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Quantification of Iron in Hair Samples of workers of Textile Industry near Sheikhupura, Faisalabad Road Pakistan

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Abstract

The current study was conducted to quantify iron content in scalp hair samples of workers of textile industry near Sheikhupura, Faisalabad Road Pakistan in 2013. This study aimed to assess nutritional deficiencies of iron. The hair samples were collected from 50 respondents working in textile industry age ranged 16-61 years. Prior to analysis, samples were washed with organic detergent and then hair samples were digested afterward in acid mixture. The concentration of iron was assessed by atomic absorption spectrophotometer (AAS). The results revealed that concentration of iron in hair was 1.03±1.29ppm. There was a significant low levels of iron in hair when compared with the permissible limit P<0.05. Pearson's correlation of iron concentration with age (.16 > .05), weight (.41 > .05), BMI (.51 > .05) and prevalent diseases (.17 > .05) was more than .05 thus showed a positive correlation. Only height (-.14 > .05) had a negative correlation with concentration. Socioeconomic status of workers had effect on the levels of iron in hair because lower income levels equated to poorer food quality and less consumption of iron rich diet.

Keywords: Iron, hair samples, Pearson's correlation, socioeconomic status.

Introduction

Iron is an essential element in life. Being a transition metal iron exists in two relevant biological oxidation states i.e. reduced ferrous form (Fe^{2+}) and the oxidized ferric form (Fe^{3+}) [1]. Iron is an important component of asbestos and other mineral and synthetic fibers[2]. Due to the exposure to synthetic fibers an elevated risk of interstitial lung disease (ILD) can be associated with employment in textile mills that can result mobilization of iron and catalysis of an oxidative stress[3]. Significant quantities of iron are introduced by dyes into textiles. Iron-tannate dyes are used to colour a vast array of woven and non-woven materials shades of black, grey and brown which may include proteinaceous materials such as silk, wool and leather, and cellulosic materials such as cotton and abaca[4].

Iron in diet present in two forms i.e.haem and non-haem. A lot of non-haem iron is found in edible grain, green leafy vegetables, some fruits, nuts, eggs, fish and animal flesh used as a food. In the form of fortificant iron is added to food and also available as supplements[5]. Approximately 4.0 and 3.5 g body iron content is presentin males and females respectively. In adults, 60–70% of body iron is present in haemoglobin in circulating erythrocytes and 10% in muscle myoglobin which is essential for oxygen transport. The remaining 20–30% is found primarily in storage pools located in the liver and reticuloendothelial system in the form of ferritin and haemosiderin. Body iron of about 1% is combined with many iron-containing enzymes and less than 0.2% is obligated to transferrin in the plasma transport pool[6].

The development of iron deficiency can be considered in three stages corresponding to these quential effects on the systemic iron stores, the supply of iron to the tissues, and the subsequent impairment of iron dependent functions[7]. The term "iron status" is used to describe body iron content in an individual to fulfill their needs that can be too little, enough or too much as well as to indicate the possible risk of deficiency or excess[8]. Markers that have been used to assess iron status are classified to represent: a functional use of iron in the formation of haemoglobin; the distribution or transport and providing iron to tissues; and deposition of iron in tissues. Elemental levels in body can be determined by the analysis of blood, by-products and human head hair[9]. As an effective bio-concentrator, bio-assay of hair is appealing because samples can be easily stored and an integrated value is indicated by concentration. Therefore, Hair analysis can detect and measure the content of iron and other metals of the hair. The presence of iron and other metals in hair samples reveals the presence of these metals in other organs of body. The hair is a spillover from what is in the body[10]. Medical studies show that analysis of hair iron can be used as a diagnostic tool in examining iron exposure, including abnormal nutritional intake and may help in the study of some other mental states. It may recommend iron disproportion present in the body that perhaps could be improved by taking an iron rich diet[11].

This study aimed to assess nutritional deficiencies of iron. Moreover, whether occupational exposure in the textile industry resulted in alterations in the levels of iron in the body and hence in the hair which could serve as a simple tool for monitoring exposure to potentially hazardous levels of iron.

Objectives: Assessment of general health status of textile industry workers by Health Assessment Questionnaire in which information related to personal profile, dietary habits, health assessment and healthy life styles of the workers was included.

Determination and comparison of the amount of iron present in the hair samples of the textile workers with the standard amount.

