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Original Article

Factors affecting the body mass index, haemoglobin and serum ferritin level in students

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Abstract: Ferritin is a protein found in reticuloendothelial system and does not work only as a mid-size protein during Hemoglobin synthesis but also as storage protein for iron delivery. This cross sectional study was conducted in District Shaheed Benazirabad during the period of August 2015 to March 2016, for obtaining credible and consolidated data. In present study we investigated BMI, Hb and S.f level with relation to socioeconomic status in children and adults from total 2040 volunteers (girls n=991, boys n=1049). The questionnaire included education, social class, age, sex, and information about dietary habits. Blood samples were collected & assessed by ELISA method and sysmex hemoglobin auto analyzer instrument for serum ferritin and hemoglobin level. The mean value of Body Mass index, the average value of hemoglobin and serum ferritin level was observed accordingly 18.6, 12.1 g/dl, 82.8 µg/l in all samples. It was concluded that monthly income of the volunteers have significant association with Hb, BMI and Serum ferritin at the P<0.01 level. However, environmental conditions, blood loss in females during menstruation, low maternal attention, socioeconomic and dietary habits are main factors which affect the BMI, Hb and S.f level in students.

Keywords: Body mass index, hemoglobin, serum ferritin, iron deficiency anemia, students

Introduction

Ferritin is an iron storage protein which is largely scattered in tissues where it does not commonly visible by the microscope [1]. Intracellular iron storage protein it is second important keys, found in Reticuloendothelial system [2]. It does not work only as a mid-size protein during Hemoglobin synthesis but also as a storage protein for iron delivery during Hemoglobin denaturalization [3]. The iron levels present in patients serum with iron inadequacy anaemia recommends that the serum concentration of ferritin definitely shows the bulk of iron stores [4]. Serum ferritin has reflected the large sensitive and predictive worth in this matter with simple anaemia and without anaemia [5]. The size of ferritin in addition to other supporting tests has special features of being the only test able to reflect risk subjects before they become symptomatic. Serum ferritin is the most authentic test showing value of iron within medium range and also iron inadequacy and excess. 11-16 in a young developing child having very subtle status between supply and requirement of iron stores. It is most important to diagnose iron deficiency at a stage before it gives results in hypochromic and microcytic anaemia. The theme of this subject is to explore the importance of serum ferritin in iron inadequacy anaemia as compared to other registers. Ferritin consists of apoferritin, which contains outercircular shell of an iron-free protein and an inner shell of trivalent iron Fe+3 (oxidized). Iron inadequacy anaemia may occur due to malabsorption of iron, injury, abnormal periods during menstruation in females, in incomplete diet and loss of blood while bleeding problem [6]. Meanwhile status of serum ferritin greater than 1000 ng/ml may be due to different causes which are not concerned to the measurement of iron in our body [7]. Serum ferritin is also concerned with behavioral varieties and developmental status in preschool problems [8]. The

