

# Iron status of Hindu brahmin, Jain and Muslim communities in Surat, Gujarat

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## Abstract

*Aim of the Study* To determine iron status of healthy, unrelated Brahmin, Jain and Muslim participants having different dietary habits.

*Methodology* Control participants other than above three communities, consumed vegetarian or non-vegetarian diet. Brahmin and Jain were strictly vegetarian but Jain did not consume roots or tubers. Muslims consumed non-vegetarian food. Standard techniques were used to measure hematological parameters, serum iron, total iron bindings capacity (TIBC), serum ferritin, transferrin and transferrin saturation. For statistical evaluation mean, standard deviation, pair t test,  $\chi^2$  and ANOVA (F test) were employed.

*Results* Study includes 565 male and 198 female children and adults. Among them 205 were children and remaining adults. All four categories i.e. control, Brahmin, Jain and Muslims showed higher incidence of anemia and iron deficiency in females compared to males. Mean values of

hematological parameters did not vary significantly in four groups. Serum iron, TIBC, transferrin and ferritin levels indicated iron deficiency anemia more frequently in Jains and less frequently in Muslims ( $p < 0.05$ ). Iron status of Brahmin was comparable with controls ( $p < 0.01$ ). Majority of the participants had serum ferritin concentration  $> 15$  ng/mL. Except one male Jain child none of the participants had serum ferritin concentration  $< 12$  ng/mL. Jain subjects more frequently had serum iron concentration  $< 60$   $\mu$ g/dL.

*Conclusion* Jain participants had higher incidence of iron deficiency anemia. Vegetarian diet consumed by Gujarati Hindu Brahmin community provided them with a sufficient iron to maintain their iron profile like Muslims consuming non-vegetarian diet.

**Keyword** Anemia · Iron deficiency · Vegetarian · Non-vegetarian · Hindu · Muslim · Jain

## Introduction

Anemia is an important public health problem in India affecting people from all walks of life. For formation and normal growth of red cells containing hemoglobin (Hb), iron and vitamins are essential. The types of diet normally consumed in India should contain 20 to 30 mg iron to meet the iron requirement of an adult. The amount of iron to be absorbed from the daily diet is one to three mg depending upon the sex and physiological status [1, 2].

In India dietary habits vary from community to community resulting in a difference in the amount of body iron. In the present communication we have determined iron status of three communities having different dietary habits. Gujarati Hindu Brahmin are vegetarian, Jain though vegetarian

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do not consume roots and tubers and also fast frequently. Muslims mainly consume non-vegetarian diet.

## Material and Methods

Before starting the project approval was taken from the Institutional ethics committee. The study includes Gujarati Hindu Brahmin who were strictly vegetarian; Jain, strictly consuming Jain diet i.e. did not consume onion, potato, carrots etc. and Muslim individuals who consumed non-vegetarian food. The control group consisted vegetarian and non-vegetarian subjects from communities other than Brahmin, Jain or Muslim. Adult blood samples were collected in camps or community functions, from healthy, unrelated subjects in the age group of 18 to 55 years. About 9 to 14 years old male children's blood samples were collected in schools, after taking informed consent from the parents and school authorities. We were unable to get consent from the Girls high school to collect blood samples from children below 12 years. Hence female children participating in our study were in the 14 to 17 years age group. About 10 ml blood sample was collected in EDTA and plain vials. EDTA samples were tested within 24 hours for hematological analysis and serum samples were stored at  $-35^{\circ}\text{C}$  till tests were carried out. Prior to blood collection information regarding age, sex, financial status, dietary habits etc was collected.

The blood samples were investigated for various hematological parameters on a fully automatic analyzer (Nihon Kohden, Japan). Samples showing mean cell volume (MCV)  $\leq 76$  fl and/or mean cell hemoglobin (MCH)  $\leq 26$  pg were subjected to Hb electrophoresis [3]. Hb A<sub>2</sub> values  $> 3.5\%$  suggested  $\beta$  thalassemia trait and such subjects were excluded from the study.

Estimations of serum iron and total iron binding capacity (TIBC) were carried out by Dipyriddy method [4]. Serum ferritin was estimated using RADIM enzyme linked immunosorbent assay kit, while transferrin concentration was determined only for children, by immunoturbidometric method using Diasys kit. The transferrin saturation value was calculated by the following formula:

$$\% \text{ Transferrin Saturation} = \frac{\text{Serum Iron } (\mu\text{g/dL})}{\text{TIBC } (\mu\text{g/dL})} \times 100$$

The mean and standard deviation (SD) values were calculated on Microsoft Excel. The pair "t" test was employed to compare two means and  $\chi^2$  test to evaluate statistical significance of different parameters. The p value below 0.05 was considered significant. ANOVA was used for multiple mean comparisons with unequal sample sizes [5].