Determination of iron deficiency and toxic levels among the workers.

Material and Methods

Sampling area and Sample collection: In order to quantify iron in hair samples of textile workers, study was conducted in a huge textile industry of a Socks Manufacturer and Exporter. The location of study area is shown in figure 1. Samples were collected from the male subjects working in textile industry. Hair sample of subjects of different ages (15-25, 26-35, 36-45, 46-55, 56-65) were taken from the cervix of the scalp by cutting 10-20mm with a pair of disinfect stainless steel scissors. Before analysis in Environmental Science Research Laboratory of Lahore College for Women University, Pakistan collected hair samples were air tight in plastic bags at room temperature.

Instrumentation: An Atomic Absorption Spectrophotometer (AAS Thermo scientific M series GF95Z Zeeman Furnace) was used for flame atomic absorption analysis of iron (Fe).

Hair Samples washing: With the reference of a standardized procedure hair samples were quantified[12]. First of all in order to ensure feasible and fast digestion of the samples, they were cut into small pieces. Then they were washed before with methanol and after that soaked in double distilled water for 10 minutes. To remove external contamination hair samples were soaked in acetone and finally washed with double distilled water. The samples were kept in an oven for 1 hour at 110°C and finally in petri dishes for rest of the digestion.

Hair Samples digestion:1 g was weighed in a weighing machine for each of the hair samples. The digestion of dried hair samples was carried out with 5ml of 6:1 mixture of concentrated nitric acid and perchloric acid. The commixture was then heated on the hotplate for the complete digestion of hair samples and the resultant mixture was colourless. Each digested samples were filtered into test tubes and filtrate were analyzed for iron.

Analytical Procedure: Hair samples were analyzed on the flame mode of Atomic Absorption Spectroscopy. Three different standards were run at the beginning of the analysis for the instrument calibration and its sensitivity. After such calibration, the prepared sample was then injected into the instrument through a small capillary. A separate source lamp of iron (Hallow cathode lamp with the atoms of the element tested) was used for iron analysis.

Data Interpretation and analysis: After completion the analysis for iron concentration in hair samples, values were demonstrated as mean, maximum, minimum, standard deviation and Pearson's correlation. All calculations were done by using SPSS-17 and Microsoft Excel 2010.

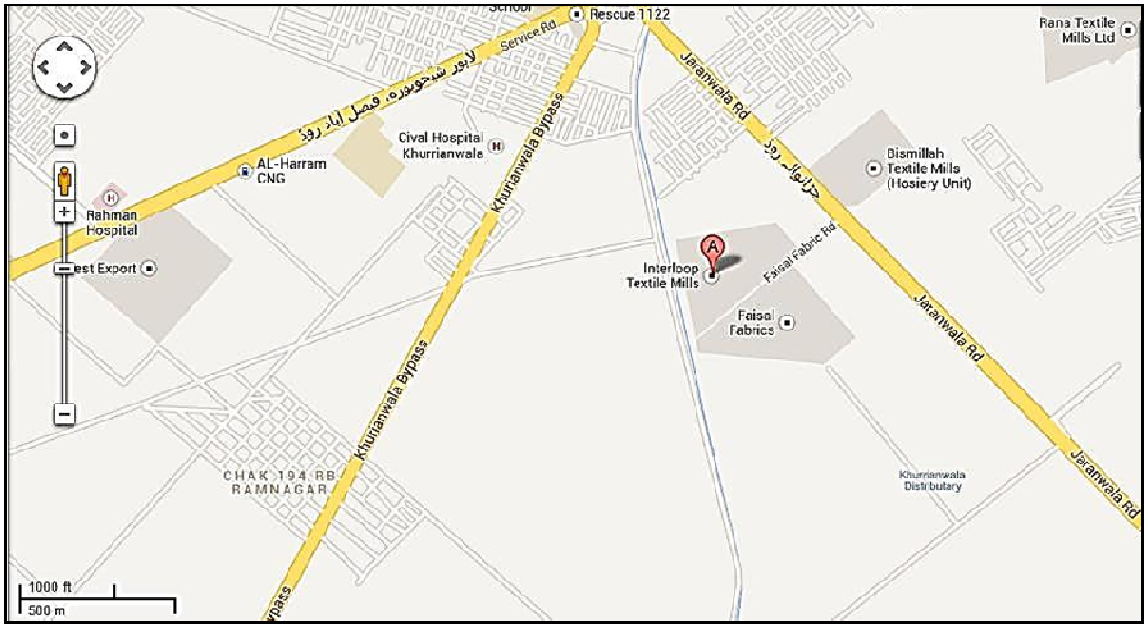

Figure-1

Map showing study area of the research work, Source: Google Earth 2013 (http://goo.gl/maps/czchj)