serum ferritin concentration in healthy adults is proportional to the measurement of body iron stores and difference in the serum ferritin level matches with varieties effects on childhood normal growth [9, 10]. A highly important correlation has been reported between serum ferritin concentration with three other indices of body iron status such as hemosiderin concentration of bone marrow, percent absorption of iron and measurement of body iron stores as found by measurable phlebotomy [11-13]. The significance of serum ferritin concentration is more developed in males than in females during adulthood but not during the childhood [14]. However ferritin is also an acute-phase protein that promotes in malignancy, liver disease, infection and inflammation [15]. Serum ferritin and serum transferrin receiver (sTfR) are a characteristic line of store verities of iron available in body while lower from normal iron-replete levels are occurred in Iron Deficiency Anaemia patients [16]. The relationship between serum ferritin and varied functions/variables like RBC, Hb, PCV, MCV, MCHC, MCH, area, age, gender, diet, etc have been deeply pointed out in children in the previous time. However, in many growing countries iron inadequacy anaemia is related to low ferritin level while Serum ferritin (<12 ng/ml) is assumed as a powerful symbol in the analysis of anaemia. Nevertheless, in some patients typically having other medical problems, the analysis could be difficult. The size of serum ferritin is presently the accepted laboratory test for diagnosing iron inadequacy and a ferritin value i-e. (<12 mg/L) which is a highly particular symbol of iron inadequacy [17]. However, these commonly used laboratory tests such as total iron binding capability, serum iron, transferring saturation and mean corpuscular volume results extra diagnostic status over ferritin [18]. Serum ferritin concentration have an important positive relationship with serum apolipoprotein B concentrations, serum triglycerides, blood glucose and have an inverse relationship with serum HDL2 cholesterol all fealints of what has been named the insulin hindrance syndrome [19]. Serum ferritin was the second-strongest determinant of blood glucose after BMI in regression shapes and the third fastest determinant of serum insulin after BMI and age [20]. The metabolic syndrome is intimately associated with insulin hindrance and countless studies show relation to iron overload. Raised serum ferritin shows body iron is in excess .It is mostly related with the size of insulin hindrance such as promoted insulin levels and blood glucose [21]. The Normal ranges for ferritin level are also varied by age and sex, such as the ferritin level are increased at birth, rising serum ferritin during the first two months of life and then it falls throughout later infancy [22]. Males had higher values of ferritin level than females, while a trend that persist into late adulthood and values among men age of between 30 to 39 years and later tend to remain constant until 70 years of age. However in women serum ferritin levels remain relatively low until menopause and risesthen after [23]. Body ferritin level may vary due to hemoglobin value which is influenced by residential elevation above sea level or smoking behavior. Iron is a significant nutritional element for normal neurodevelopment and yet it is the mainly general nutrient insufficiency among young children and infants worldwide [24]. The European pediatrics association (EPA) and (WHO) recommends using ferritin less than 12 µg/L for diagnosis in amalgamation with Hb less than 110 g/L in children aged from 6 months to 5 years [25].

Objective: 1. Determination of Hemoglobin, Serum ferritin level and Body mass index in association with income in school and college age students of District Shaheed Benazirabad, Sindh. 2. To investigate the factors affecting Body Mass Index, Hemoglobin and serum ferritin level of students. 3. Examine the rate of low iron causing anemia in school and college going healthy students in association with socioeconomic status, age education and dietary intake.

Material and methods

Students and study design

The cross sectional study was conducted in District Shaheed Benazirabad during the period of August 2015 to March 2016, for obtaining credible and consolidated data, the whole district was divided into four taluka, Sakrand, Nawabshah, Kazi Ahmed and Daur. For the purpose of full study 6 Degree Colleges, 10 higher secondary schools and 69 high schools were surveyed under four clusters (Nawabshah, Sakrand, Daur and Kazi Ahmed). The healthy students were selected by visiting different Government High/higher secondary schools and Colleges. Male and Female students aged

Table 1. Classification of Body Mass Index (BMI)

	Body index Kg/m^2	Health risk associated
Under weight	Below 18.5	Low
Normal range	18.5-25.0	Moderate
Over weight	25.1-29.1	High
Obesity	30 above	Very high

11 to 18 years were enrolled for the study. The questionnaire included education, social class, age, sex, and dietary habits. The consent commencement for the participation was obtained from parents of selected subjects prior to study. Apparently normal students from both genders groups were selected, having no history of bleeding, blood transfusion, inflammation, infection, liver disease, malignancy and any extensive surgery from both rural and urban areas. Neither of the volunteers used iron supplements, and nor any one had nutritional restrictions as well as all cases having clinical manifestations of hematological disorder were excluded from this study. Students were distributed in three age groups, First 11 to 13 years, Second 14 to 16 years and Third 17 to 18 years. The monthly incomes of parents of all volunteers were divided into three classes. The persons whose monthly income was less than Rs: 20,000 per month (lower income class), Rs: 20,000-27,000 (middle income class) and were more than Rs: 28,000 (middle upper income class). The population included in this study were 2040 where in this 1049 were male and 991 were female students.

Anthropometric measurements

Anthropometrical and clinical examinations were carried on these students. Various anthropometric measurements used were height weight and BMI.