## Results

Study includes 565 male and 198 female children and adults. Among them 205 were children and remaining adults. The information obtained from the study participants revealed that they belonged to middle class or higher middle class group and consumed adequate diet mainly consisting Cereals, millets, pulses and vegetables. Muslims consumed meat or fish about one to three times a week. Non-vegetarian Hindu subjects ate meat or fish about once in a week.

Various hematological indices did not show significant variation in four categories of study participants (insignificant "F" values by ANOVA,  $p > 0.1$ ). The mean values of MCV ranged between from 81.3 to 86 fl, MCH 27.8 to 30.5pg, mean cell hemoglobin concentration (MCHC) 33 to 35.4 g/dL and red cell distribution width (RDW) 12.9 to 14.2 %.

Table 1 gives mean values of various laboratory parameters measured in male children. There was not significant difference in Hb levels of different communities, but serum iron values were low in Jain and high in Brahmins.

Table 2 presents the data of female children. The numbers were too small but the statistical analysis revealed increased serum ferritin levels in Muslim children.

Table 3 gives the laboratory findings of male adults. Jain subjects showed lower levels of hemoglobin and serum iron and higher values for TIBC. The Muslims and Brahmin had lower TIBC and higher serum ferritin levels.

Table 4 presents the laboratory findings of adult females. Brahmin and Muslim had higher levels of serum iron and ferritin while Jain participants were comparable to controls.

As per the recommendation of National Institute of Nutrition (ICMR) the cut off values were decided to identify iron deficiency anemia as serum iron  $\leq 60$   $\mu\text{g/dL}$ , TIBC  $> 380$   $\mu\text{g/dL}$ , transferrin saturation  $< 15\%$  and serum ferritin  $< 12$  ng/dL [6].

Majority of our participants had serum ferritin values  $> 15$  ng/dL. Only one male Jain child had ferritin value below 12 ng/dL and four male children and one adult female of Jain community had values  $< 15$  ng/mL. In control series there was one male adult and among Muslims two male children having  $< 15$  ng/mL ferritin. None of the Brahmin subjects had low ferritin. Hence ferritin was not included in Table 5 and Table 6.

Table 5 shows the number of subjects having iron deficiency anemia based on different parameters. Chi-square test showed significant relationship with Hb, Iron and TIBC. Jain adults showed higher incidence of iron deficiency anemia while Muslim had low incidence.

As seen in Table 6, significant relationship was observed only with Hb as anemia was more frequently present in Jain

**Table 1** Mean  $\pm$  SD values of age and various laboratory parameters in male children

Study Participants	Total Number		Age (Years)	Hb g/dL	Serum Iron * $\mu$ l/dL	TIBC $\mu$ l/dL	Serum Ferritin ng/mL	Transferrin mg/dL	Transferrin Saturation** %
Control	50	Mean	9.9	12.2	85.7	322.2	39.3	271.9	26.3
		SD	2.2	0.7	21.9	54	15.6	49.4	7.5
Brahmin	42	Mean	11.7	11.8	95.6	347.8	37.1	264.1	28.1
		SD	2.9	1.38	22.6	44.3	19.5	44.3	8.0
Jain	46	Mean	11.8	12.2	76.2**	359.1	37.8	278	21.2
		SD	3.1	0.8	13.8	36.3	24.7	48.4	4.2
Muslim	27	Mean	12.1	12.5	84	356.9	36.4	253.5	24.3
		SD	2.5	1.3	14.5	50	12.7	35.6	6.9

df = Degrees of freedom

\*ANOVA test revealed significant F values of 7.6 and 5.3 at  $df_1$  161 and  $df_2$  3 for serum iron ( $p < 0.01$ ) and transferrin saturation ( $p < 0.01$ ) respectively.

