priemel M, Schilling AF, Beil FT, et al. Leptin inhibits bone formation through a hypothalamic relay: a central control of bone mass. Cell 2000; 100: 197-207.

13. Livshits G, Pantsulaia I, Trofimov S, Kobyliansky E. Genetic variation of circulating leptin is involved in genetic variation of hand bone size and geometry. Osteoporosis Int 2003; 14: 476-483.

14. Livshits G, Peter I, Vainder M, Hauspie R. Genetic analysis of growth curve parameters of body weight, height and head circumference. Ann Hum Biol 2000; 27: 299-312.

15. Helvaci MR, Kaya H. Effect of sickle cell diseases on height and weight. Pak J Med Sci 2011; 27: 361-364.

16. Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. Lancet 2005; 365: 1415-1428.

17. Helvaci MR, Kaya H, Sevinc A, Camci C. Body weight and white coat hypertension. Pak J Med Sci 2009; 25: 6: 916-921.