Body Mass Index: It is calculated by dividing weight in kg by the square of height in meters. The calculations were compared with standard for classification of the sample.

$$BIM = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Table 1: Since the height of respondents was recorded in centimeters, for the calculation, BMI heights in centimeter were first converted into height in meters [26]. After collecting personal, anthropometry and dietary intake data, baseline levels of volunteers fulfilling all criteria were taken for determination of hemoglobin and serum ferritin level.

The 5 ml of blood was taken as sample from each of the volunteers. A total number of 2040 blood samples were collected including all four clusters, Sakrand, Nawabshah, Kazi Ahmed and Daur. Blood collecting tubes were cleaned and made infection free with antiseptic solution to kill germs. 5 ml of blood was collected and finally poured into tube containing Ethylene diamine tetra acetic acid. Hemoglobin and serum ferritin were estimated on the same day of sample collection in Diagnostic & Research Laboratory Liaquat University of Medical & Health Sciences Hyderabad. For assessing serum ferritin, 3 ml of blood was transferred to a test tube, kept at room temperature for about half an hour and then centrifuged for 15 minutes at 3500 r.p.m. The hemoglobin and ferritin levels were estimated under the strict quality control. Hemoglobin concentration was measured using Sysmex kx-21N hemoglobin auto analyzer and-Ferritin concentration was estimated by using ELISA method (Enzyme linked immunosorbent assay). The Lab tests were performed at Liaquat University of Medical & Health Sciences Diagnostic Laboratory Hyderabad with help of the highly trained persons. (WHO) specified lower limit for the hemoglobin (Hb) level were different according to sex.12 g/dl for female and for male the limits were 12.5 g/dl for Hb, Serum ferritin <18 μg/l was considered diagnostic.

Statistical analysis

The data were entered, checked and analyzed by using SPSS version (22) for required statistical parameters including simple mean, frequency distribution, standard deviation, Correlation co-efficient and *P*-value for interpretation of observed results.

Results

Figure 1 shows that the whole District (Shaheed Benazirabad) population data were divided into four clusters such as Nawabshah, Daur, Sakrand and Kazi Ahmed. The total number of (2040) volunteers (813=39.9% Urban), (1227= 60.1% Rural), (1049=51.4% Males) and (991= 48.6% Females) from taluka Nawabshah (25%),

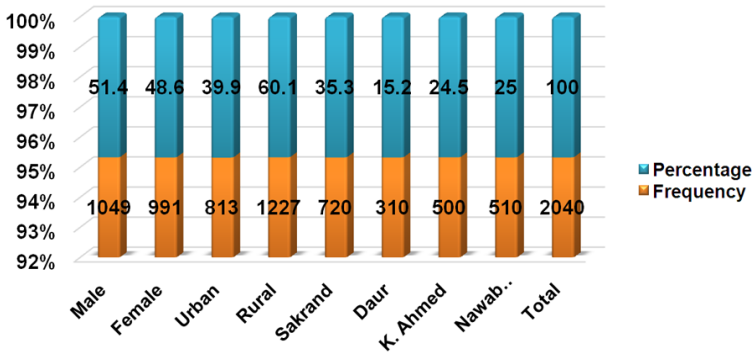

Figure 1. Gender, Residential area and Taluka wise frequency distribution of volunteers.

taluka Sakrand (35.3%), taluka Daur (15.2%) and taluka Kazi Ahmed (24.5%) were selected in present study.

Table 2: The mean value of Body Mass index, Hemoglobin and Serum ferritin levels were observed 18.63±142, 12.15±1.36 g/dl, 82.89 ±51.09 µg/l respectively from all samples, while mean of Monthly income, BMI, Hb and S.f levels were 22058±6765.81, 19.62±1.18, 12.71±1.53, 88.72±57.37 of male volunteers respectively. It was found higher in male volunteers as compared to female volunteers having mean 21229±6474.6, 17.56±0.69, 11.53±0.85, and 83.35±42.68 respectively. According to residential area considering both rural and urban mean of each, Monthly income=23534±8088.5, BMI=19.00± 1.32, Hb=12.48±1.62 and S.f level=95.30± 56.25 in urban region were found higher as compared to rural areas.

Table 3: Discussing in taluka Nawabshah mean of Monthly income=23609±7987.2, BMI= 19.08±1.46, Hb=12.65±1.44 and S.f level= 86.89±62.34 was highest as compared to Taluka Kazi Ahmed, Daur and Sakrand because taluka Nawabshah consists (70%) urban populated areas. Hence their socioeconomic status bit is better than three talukas.

