ORIGINAL ARTICLE

Iron status of women of reproductive age living in pearl millet consuming areas of Banaskantha, Gujarat

Vanisha S Nambiar[1], Rujuta Desai[2], JJ Dhaduk[3]

Department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayaji Rao University of Baroda, Vadodara – 390002, Gujarat, India

Abstract | Introduction | Methodology | Results | Conclusion | References | Citation | Tables / Figures

Corresponding Author

Address for Correspondence: Rujuta Desai Department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayaji Rao University of Baroda, Vadodara – 390002, Gujarat. India
E Mail ID: rujuta.desai25@gmail.com

Citation

Nambiar VS, Desai R, Dhaduk JJ. Iron status of women of reproductive age living in pearl millet consuming areas of Banaskantha, Gujarat. Indian J Comm Health. 2015;27, Suppl S1

Source of Funding : Nil **Conflict of Interest:** None declared

Article Cycle

Submission: 10/10/2014; **Revision:** 11/12/2014; **Acceptance:** 30/12/2014; **Publication:** 31/01/2015

Abstract

Background: Anemia is a major health problem in India, especially among women and children (NFHS III, 2006). The Indian Council of medical Research study reported the prevalence of anemia among pregnant women was 84.9% and in adolescent girls was 90.1% based on their study from 16 districts of India (Food and Nutrition Bulletin, 2006). Pearl millet (Pennisetum glaucum) (Bajra), grown extensively in the arid and semi-arid tropical regions of the world, is one of the most important cereals for food security and consumed as a staple food for rural and tribal population dwelling in this area. Pearl millet has high amounts of iron (8mg/100g, NIN 2010) along with several other factors such as phytates, oxalates and polyphones, which may decrease the bio available iron. IFPRI (Pray and Nagarjan, 2009) has identified Banaskantha, district in Gujarat as one of the important pearl millet producing belts of India. **Aims and Objectives:** The present study aimed to assess the background information, morbidity profile and dietary intake focusing on the pearl millet consumption of women residing in the pearl millet producing belts of Banaskantha and to assess the status and immunity profile from a subsample of this population.

Key Words

Pearl millet; Gujarat.

Introduction

Anemia is a major health problem in India, especially among women and children (NFHS III, 2006). The Indian Council of medical Research study reported the prevalence of anemia among pregnant women was 84.9% and in adolescent girls was 90.1% based on their study from 16 districts of India (Food and Nutrition Bulletin, 2006).

Pearl millet (Pennisetum glaucum) (Bajra), grown extensively in the arid and semi-arid tropical regions of the world, is one of the most important cereals for food security and consumed as a staple food for rural and tribal population dwelling in this area. Pearl millet has high amounts of iron (8mg/100g, NIN 2010) along with several other factors such as phytates, oxalates and polyphones, which may decrease the bio available iron. IFPRI (Pray and Nagarjan, 2009) has identified Banaskantha, district in Gujarat as one of the important pearl millet producing belts of India.

Aims & Objectives

The present study aimed to assess the background information, morbidity profile and dietary intake focusing on the pearl millet consumption of women residing in the pearl millet producing belts of Banaskantha and to assess the status and immunity profile from a subsample of this population.

Material and Methods

Study area: Banaskantha district of Gujarat State, Western India. Using WHO's 30 cluster sampling approach, 3 rural blocks (Dantiwada, Deesa and Palanpur) of Banaskantha district that produce

maximum pearl millet were selected from which 30 villages were randomly selected (Census data of Banaskantha, 2010, Dept of agriculture report, 2007).

Sample size: The sample size was calculated on the basis of prevalence of iron deficiency as 40 %, level of confidence - 95 %, relative precision - 20 % and design effect of 2. Using formula (Za) 2 Q / (L2) P, and 20% non-response, and considering migration as a concern in this area, 1077 women were studied in the present study. Using the WHO guidelines, a sub-sample of 30% with 10% non-response (n=360) was considered for the bio-chemical analysis in this cross sectional study.

Ethical considerations: The study was cleared in the Medical ethics committee of Department of Foods and Nutrition, The M S University of Baroda. Vadodara, Gujarat. No. FFCSc/FND/ME1 dated 30/9/11.