Results and Discussion

In almost all of the workers deficiency of iron was observed, as was expected. According to Dr. Lawrence Wilson, the ideal iron level in the hair sample should be about 1.8-2mg% or 18-20 ppm in unwashed hair sample. The prevailing situation of iron that appeared in alarmingly low concentration in all samples of hair of the textile industry workers is quite concerning.

Descriptive Statistic: The descriptive analysis of data revealed average scores and deviation of variables. It also showed the minimum and maximum values of the variables. Results in table 1 indicated the mean age of participants of the study was 39.50±12.41yrs, the mean weight was 69.12±10.16kg, mean height was 1.70±0.08m, mean BMI was 23.77±3.67 and the mean concentration ppm of iron was 1.03±1.29ppm. The table also showed that the minimum age of the participants of this study was 16 years and the maximum age was 61 years, the minimum weight was 43 kg and the maximum weight was 91 kg, the minimum BMI was 16.4 and the maximum BMI was 31.4. Moreover, the minimum concentration ppm of iron was 0.01 and the maximum concentration ppm of iron was 7.38.

Inferential Statistic: Inferential analysis of the data collected from the workers of the textile industry included Pearson's correlation.

Analysis of relationship: Pearson's correlation determines analysis of relationship within the variables at the level of significance of 0.05 (2-tailed). If the value of sig. was ≤ 0.05 then the correlation was significant and if the value of sig. was ≥ 0.05 then there was found no significant correlation in the variables. Also, if the Pearson's correlation value was ≥ 0.05 it showed a strong correlation and if ≤ 0.05 there was a weak correlation. If no sign (+ or -) is present the correlation is positive and if a "– ve" (negative) sign is present, it is a negative correlation.

Results of table 2 revealed a significant correlation of iron concentration ppm with weight (.00 < 0.05) and BMI (.00 < 0.05). However, all the variables (age, weight, and BMI) showed a positive correlation with the iron concentration ppm. The Pearson's correlation of iron concentration with age (.16 > .05), weight (.41 > .05), BMI (.51 > .05) and prevalent diseases (.17 > .05) was more than .05 thus showing a positive correlation. The table also showed that only height (-.14 > .05) had a negative correlation with concentration.

Iron is particularly important in muscle, brain and red blood cells. Iron deficiency may happen at any age if diets are based on basic foods with little meat or people are exposed to infections that cause blood loss[13]. Studies were conducted on levels of heavy metals in human hair samples collected from different subjects with respect to gender and age of those working in iron welder workshop from Maiduguri Metropolis, Borno State, Nigeria have found that nutritional deficiencies of iron (Fe) which are very prevalent in young age in developing countries due to their more precarious activities, ill-timed outdoor activities and not fully developed hygienic habits and active metabolism[14].

Table-1
Mean and Standard Deviation of the variables

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	16	61	39.50	12.41
Weight	50	43	91	69.12	10.16
Height	50	1.55	1.88	1.70	0.08
Body Mass Index	50	16.4	31.4	23.77	3.67
Prevalent Diseases	50	0.00	6	2.36	2.11
Concentration ppm	50	0.01	7.38	1.03	1.29

Table-2
Correlation of concentration ppm with age, weight, height, BMI and prevalent diseases

		Age	Weight	Height	BMI	Prevalent Diseases
Concentration ppm	Pearson's Correlation	.164	.414	-.144	.515	.172
	Sig. (2-tailed)	.256	.003	.320	.000	.232
	N	50	50	50	50	50

Experimental and clinical studies indicate that there is a relationship between iron metabolism and weight status. Underweight mainly arises from poor diet and frequent infection which may lead to insufficient intake of calories, protein, vitamins and minerals especially iron. According to World Health Organization (WHO) iron deficiency development among obese and overweight workers has potentially harmful effects, which can lead to behavioral and learning problems as well as lowered resistance to infections.

