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An Assessment on the Iron Deficiency Anemia among College Going Teenagers Using $CUSO_4$ Gravimetric Method

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A B S T R A C T

Adequate iron intakes play a vital role in physical growth and development of teenagers and are key to a healthy system. Iron deficiency is the most common nutritional deficiency in the world. Iron deficiency anemia occurs when the body lacks sufficient amounts of iron, resulting in reduced production of the protein hemoglobin. Hemoglobin binds to oxygen, thus enabling red blood cells to supply oxygenated blood throughout red blood cells. Insufficient level of iron in the body may lead to poor growth, hence causing anemia. Teenagers between the age of 18-21 are found to be susceptible to anemia. As teenagers turns into a young adult, they undergo an intense physical and psychological transformation. Due to this sudden spurt of growth and transformation, they are merely susceptible to anemia. Iron is needed for many enzymes to function normally, so a wide range of symptoms may eventually emerge, either as the secondary result of the anemia, or as other primary results of iron. Iron deficiency may progress to anemia and worsening fatigue, Thrombocytosis, or an elevated platelet count. A lack of sufficient iron levels in the blood is a reason that some people cannot donate blood. Around 300 college going teenagers were assessed for iron deficiency and eventually anemia. The analysis was carried out by $CuSO_4$ Gravimetric method, a standard operating procedure for blood bank to determine the iron deficiency status in both males and females. The results of the present study indicated the no of individuals lacking iron content and teenagers with iron deficiency anemia and a detailed assessment of symptoms and causative factors were analyzed to intervene and overcome the deficiency by proper intake of dietary and medicative supplements.

Introduction

Iron deficiency is the most common nutritional deficiency in the world. Iron deficiency is estimated to be the most prevalent micronutrient deficiency worldwide and contributes to multiple pathologies mediated both through iron-deficiency anemia and through direct effects on the formation and function of organs,

especially the brain. (Andrew *et al.,* 2017). Anemia is a late indicator of iron deficiency, so it is estimated that the prevalence of iron deficiency is 2.5 times that of anemia (WHO, UNICEF, and UNU, Iron Deficiency Anemia: Assessment, Prevention and Control, A Guide for Programme Managers, 2001 ; Zimmermann *et al.,* 2007). Iron is present in all cells in the human body and has several vital functions, such as carrying oxygen to the tissues from the lungs. It is the key component of the hemoglobin protein that act as a transport medium for electrons within the cells in the form of cytochromes; facilitating oxygen use. It is stored in the muscles as a component of myoglobin and as an integral part of enzyme reactions in various tissues. Reduced amount of iron can interfere with several vital biochemical functions and lead to morbidity and death (Centers for Disease Control and Prevention, MMWR, 1998). In the blood plasma, iron is carried tightly bound to the protein transferrin. There are several mechanisms that control human iron metabolism and safeguard against iron deficiency. The main regulatory mechanism is situated in the gastrointestinal tract. When loss of iron is not sufficiently compensated by adequate intake of iron from the diet, a state of iron deficiency develops over time and when this condition is not managed it leads to iron deficiency anemia *(Centers for Disease Control and Prevention, MMWR, 2002).* Before anemia occurs, the medical condition of Iron deficiency without anemia is called Latent Iron Deficiency (LID) or Iron-deficient erythropoiesis (IDE) (Hider *et al.,* 2013). Iron deficiency anemia occurs when the body lacks sufficient amounts of iron, resulting in reduced production of the protein hemoglobin. Hemoglobin binds to oxygen, thus enabling red blood cells to supply oxygenated blood throughout red blood cells. It is a known fact that children, pre-menopausal women (women of child-bearing age) and people with poor diet are most susceptible to the disease (Dlouhy *et al.,* 2013). But in this transforming technical era, teenagers especially female youngsters are more likely to acquire iron deficiency due to several factors. Most cases of iron deficiency anemia are mild, but if not treated can cause problems like fast or irregular heartbeat, complications during pregnancy, and delayed growth in infants and children (Ganesh Mohan *et al.,* 2016) The highest prevalence rates of iron deficiency and iron-deficiency anemia occur in low-income countries where the combination of poor diet and high levels of infection chronically limits the uptake of iron. This work was carried out to study the prevalence and severity of anemia stratified by age and gender in college going teenagers.