In **Table 4**: According to monthly income, in lower income class volunteers had mean of Monthly income=17937±1507.4, BMI=17.66± 0.65, Hb=11.61±0.87 and S.f level=75.48± 41.45 respectively. They were found less in number than the middle and upper middle income class volunteers. The income of middle class volunteers was between 21,000 to 27,000. In middle income class, the mean of Monthly income was=23581±2527.2, BMI=19.52±0.41, Hb=12.64± 1.55 and S.f level=80.33± 51.79 respectively. These volunteers had higher HB, S.F and BMI compared to lower income class volunteers but less than the upper middle income class volunteers. In this upper middle income class volunteers, the mean of Monthly income=38968±6649.1, BMI=20.59±1.13 Hb=13.85± 1.08 and S.f level=138.46±67.44 figured out respectively. These results were found highest as compared to lower and middle income class amongst all volunteers. These all results finely show that direct effect of increasing income on Body mass index, Hemoglobin, and Serum ferritin level.

Table 5: This table also reflect distribution of volunteers according toage, In volunteers with age 17 to 18 years BMI=20.54±1.11, Hb= 13.26±1.70 and S.f level=113.43±66.15 were found higher while contrary to this lower value observed in the age of 11-13 years and 14-16 years age.

Table 6: reflects that monthly income is significantly associated with HB, BMI and Serum ferritin at the P<0.01 level, While Serum ferritin is significantly associated with HB and BMI at the P<0.01 level. However Hemoglobin is also significantly associated with BMI at the P<0.01 level.

Table 7: This table shows that the total occurrence of Anemia 45.8% students of District Shaheed Benazirabad. In males, volunteers with Hb<12.5 were 20.2% anemic with Serum ferritin <18 µg/L 5.2% of total males and females having Hb<12.0 were 25.6% anemic with S.f <18 µg/L level comprising 7.7%of total representatives. It was found higher in female volunteers as compared to males. This table demonstrates each area that in rural areas 29.7% and urban areas 16.1% volunteers were found anemic with low ferritin level, asserting its percentage high in rural areas. In age group 11-13 years 21.6% volunteers were anemic, this resulted higher as compared to other age

Table 2. Gender wise, Area wise frequency distribution of Monthly income, Body mass index, Hemoglobin and Serum Ferritin level (N=2040)

Variable	Frequency		M.Income Rs:	BMI	Hb gram/dL	S.F µg/L
	No.	%	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Males	1049	51.4	22058±6765.81	19.62±1.18	12.71±1.53	88.72±57.37
Female	991	48.6	21229±6474.6	17.56±0.69	11.53±0.85	83.35±42.68
Urban	813	39.9	23534±8088.5	19.00±1.32	12.48±1.62	95.30±56.25
Rural	1227	60.1	20514±5250.8	18.38±1.44	11.94±1.10	74.77±45.72
Total	2040	100.0	21710±6685.0	18.63±1.42	12.15±1.36	82.89±51.09

Table 3. Taluka wise frequency distribution of Monthly income, BMI, Hemoglobin and Serum Ferritin level (N=2040)

Variable (Taluka wise)	Frequency		M.Income Rs:	BMI	Hb gram/dL	S.F µg/L
	No.	%	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Sakrand	720	35.3	20892±5713.5	18.34±1.29	11.88±1.3	89.15±49.36
Daur	310	15.2	22145±6564.1	19.05±1.47	12.29±1.46	80.03±33.47
Kazi Ahmed	500	24.5	20690±6165.7	18.32±1.35	11.95±1.06	71.58±47.92
Nawabshah	510	25.0	23609±7987.2	19.08±1.46	12.65±1.44	86.89±62.34
Total	2040	100.0	21710±6685.0	18.63±1.42	12.15±1.36	82.89±51.09

groups. This table also shows that majority of volunteers belonged to lower income class i.e. 15000-20000/per month. Those volunteers whose monthly income was 15000-20000 rupees, 38.2% were anemic against each income group. The Prevalence of iron deficiency anemia plotting against talukas, in taluka Sakrand was (19.1%) and (14.2%) in taluka Kazi Ahmed. The prevalence was high in taluka Sakrand and taluka Kazi Ahmed as compared to taluka Daur and Nawabshah.