\*\*The pair “t” test between means of control and Jain participants revealed significantly reduced iron levels in Jain ( $p < 0.001$  for 94 df)

**Table 2** Mean  $\pm$  SD values of age and various laboratory parameters in female children

Study Participants	Total Number		Age (Years)	Hb g/ dL	Serum Iron* $\mu$ l/ dL	TIBC $\mu$ l/ dL	Serum Ferritin* ng/ mL	Transferrin mg/ dL	Transferrin Saturation** %
Control	10	Mean	15.5	12.1	87	348	34.4	239.5	25.3
		SD	1.2	1.2	15.6	37	18.3	45.4	6.1
Brahmin	10	Mean	15	12.3	90.7	332.8	31.3	244.3	26.1
		SD	2.5	1	23.1	23.6	16.1	28.6	5.3
Jain	10	Mean	16	12.3	79.5	335.4	32.8	234	23.2
		SD	1.5	1.1	21.2	57.3	19.9	52.7	6.2
Muslim	10	Mean	16	12.3	97	353.8	77.6**	247.4	27.5
		SD	3	1.3	19.6	35.2	54.3	38.2	5.22

df = Degrees of freedom

\*ANOVA test revealed significant relationship with ferritin ( $F=5.11$  at  $df_1$  36 and  $df_2$  3,  $p < 0.01$ ).

\*\*Significant increase in ferritin concentration compared to control by pair “t” test ( $t = 2.4$   $df$  18,  $p < 0.05$ )

women. Incidence of anemia was also high in the control group.

## Discussion

Anemia (Hb  $< 12$ g/dL) being the commonest problem in India [6] it was difficult to select a control group. Our healthy control group consuming vegetarian or non-vegetarian diet showed anemia in 52% of women. The overall incidence of anemia was 32.6% in Jain, 24.8% in control, 21.8% in Brahmin and 13.9% in Muslims. Several studies conducted in India [7–9] and in other countries [10] have shown higher prevalence of anemia in women. In the present study also

in all four categories female participants more frequently had low Hb level ( $p < 0.01$ ). Mehta [11] reported anemia in 20.3% adult females while our study showed overall incidence of 35.44% in the same category. Patel [7] has reported  $> 95\%$  incidence of anemia in children, 65.7% in male adults and 88.4% in adult females in rural Maharashtra. Surat being a big city with a lot of health consciousness in the middle class and higher middle class population, study has reported comparatively lower incidence. The higher incidence in rural area is attributed to helminthiasis.

Globally 50% of anemia cases are attributed to iron deficiency [12]. Iron deficiency anemia is widely prevalent in India [6, 13, 14]. Hematological parameters like MCV, MCH and RDW are considered important in identifying

**Table 3** Mean ± SD values of age and various laboratory parameters in adult males

Study Participants	Total Number		Age (Years)	Hb* g/ dL	Serum Iron * µl/ dL	TIBC* µl/ dL	Serum Ferritin* ng/ml	Transferrin Saturation * %
Control	100	Mean	28.5	14.1	83.1	344.8	59.2	28.1
		SD	9.7	1.5	23.9	36.2	45.0	10.4
Brahmin	100	Mean	32.9	13.8	85	320.9**	78.9**	27.4
		SD	11.3	1.6	24.1	32.5	59.5	10.4
Jain	100	Mean	33.8	12.8***	68.9***	359.8***	58.5	19.6
		SD	8.6	1.65	17.6	26.2	42.8	6.8
Muslim	100	Mean	33.6	14.2	90.8	312****	92.5****	30.2
		SD	11.2	1.6	21.9	407	72.9	10.4

df = Degrees of freedom

\*ANOVA test revealed significant F values for all laboratory parameters ( $p < 0.01$   $df_1 = 396$ ;  $df_2 3$ ).

\*\*Pair “t” test reveals significant reduction in TIBC and increase ferritin compared to control ( $p < 0.01$ ) in Brahmin.

\*\*\*Pair “t” test shows significant reduction in Hb, iron and significant increase in TIBC compared to control ( $p < 0.01$ ).

\*\*\*\*Pair “t” test shows significant reduction in TIBC and increase in ferritin in Muslims compared to control ( $p < 0.01$ ).

**Table 4** Mean ± SD values of age and various laboratory parameters in adult females

Study Participants	Total Number		Age (Years)	Hb* g/dL	Serum Iron * µl/dL	TIBC µl/dL	Serum Ferritin* ng/mL	Transferrin Saturation * %
Control	50	Mean	32.3	11.6	65.5	350.1	34	19
		SD	10.7	1.4	9.2	33.5	19.7	4.1
Brahmin	36	Mean	32.9	12.2**.	72.5**	351.8	58**	21
		SD	11.3	1.1	19.8	40.8	22	9
Jain	22	Mean	32.3	11.6	34.3	364.3	38.9	18.2
		SD	10.7	1.4	13.3	28.7	15.6	5.3
Muslim	50	Mean	34.1	12.5***	77.8***	337	51.5***	21.7
		SD	11.3	1.6	19.7	43.5	23.9	9

df = Degrees of freedom

\*ANOVA test revealed significant F value for Hb, serum iron TIBC and serum ferritin at  $Df_1 154$  and  $Df_2 3$  ( $p < 0.01$ )

\*\*Brahmin showed increased levels of Hb, iron and ferritin compared to controls by pair “t” test ( $p < 0.01$ ).