Materials and Methods

This was a prospective observational study done in a private college, Chennai, Tamil Nadu. We undertook this study after obtaining clearance from Institutional Ethics Committee. Students before a blood donation programme were screened for Anemia. Randomly collected EDTA blood samples from 230 individuals both male and female donors were included for the studty. We analyzed the samples using CuSO4 solution (specific gravity of 1.053). $CuSO_4$ solution is a semi quantitative method which works by the principle of specific gravity (gravimetric) where Hb value12.5 g/dL has specific gravity of $\geq$ 1.053, these samples will sink to the bottom of the solution as it has more specific gravity. If the Hb < 12.5 g/dL, it floats on top as the specific gravity is < 1.053. Whole blood is dropped from a height of 1cm above the solution surface and $CuSO_4$ will create a copper proteinate sphere around the blood drop. The working $CuSO_4$

solution should be taken in a clear beaker of 3 inch depth and results should be declared negative only after 15 seconds. Working $CuSO_4$ solution was prepared every day and was changed every 6 hours or after every 25 tests according to the Standard Operating Procedure (SOP) (Mohan *et al.*, 2016). The test results were then analysed for the prevalence of iron deficiency in both male and female genders which was stratified by age and the severity of anemia was also monitored through several factors by making the individuals answer a programmed questionnaire.

Results and Discussion

The study sample included 300 individuals out of which only 230 individuals were screened for iron deficiency. Out of 230 individuals, 120 were males and 110 were females. Data were obtained on Age, height and weight to calculate the Body mass index (BMI) and iron deficiency. Several methods of screening donors for their blood Hb concentration are available. These include i. Gravimetric method using solutions of copper sulphate on blood samples obtained by finger prick, ii. spectrophotometric devices using capillary or venous samples, iii. non-invasive technology, iv. Full blood count using venous or capillary samples. From the mentioned above methods Gravimetric method using solutions of copper sulphate were carried out. Data on Food habits, menstrual cycle, and other nutritional deficiencies like Zinc deficiency were also collected. The prevalence rates of anemia and iron deficiency were 13% in males and 66.6% in females under age 17years old. 8.3% in males and 32.4% in females under age 18 years old. 17.4% in males and 38.5% in females under age 19 years old. 8.3% in Males and 70% in females under age 20 respectively. Among the studies carried out, 95% of the anemic women were iron deficient.

The mean Hemoglobin level was <12.5 mg for the anemic individuals due to the fact that copper sulphate used in the gravimetric method has a specific gravity of 1.053 which will predominantly make the blood drop sink to the bottom accordingly. Healthy food intake including cereals, pulses green leafy vegetables were also recorded. The data analysed showed the teenagers negligence of iron rich and iron fortified foods in both males and females. Dietary intakes were suboptimal for several nutrients. The correlation for several parameters including age, sex, height, weight and anemic status is significantly assessed and shown in the Fig 2, Fig.3 and Fig 4 respectively

Fig.1 Heme containing Iron

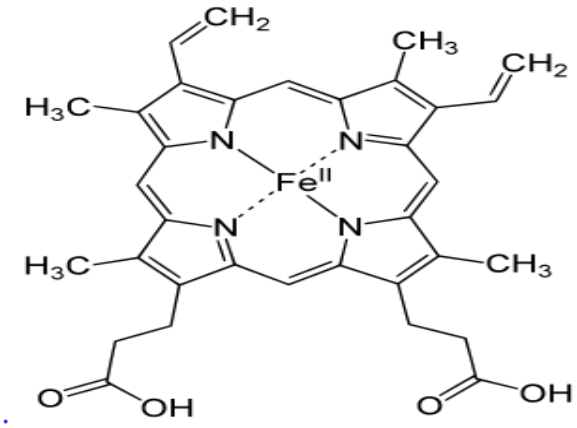


Fig.2 Comparison of Age, Height, Weight, No of person surveyed and Anemic status in Male students