The analysis of the data showed that about 70% of the respodents were suffering from different diseases shown in figure 2. Anemia is typically the first clue to iron deficiency. It is confirmed that insufficient dietary iron intake in humans leads to hypochromic and microcytic anemia[15]. Non-anemia iron deficiency probably does reduce work capacity.

The most common cause of iron deficiency which was observed in textile industry workers is lack of balanced diet and poor nutrition. Vegetables and pulses have largest proportion in the diet of these workers while chicken, meat, rice and fruits are consumed less frequently by them shown in figure 3. It is obvious that the lack of meat and poultry products and no consumption of fruits in daily diet is the major cause of iron deficiency in these respondents.

It is considered that iron is the food constituent and a well-recognized nutrient which is measurable in foods by using established methods. Iron is also sufficiently characterized and concluded cause and effect relationship has been established between the dietary intake of iron and normal formation of red blood cells and haemoglobin, normal oxygen transport, normal energy-yielding metabolism, normal function of the immune system, normal cognitive function and normal cell division. The high prevalence of iron deficiency in the workers of textile industry is supported by the fact that dietary iron bioavailability is low in populations consuming monotonous plant-based diets.

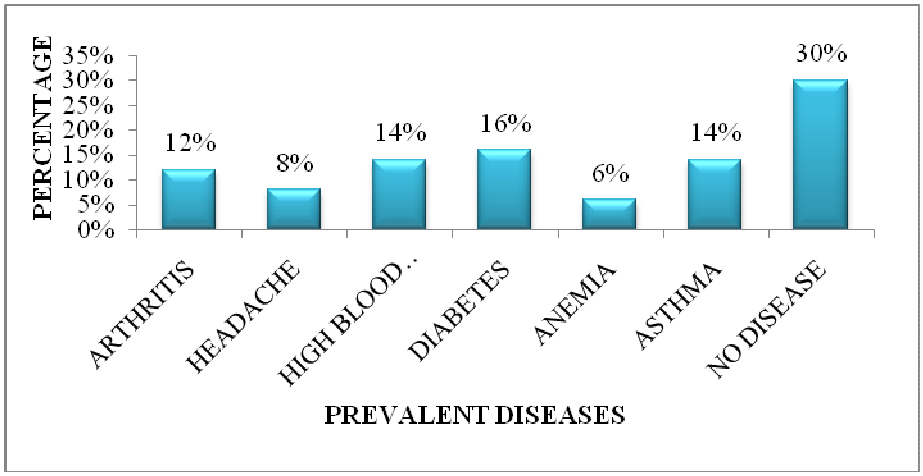

Figure-2
Percentage of prevalent diseases in textile industry workers

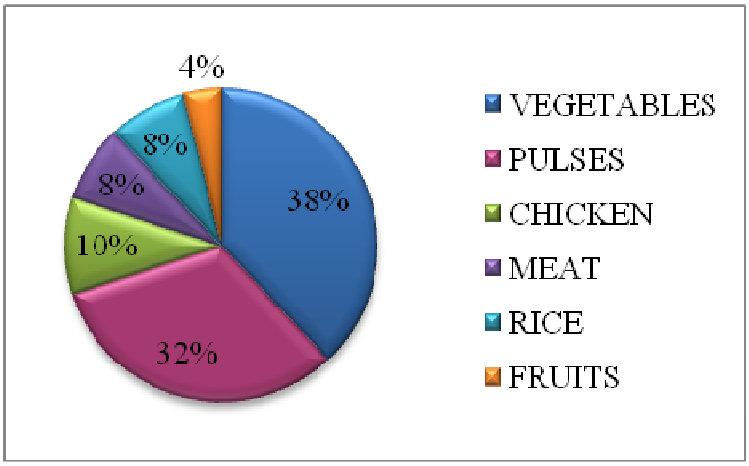

Figure-3
Preference of food items by workers in textile industry

Conclusion

The present study reveals deficiency of iron in textile industry workers and reason for this deficiency is lack of balanced diet and poor nutrition. Analysis of hair iron may recommend iron disproportion present in the body that perhaps could be improved by taking an iron rich diet. Socioeconomic status does play an important role in health of textile industry workers. It is also concluded that synthetic fibers and dyes which are used in textile industry does not play any role in body's iron levels.

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