\*\*\*Muslims showed increased levels of Hb, iron and ferritin compared to controls by pair “t” test ( $p < 0.01$ ).

suspected cases of iron deficiency [3, 15]. In the present study all these parameters showed comparable mean values by ANOVA in all four groups studied.

Based on ICMR reports Raman and Sarma [6] have recommended cut off to identify iron deficiency anemia for serum iron as  $\leq 60 \mu\text{g/dL}$ ,  $\text{TIBC} > 380 \mu\text{g/dL}$ , transferrin saturation  $< 15\%$  and serum ferritin  $< 12 \text{ ng/dL}$ . Present study observed the lowest value for iron and transferrin saturation in Jain participants and higher values in Muslim and Brahmins. Thus it is clear that Brahmins consuming vegetarian diet can also maintain their iron profile like Muslims who

are non-vegetarians. Serum transferrin measured on 205 samples of children did not show significant relationship with iron deficiency. TIBC and serum transferrin levels are increased in iron deficiency but decreased in inflammations and infections [16]. In country like India where chronic infections are common these parameters probably have limited value.

Roots and tubers are not very rich source of iron [2]. Hence iron status of Jains should have been like that of Brahmins. Probably frequent fasting habits of Jains are responsible for iron deficiency in them.

**Table 5** Iron deficiency anemia in male participants

Study Participants	Children				Adults				
		Hb < 12 g/dL	Iron < 60 µg/dL	TIBC > 380 µg/dL	Transferrin Saturation ≤ 15 %	Hb < 12 g/dL	Iron < 60 µg/dL	TIBC > 380 µg/dL	Transferrin Saturation ≤ 15 %
Controls	n	16	6	8	1	7	9	12	5
	%	32	12	16	2.0	7.0	9.0	12.0	5.0
Brahmin	n	19	5	7	3	13	10	2	8
	%	45.2	11.9	16.7	7.1	13.0	10.0	2.0	8.0
Jain	n	19	6	13	4	26	34	8	1
	%	41.3	13.0	28.3	8.7	26.0	34.0	8.0	1.0
Muslim	n	8	2	6	0	1	0	5	0
	%	29.6	7.4	25.2	0.0	1.0	0.0	5.0	0.0
Σχ <sup>2</sup> , p 3 df	NS	NS	NS	NS	28.42 <0.01	47.91 <0.01	8.06 <0.05	7.7	>0.05

NS = Non Significant df = Degrees % freedom

**Table 6** Iron deficiency in female participants

Study Participants	Children				Adults				
		Hb < 12 g/dL	Iron < 60 µg/dL	TIBC > 380 µg/dL	Transferrin Saturation ≤ 15 %	Hb < 12 g/dL	Iron < 60 µg/dL	TIBC > 380 µg/dL	Transferrin Saturation ≤ 15 %
Controls	n	3	2	1	1	26	14	6	4
	%	30.0	20.0	10.1	10.0	52.0	28.0	12.0	8.0
Brahmin	n	3	1	1	1	6	10	10	8
	%	30.0	10.0	10.0	10.0	16.7	27.8	27.8	22.2
Jain	n	3	2	2	1	10	8	8	6
	%	30.0	20.0	20.0	10.0	45.5	36.4	36.4	27.2
Muslim	n	3	0	2	0	14	10	8	6
	%	30.0	0.0	20.0	0.0	28.0	20.0	16.0	12.0
Σχ <sup>2</sup> , p 3 df	NS	NS	NS	NS	9.01 <0.01	1.66 >0.1	6.0 >0.1	4.5 >0.1	

NS = Non Significant df = Degrees of freedom

Most of the studies in literature [11, 17] have employed serum ferritin as a marker to detect iron deficiency and <15 ng/mL levels are considered diagnostic. Majority of our participants had serum ferritin values greater than 15ng/mL. Jain community though showed reduced iron concentration, only one male child from this community had ferritin value below 12 ng/mL indicating depletion of iron stores and four male children and two male adults had ferritin levels below 15 ng/mL. Only one control subject, two Muslim children and none of the Brahmin had ferritin value <15 ng/mL. Thus in majority of subjects there was no evidence of depletion of iron stores.

Thus this study has shown that only Jain participants had higher incidence of iron deficiency anemia. Vegetarian diet

consumed by Gujarati Hindu Brahmin community provided them with a sufficient iron to maintain their iron profile like Muslims consuming non-vegetarian diet.

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