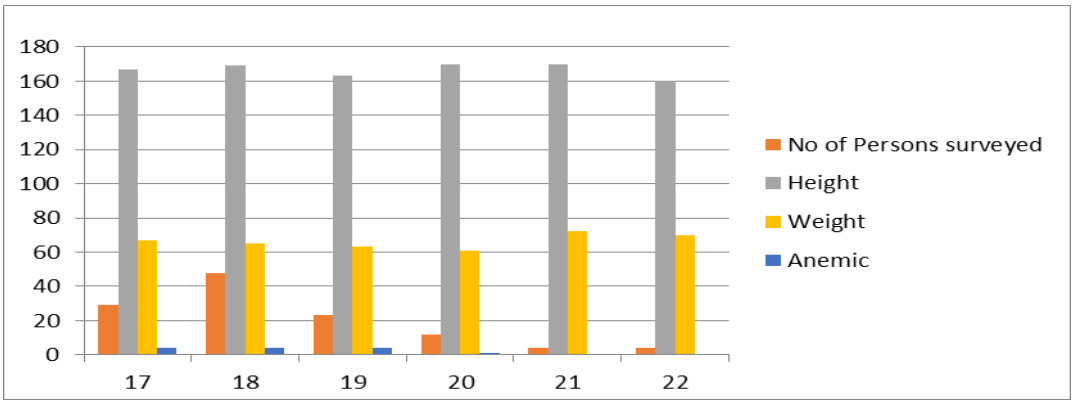


Fig.3 Comparison of Age, Height, Weight, No of person surveyed and Anemic status in Female students

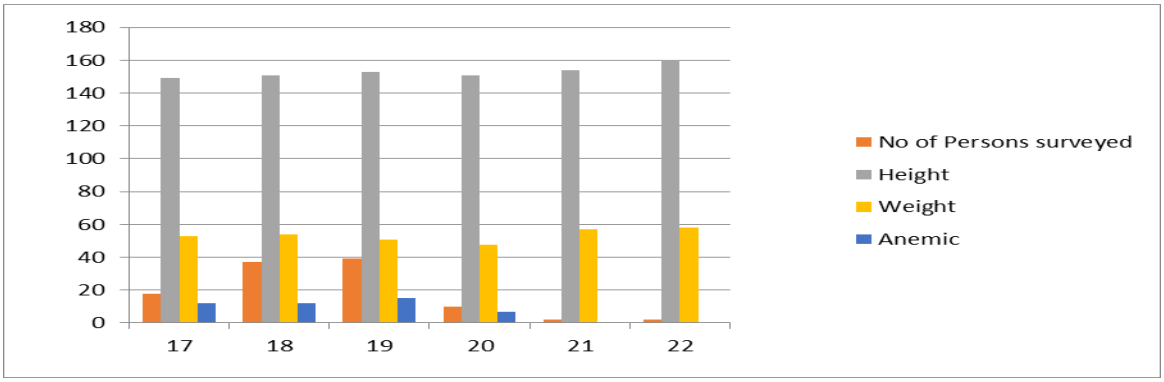
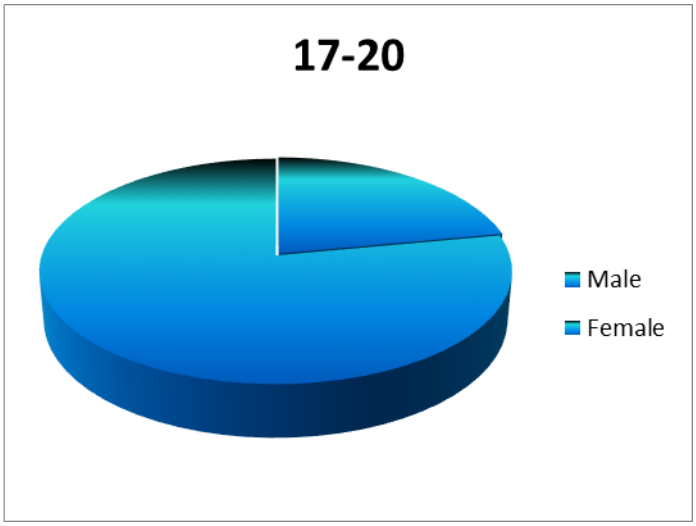