Table 8: This table shows that minimum value of M.Income 15000 rupees per month, BMI= 17.2, Hb=10.7 g/dl and Serum ferritin level=13.0 µg/l, and maximum value of M. Income 50000 rupees, BMI=25.2, Hb=15.4 g/dl and Serum ferritin level=334.0 µg/l were observed in all students. Meanwhile the minimum and maximum value of BMI, Hb and S.f levels were remained lower in females incomparison with male volunteers. However considering both urban and rural area volunteers, low values of income, BMI, Hb and S.f level were observed in rural areas as compared to urban area volunteers. Discussing both taluka Sakrand and Kazi Ahmed BMI, Hb and S.f level were quite low in students.

Discussion

Present study was done for the Determination of Body mass index, Hemoglobin and Serum Ferritin level with socioeconomic status and relationship of all these values in School and College students of District Shaheed Benazirabad, Sindh Pakistan. The purpose of focusing school and college students is that, this area of study has never been taken in consideration and no suffient data base has been established in this remote, peripheral part of Interior Sindh considering that it will help in raising the living standard of people of remote interior Sindh as well as better policy making for students of schools and college. Our study was based on 2040 students aged 11 to 18 years including both genders (**Figure 1**).

Various studies contain inveterate to the level of serum ferritin estimation is unique most important methods for the evaluation for the detection of mild iron reduction and iron stores. The ferritin levels of serum are directly associated with the iron content of bone marrow. Talking as a whole, diseased group's i.e. malignancy, increased red cell turnover and chronic inflammatory stage, all were excluded; hence all healthy volunteers were enrolled for present study. Serum ferritin is an indicator of neuroblastoma or renal cell carcinoma [27]. It has been reported also that elevating ferritin thresholds to high values being there of swelling to distinguish iron deficiency [28]. The scenario on the iron status of adolescent girls in conducted study was also not satisfactory as

Table 4. Relationship of monthly income with BMI, Hemoglobin and Serum Ferritin (N=2040)

Variable (M.Income wise)	Frequency		M.Income Rs:	BMI	Hb gram/dL	S.F µg/L
	No.	%	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Rs: 15000-20000	1189	58.28	17937±1507.4	17.66±0.65	11.61±0.87	75.48±41.45
Rs: 21000-27000	662	32.45	23581±2527.2	19.52±0.41	12.64±1.55	80.33±51.79
Rs: 28000-50000	189	9.27	38968±6649.1	20.59±1.13	13.85±1.08	138.46±67.44
Total	2040	100.0	21710±6685.0	18.63±1.42	12.15±1.36	82.89±51.09

Table 5. Distribution pattern of Monthly income, BMI, Hemoglobin and Serum Ferritin level in age groups (N=2040)

Variable (Age wise)	Frequency		M.Income Rs:	BMI	Hb gram/dL	S.F µg/L
	No.	%	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
11-13 (years)	765	37.5	1959±4303	17.27±0.45	11.32±0.82	79.44±39,95
14-16 (years)	790	38.7	20995±5615	18.77±0.48	12.27±0.96	67.49±41.15
17-18 (years)	485	23.8	26219±8884.8	20.54±1.11	13.26±1.70	113.43±66.15
Total	2040	100.0	21710±6685.0	18.63±1.42	12.15±1.36	82.89±51.09

Table 6. Correlation Co-efficient of M.Income, S.F, HB, BMI with Hb, BMI and S.f and M.Income

Variable	Income	BMI	HB	S.F
M.Income		0.447**	0.419**	0.478**
Hb	0.419	0.604**		0.384**
S.f	0.478	0.306**	0.384**	