Data collection: The socio-economic status and morbidity profile of the women was assessed using a pre-tested semi-structured questionnaire; while the dietary intake was assessed using a 24-hour diet recall method. The subjects were asked to recall the food consumed in last 24 hours with details on meal type, time; ingredients used in terms of volume and weight, total amount cooked, left over and amount consumed by the women.

Biochemical estimations: Using simple random sampling technique, every 3rd household was selected for collecting blood from non-pregnant-non-lactating women on basis of their willingness and signed consent. Any woman with ongoing or recent (within previous 1 or 2 weeks) infection was excluded. The blood was collected at anganwadi during morning hours (before noon) with help of Anganwadi and ASHA workers.

To avoid hemolysis portable centrifuges were carried in the field for serum separation within 1 hour of blood collection. Hb was estimated using the Hemocue and plain vaccutainer tubes were used to collect venous blood (10 mL) for the biochemical parameters (CBC, serum α-1-glycoprotein acid, ferritin, STfR and protein C-reactive) analysis.

Sample Storage and transportation: The collected blood samples were placed carefully in tightly fitting slots in trays, surrounded by gel packs in a thermocol box whose bottom and top sections were lined with absorbent material. The samples were transferred through an air-conditioned vehicle with good suspension within 8 hours following blood collection. Every day the collected blood samples were transferred to ASPEE College of Home Science and Nutrition, Sardarkrushinagar, Dantiwada Agricultural University, SK Nagar, Banaskantha. sorted, checked for hemolysis, verified and run through the centrifuge again for additional separation of the serum. All the serum was collected in plain vials and 5 aliquots of 500 mcg each (black labeled eppendorfs) were made using the fixed volume micropipettes. Additional serum was placed in tube number 6. These vials were stacked in trays and kept in a freezer at -80 degree and transferred in dry ice to the laboratory for further analysis. Serum ferritin, serum transferrin receptor, CRP and alpha glycoprotein were analyzed using Roche, HITACHI (Automated clinical chemistry analyzer), at St John's Research Institute's laboratory, Bangalore.

Statistical analysis: Dietary data were analyzed using CS Dietary software donated by Harvest Plus, USA. All statistical analyses were done by using SPSS version 13.0, for Windows (SPPS Inc, Chicago, IL).

Results

Background information, morbidity profile and dietary intake

Of the 1077 women selected for the study, 79.39% were married, 46% were illiterate, 12.16% were landless agricultural laborer, 78% were housewives associated with all household chores including the farm and the domestic animals, 66.95% belonged to backward class while 16.43% belonged to scheduled caste and 12.72% were from general class. Majority of the women (95.26%) followed Hindu religion (Table 1).

Among the enrolled subjects, 372 were non-pregnant non-lactating married women (NPNL), 102 were pregnant, 390 lactating mothers and 213 were adolescents with an average age of 25y (Table 2). Women who had nuclear family formed 58.77 % (n=633). The average the family size of 66.76% (n=718) women was 5-8 members in their households.

Out of the 1077 households surveyed, 83.75% had electricity and 65.83% had access to tap water for drinking, 20% households had toilet facilities in their house and only 24.42% households had a separate kitchen area in their houses, others cooked in the courtyard or sheds outside the huts/house. Firewood was the major source of cooking (81.89%) and only 7% families had LPG or cooking gas for cooking food. Only 24.7% families lived in a decent house with a brick/stone wall and a protected RCC

roof while others lived in small huts (Table 3). The overall income of the households from land cultivations was 25%; Animals such as dairy animals (buffaloes, cows, goats), plough animals (camel, horse) and poultry was were owned in 23.88% households.

Dietary nutrient intake: Cereals including millets are consumed as a staple diet in India (Agte *et al*, 1995) and millets are rich source of trace minerals who interact with other nutrients in vitro affecting the bioavailability (Nambiar *et al*, 2012). Therefore the dietary intake of micro and macro nutrients was assessed among the subjects using the CS Dietary software. The results revealed (Table 4-6) that the mean energy level of the subjects was 1884 Kcal/d, protein 56.8g/d, fat 43/5g/d and total carbohydrate 310g/d.