Fig.4 Comparison of Iron deficiency Anemic status between Male and female teenagers under difference age groups



Organisms have specific ways to assimilate necessary nutrients. Humans have to ingest food and process it mechanically and chemically during the digestion. The principal nutrients needed are carbohydrates, lipids, proteins, vitamins, and minerals, that are found in different sources (Gropper *et al.,* 2013). A balanced alimentation is hence very important. Lack of essential vitamins or minerals in the diet affects immunity and healthy development. This condition of unproportional alimentation is called undernourishment. In healthy humans, iron represents around 40 mg/kg body weight (Maria Augusta *et al.,* 2016). Most iron contained in the human body (70%) is circulating with the erythrocytes in form of hemoglobin, around 10% in the muscles as myoglobin, cytochrome, and iron-containing enzymes and the residual 20% as ferritin (Conrad *et al.,* 2006 ; Lieu *et al.,* 2001). The daily- recommended iron dosage for healthy adults is 8 mg for men, 18 mg for women and 27 mg for pregnant women (Trumbo *et al.,* 2001). Iron absorption efficiency varies depending on the iron type (heme iron or nonheme iron), iron content of the food, iron status of the body, and consumption of iron-absorption inhibitors or enhancers (Baynes *et al.,* 1990). Meat, poultry, and fish contribute to heme iron while all vegetables, cereals, and legumes with the inorganic oxidized ferric form (Fe3+) (nonheme iron). An inadequate intake of dietary iron, its poor bioavailability, and concurrent inadequate intake of dietary micronutrients appear to be the primary factors responsible for the high prevalence of anemia and iron deficiency in this population (Thankachan *et al.,* 2007). The high proportion of Normocytic anemia and the fact that gender differences were only seen after the menarche period in teenage girls suggest that iron deficiency was the main cause of anemia. Anemia and iron deficiency lead to substantial physical productivity losses in adults (Zimmermann *et al.,* 2007). Young women prone to Iron deficiency during pregnancy are associated with maternal mortality, preterm labor, low birth-weight, and infant mortality (Uria *et al.,* 2014). The above condition can be a prerequisite factor for anemic teenage girls especially after the onset of puberty, and older adults. Iron deficiency also relates to several factors such as parasitic infection or worm infestations, inadequate dietary intake, a decreased ability to absorb iron due to result of Celiac disease, Crohn's disease or in conditions where a part of the stomach or small intestine is being removed and other socio demographic factors (Kumar *et al.,* 2016). Other risk factors also include chronic blood loss due to heavy menstruation, from an injury or during a child birth. People, such as vegetarians, who eat a plant-based diet, may be lacking in iron. To combat this, they should be sure to include foods rich in iron, such as beans or fortified cereals. Blood donors who give blood regularly increase their chances of developing an iron deficiency because of the frequent blood loss. Such donors should make sure to donate blood only after 3-4 months after an iron load monitor. Premature babies and those with a low birth weight even after reaching adolescence can be at risk of iron deficiencies (Bhutta *et al.,* 2014). Teenagers going through growth spurts have an increased risk of iron deficiency. It is important for them to eat a varied and nutrient-rich diet to help avoid iron deficiencies. Iron deficiency anemia is usually treated in two ways, which involve increasing iron intake and treating any of the above underlying conditions. Treatments for underlying conditions will depend on the problem but may mean additional medications, antibiotics, or surgery. Self-management involves adding more iron and vitamin C to the diet.

Iron deficiency anemia is a common disability in our population due to a wide variety of conditions. The replenishment of iron stores along with correction of the primary etiology lead to significant improvement in hemoglobin without any recurrence of the disease. Effective public health programmes aimed at reducing iron deficiency among young women could have a major impact. Foods rich in iron, such as eggs and meat, supply the body with much of the iron it needs to produce hemoglobin. We used data from students studying in one private college to assess the prevalence of anemia in the population. This might have led to an overestimation of anemia in our setting.

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