**Correlation is significant at the 0.01 level.

evaluated iron status in 199 volunteers it seems that healthy male and female adolescents aged 12 to 19 years living in a fishing society in Sabah, Malaysia. The mean hemoglobin value for the females was (12.4±1.6 g/dl) with (28.6) percent of adolescents having hemoglobin level <12 g/dl [29, 30]. Our findings shows that the mean value of Body Mass index, Hemoglobin and Serum ferritin level was observed 18.63±142, 12.15±1.36 g/dl, 82.89±51.09 µg/l and respectively from all samples, while mean of Monthly income, BMI, Hb and S.f level were 22058±6765.81, 19.62±1.18, 12.71±1.53, 88.72±57.37 of male volunteers respectively. It was found higher in male volunteers as compared to female volunteers 21229±6474.6, 17.56±0.69, 11.53± 0.85, and 83.35±42.68 respectively. Focusing residential area, (Rural and Urban), in urban region the mean of Monthly income=23534 ±8088.5, BMI=19.00±1.32, Hb=12.48±1.62 and S.f level=95.30±56.25 were found higher as compared to rural areas. In our study Serum ferritin and Hemoglobin level were determined individually for Male and Female both in urban and rural regions and there is no significant relation between them. However, Serum ferritin standard deviation was high because Serum ferritin values was scattered. It was found in highly variable range (**Table 2**). Considering in taluka Nawabshah the mean of Income, Body mass Index, Hemoglobin and Serum ferritin level was highest as compared to Taluka Kazi Ahmed, Daur and Sakrand because taluka Nawabshah consists 70% populated of urban areas and their socioeconomic status is bit better than other taluk's (**Table 3**).

Kilbride J, et al., (2000) was suggested that children in lower income homes are at higher risk than those belonging to higher income class families. Whatever the underlying cause may be poor socio-economic conditions, lack of health education and inadequate health facilities in rural areas of the developing countries is important contributors [31]. Considering lower iron status of our population is due to dietary factors, environmental and socioeconomic. Socioeconomic factors like father's income, literacy rate and huge numbers of family members are the common factors of causing iron deficiency. In a study, the prevalence of anemia in adolescent girls (10 to 15 years) from a low socio-economic background was found to be quite high. The mean initial hemoglobin levels of the experimental group of adolescent girls 10 to 14 years of low socio-economic commu-

Table 7. Gander wise, Area wise, Age wise, Monthly income wise, Taluka wise frequency and distributions of volunteers with Hb and S.f less than Cut off value

Variable	Variables	N	%	Hb<12.5 gram/dl		S.F<18 µg/l	
				N	%	N	%
Gender wise	Male	1049	51.4	414	20.2	107	5.2
	Female	991	48.6	522	25.6	158	7.7
Area wise	Urban	813	39.9	330	16.1	63	3
	Rural	1227	60.1	606	29.7	203	9.9
Age wise	11-13 years	765	37.5	441	21.6	128	6.2
	14-16 years	790	38.7	270	13.2	63	3.1
	17-18 years	485	23.8	225	11.0	74	3.6
M.Income wise	RS: 15000-20000	1189	58.2	668	32.8	158	7.8
	RS: 21000-27000	662	32.4	205	10.0	85	4.1
	RS: 28000-50000	189	9.2	63	3.0	22	1.0
Taluka wise	Sakrand	720	35.3	390	19.1	95	4.7
	Daur	310	15.2	146	7.2	55	2.6
	Kazi Ahmed	500	24.5	290	14.2	78	3.8
	Nawabshah	510	25.0	110	5.3	37	1.8
Total	Shaheed Benazirabad	2040	100	936	45.8	265	12.9

Table 8. Minimum & maximum value of M.Income, BMI, Hb and S.f level in volunteers

Variables	Frequency		M.Income		BMI		Hb gram/dL		S.F µg/L	
	No.	%	Min	Max	Min	Max	Min	Max	Min	Max
Males	1049	51.4	15000	50000	17.2	25.2	10.7	15.4	13.0	334.0
Female	991	48.6	15000	50000	16.1	18.6	8.7	13.7	10.0	220.0
Urban	813	39.9	15000	50000	16.5	25.2	10.7	15.5	13.0	334.0
Rural	1227	60.1	15000	42000	16.2	21.1	8.7	13.4	10.0	270.0
Sakrand	720	35.3	15000	40000	16.1	20.6	8.7	13.6	11.0	270.0
Daur	310	15.2	16000	45000	16.4	22.2	10.1	14.7	10.0	230.0
Kazi Ahmed	500	24.5	15000	35000	16.3	23.5	9.4	13.2	12.1	190.0
Nawabshah	510	25.0	17000	50000	17.4	25.2	10.4	15.4	16.0	334.0
Shaheed Benazirabad	2040	100	15000	50000	16.1	25.2	8.7	15.4	10.0	334.0