When segregated based on their physiological status, the mean calorie intake (Figure 1) of the women was maximum for the Lactating mother > NPNL women > Pregnant women > Adolescent girls i.e. 1944.18 > 1912.39> 1825.15> 1743.88 Kcal and same in the case of Protein (57.83> 57.48> 56.43 > 54.02 g) Fat (45.98> 44.79> 39.62> 38.48 g) and Carbohydrate (319.32> 313.65> 304.08> 289.55 g respectively (NIN/ICMR, 2010). Dietary fibre consumption ranged from a minimum of 21.61g in adolescent girls to a maximum of 35.60 g in lactating women. The mean iron vlaues of 1075 women was 27.13mg/d with a range of 23.42 - 29.28 mg/d (NIN, 2003). The mean zinc intake was 10.74mg/d and the mean calcium intake was 595 mg/d with a range of 576.52 - 616.54 mg (Figure 2).

Biochemical profile of the women:

Hemoglobin: The mean Hb levels of the subjects were 9.95 gm% which is only 82.92% of the normal values of 12gm%. Figure 3 shows the frequency distribution of the Hb values. The maximum frequencies of Hb levels were between 10-10.9 gm%. Overall 51.9% women were mildly anemic and 45.56% were moderately anemic. Only 3.16% were severely anemic (Table 7); in tandem with the prevalence as reported by WHO, 2001. As reflected in the dietary intake, iron consumption was adequate but vitamin A was consumed just up to 40% of the RDA which also could be involved in the pathogenesis of anemia (Semba and Bloem, 2002).

Serum Ferritin: The mean value of SF was 25.94±26.96 ng/ml. The present values are closer to the lower normal range of 20ng/ml which represents pre latent iron deficiency. The standard deviation values of 26.96 indicate vast variation in the serum ferritin levels in the women. However 715 women had SF values below 30ng/ml and 44/9% had SF values below 15ng/ml.

Serum Transferrin Receptor: Results of the immunoturbidimetic assay for the in vitro quantitative determination of soluble transferrin receptor from the serum reveal a mean value of 10.54±9.69 mg/L, of these 56.33% had sTfR values below 8mg/L. Since 94.58% women were reported to have their Hb levels below 12 gm%, a high value of STfR (46.67%) denoted enhanced erythropoiesis in women. The elevation of the soluble transferrin receptor may also denote haemolytic anaemia, polycythaemia or thalassemia. The values indicate anemia of chronic disease. Anaemia caused due to chronic pathophysiological conditions leads to the early increase in sTfR values (Beguin, 2003).

C - reactive protein (CRPL3): Anemia of inflammation is commonly observed among patients having of inflammatory diseases, severe infection (sepsis), major trauma, bacterial infections or intrauterine infections (Andrews, 2004). However the results of the immunoturbidimetic assay for the in vitro quantitative determination of CRP from the serum samples of rural women reveal a mean value of 1.71mg/L which is within the normal limit of <5mg/L (Table 7), indicating absence of any such disease. Normal CRP and SF levels with high sTfR levels also indicate that the cause of anemia (94.58%) may not be due to any infections. The reason may be insufficient functional iron availability. This could also be attributed to the functional properties of the pearl millet (Nambiar et al., 2011).

Serum Alpha-1-acid Glycoprotein (AGP): Results of the immunoturbidimetic assay for the in vitro quantitative determination of Alpha-1-acid glycoprotein (AGP) reveal a mean value of 0.83 g/L which is within the normal limits of 0.5-1.2g/L (Table 7). These values of AGP (secretary protein) clearly indicate the absence of acute and recurring inflammation, tumors, cell necrosis and also absence of in vivo hemolysis. Overall normal value of CRP & AGP proves the absence of any kind of infection (tapeworm, hookworm etc) which is very common in a rural setup.

Discussion

As per the WHO (2007) report, our values indicate that the population is iron deficient with SF values of 25.94% and STfR of 10.54% mcg/L. Such a high prevalence of anemia among population consuming

iron rich pearl millet, might have a wide spread negative consequence (Beard, 2001) and therefore sustainable approaches such as biofortification may be recommended (Pray and Nagarjan, 2009). However, the CRP and AGP values indicate that the population does not suffer from any underlying inflammation. Presence of anemia and absence of infection explains the need to understand the basic and in-depth relation of iron with morbidity, mortality and functioning of iron-deficient individuals (Beard, 2001).