nities of Vadodara, India was (10.80±1.2 g/dl) and that of the control group of adolescent girls 10 to 14 years was (10.93±1.3 g/dl). In a previous study, the mean hemoglobin concentration was found to be (9.43±1.365 g/dl) which was lower than normal level [32]. In present study findings show that, in lower income class volunteers, mean of Monthly income=17937± 1507.4, BMI=17.66±0.65, Hb=11.61±0.87 and S.f level=75.48±41.45 respectively, Establishing it less than the middle and upper middle income class of volunteers. In middle income class the mean of Monthly income= 23581±2527.2, BMI=19.52±0.41, Hb=12.64± 1.55 and S.f level=80.33±51.79 respectively. In middle income class volunteers'mean of HB, S.F and BMI were found higher compared to lower income class volunteers but less than the upper middle income class volunteers. In upper middle income class volunteers, the mean of Monthly income=38968±6649.1, BMI=20.59±1.13 Hb=13.85±1.08 and S.f level=138.46±67.44 were respectively. These results were found at the top as compared to lower and middle income class of volunteers, These all results finely shows a positive effect of increasing income on Body mass index, Hemoglobin, and Serum ferritin level (**Table 4**). Our findings revealed that monthly income is significantly associated with Hb, BMI and Serum ferritin at the P<0.01 level, While Serum ferritin is significantly associated with Hb and

BMI at the P<0.01 level. However Hemoglobin is also significantly associated with BMI at the P<0.01 level (**Table 6**).

In the period of rapid growth, the demand of systemic iron is increased. This makes the interpretation of ferritin concentration difficult in young children and infants. Normal ferritin concentrations vary by sex and age. It is vital to emphasize that to diagnose iron deficiency, appropriate reference values are needed individually for every age group. Concentrations are high at birth; rise for the period of the first two months of life, and then fall throughout later infancy [33]. It was also reported that at the age about one year, concentrations of serum ferritin begins to rise again and it persistently increase up to adulthood [22]. The normal range of serum ferritin is dependent on several variables including methodology, age and sex. Serum ferritin is also dependent of hemoglobin. Present results revealed that nutritional iron deficiency was less prevalent in higher age group volunteers than in younger age group. A significant increase in hemoglobin levels was established having positive association with the progression of age [35]. Similar patterns of findings in our study regarding age of volunteers, taking foot prints of previous studies shows that volunteers with age 17 to 18 years mean value of BMI 19.41±1.11 Hb 13.26±1.70 and Serum ferritin level 113.43±66.16 were higher while lower value observed at the age of 11-13 years and 14-16 years age group (**Table 5**). Although according to some reporters serum ferritin is sex dependent and Males have higher levels as compared to females. The similar has been supported by further investigators, in urban and rural areas; found more anemia attribute in females [34]. Our findings show that hemoglobin and serum ferritin is quite low in most of the female population belonging to rural areas. (25.6%) female volunteers were found to have anemia with low serum ferritin (7.7%) which is quite higher in females as compared to male volunteers (**Table 7**).

Severe anemia can impair growth and mental development in school age children. Risk for stroke in children having severe iron deficiency anemia may also increased manifold. The low Hb and MCV have strong relationship with low serum ferritin concentration in anemic children [35]. It is established in our present study with resembling previous similar findings (**Table 7**).

In the population survey it has been reported that women and children of childbearing age are more affected. It was found that iron deficiency anemia may vary from 17% to 70% in pre-school children, while in adolescents it may vary between 14% to 42% and in females of childbearing age between 11% to 40% [36].The prevalence of iron deficiency anemia in children occurs due to low hemoglobin, serum ferritin and low blood hematological parameters, The present study shows that the Prevalence of iron deficiency anemia (45.8%) was observed in School and college students. The occurrence of anaemia in students of taluka Sakrand was (19.1%) and (14.2%) in taluka Kazi Ahmed. The prevalence was high in taluka Sakrand and taluka Kazi Ahmed as compared to Daur (7.2%) and (5.3%) Nawabshah (**Table 7**). However, minimum value of M.Income 15000 rupees, BMI=17.2, Hb=10.7 g/dl and Serum ferritin level=13.0 µg/l, and maximum value of M. Income 15000 rupees, BMI=17.2, Hb=10.7 g/dl and Serum ferritin level=13.0 µg/l were observed in all students, However comparison between urban and rural areas volunteers, low values of income, BMI, Hb and S.f level were observed in rural areas as compared to volunteers of urban areas. Meanwhile in taluka Sakrand and Kazi Ahmed BMI, Hb and S.f level were quite low in students (**Table 8**). The normal range of serum ferritin is dependent on several variables including methodology, age and sex. Serum ferritin is also dependent on hemoglobin, serum iron, and transferring [37]. In the developing world iron deficiency is mostly a single nutritional problem. However balanced diet and hygienic condition also effect serum ferritin concentration and causing iron deficiency and other diseases. In our study also shows that children like's junk foods had low serum ferritin, Hb, Mcv, Pcv, Hct and other parameters. Iron deficiency is an important determinant of anemia and significant positive correlation has been reported between the levels of hemoglobin and serum ferritin [38]. Iron deficiency caused by diet is uncommon in healthy adults in countries where meat is an important part of the diet [39]. Present study explain that in rural areas iron deficiency mostly caused by low consumption of meat due to low of socio-economic status. Economic status, Balance

diet and parent education also affects Serum ferritin and Hemoglobin levels. In our study it has been reported that, the children with low diet have low concentration of Serum ferritin and Hemoglobin level belonged to rural areas. Children belonging to lower income families are at higher risk than those in higher income class families. Whatever the underlying cause may be due to poor socio-economic conditions, lack of health education and inadequate health facilities in rural areas of the developing countries are important contributors. Lower iron status of our population is due to environmental, socioeconomic and dietary factors. Socioeconomic factors like father's income, literacy rate and huge numbers of family members are the common factors leading further to iron deficiency anemia. It has been examined that folic acid and vitamin B12 deficiency also affect total iron intake and anemic status, our present study with resembling previous similar findings with [40]. High fetal mortality is common in pregnant anemic females. So babies after birth have low weight, low hemoglobin and stored iron levels as compared to non-anemic women in gestational [41]. So socioeconomic status and mothers education plays a very important role in children.

Conclusion

Present study findings confirm the fact that nutritional deficiency is the common cause of iron deficiency in District Shaheed Benazirabad. It is concluded that Environmental conditions, blood loss in females during menstrual cycle, low maternal attention, socioeconomic and dietary habits are main factors which affect the BMI, Hb and S.f level in students. The Prevalence of anemia was high in school and college age students. The Hb level was below the suggested cut-off value of Hb level (45.8%) volunteers were anemic in district Shaheed Benazirabad. The Hb level was low in girls comprising (25.6%) than boys comprising (20.2%) where as 58.28% volunteers belonged to poor families. Present study reveals that Hb level is quite low in adult female volunteers in both urban and rural areas; hence anemia and low iron status are more prevalent in female population. BMI of females volunteer was less than boys and BMI majority of volunteers was less than normal recommended standard range. Iron deficiency was observed more prevalent in 13-16 years age group. Indicating that during this age iron requirement is increased. It was also observed more in volunteers belonging to Government Schools and Colleges as they were found severely malnourished.

Recommendations/Suggestions

In order to design an effective technique, Government should initiate health education and awareness programs which will further lead to adopt healthy eating patterns and selection of appropriate foods and appropriate programs for the prevention, treatment and control of anemia should also be included.

In this regard Education department should start Primary health education awareness programs not only for school and college students but their parents as well on quarterly or twice a year basis assuming that it will bring a dramatic change in adolescent health. In order to improve nutritional status, especially considering iron in adolescent girls, important urgent firm steps should be taken and consequently youth should be encouraged for adopting-healthy eating and lifestyle.

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Disclosure of conflict of interest

None.

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