Conclusion

Pearl Millet (bajra) is the staple cereal of Bansakantha. Adequate dietary intake of iron among the study population can be attributed to high iron content of bajra; while its rich polyphenol content seems to offer protective effect against infections and chronic degenerative diseases as reflected from the morbidity profile. In spite of high intake of iron, prevalence of anemia has been reported as high as 94.5% which states its non-bio-accessibility. Overall severity of anemia indicated that 45% suffered from moderate anemia and 51.3% from mild anemia with Hb values 10-11.9gm/dl.

Recommendation

Efforts should be thus directed in improving the variety of pearl millet in this regions and its biofortification can be a feasible option. Dietary iron intake and Hemoglobin values for predicting iron deficiency anemia may not be true in all situations. Further in depth studies on relationship between the total dietary iron and total body iron need to be conducted.

Acknowledgement

We are grateful to Dr Erick Boy, CIAT/IFPRI/Harvest Plus, Washington, USA, grant no #8220, for funding; Dr Anura Kurpad and Dr Prashanth, St John's Research Institute, Bangalore and Dr JJ Dhaduk, Sardar Krushinagar Dantiwada Agricultural University, Banaskantha for their support. Medical ethics committee clearance number FFCSc/FND/ME1 dated 30/9/11.

References

1. Agriculture Department of Banaskantha district. Palanpur, Banaskantha, Gujarat, 2007.
2. Agte V V, Gokhale M K, Paknikar K M, Chiplonkar S A. Assessment of pearl millet vs. rice based diets for bioavailability of four trace metals. Plant Foods for Human Nutrition 1995; volume 48, pages 149-158.
3. Andrews NC. Anemia of inflammation: the cytokine-hepcidin link. Journal of Clinical Investigation, 2004, 113:1251–1253.
4. Beard JL. Iron biology in immune function, muscle metabolism and neuronal functioning. Journal of Nutrition 2001. 131:568S–579S.
5. Pray CE and Nagarjan L. Pearl Millet and Sorgum improvement in India. IFPRI Discussion Paper 00919. November 2009
6. Beguin Y. Soluble transferrin receptor for the evaluation of erythropoiesis and iron status. Clinica Chimica Acta. 2003, 329:9–22.
7. Nambiar VS, Sareen N, Daniel M, Gallego EB. Total and individual polyphenols from raw and cooked traditional pearl millet recipes (Pennisetum glaucum) consumed in Banaskantha, India and their health implications. Functional Foods in Health and Disease, 2012, Volume 2, Issue 7 (July 5, 2012)
8. Nambiar VS, Dhaduk JJ, Sareen N, Shahu T and Desai R. Potential functional implications of pearl millet (pennisetum glaucum) in health and disease. Journal of Applied Pharmaceutical Science, 2011. 01 (10); 2011: 62-67
9. NIN. Nutritive value of Indian Foods. Ed Gopalan and Deosthale. National Institute of Nutrition, Hyderabad 2003.
10. NIN/ICMR. Nutrient requirements and recommended dietary allowances for Indians. A report of the expert group of ICMR. National Institute of Nutrition. Hyderabad 2010.
11. Semba RD, Bloem MW. The anemia of vitamin A deficiency: epidemiology and patho-genesis. European Journal of Clinical Nutrition 2002. 56:271–281.
12. WHO. Report of a Technical Consultation on the Assessment of Iron Status of Populations. WHO, Department of Nutrition for Health and Development. Geneva, Switzerland 2007.
13. WHO, UNICEF, UNU. Iron deficiency anemia: assessment, prevention, and control. A guide for programme managers. Geneva, World Health Organization. WHO/NHD/01.3. 2001

Tables

TABLE 1 DETAILS ON THE MARITAL STATUS, EDUCATION AND OCCUPATION OF THE ENROLLED WOMEN

Women characteristics (n=1077)	N	Percentage
Marital Status		
Married	855	79.39
Unmarried	209	19.41
Widowed	12	1.11
Divorced	1	0.09
Highest Level of Schooling		
Illiterate	496	46.05

Preschool and Anganwadi	7	0.65
1st to 8th Standard	429	39.83
9 to 12th standard	106	9.84
College	39	3.62
Occupation		
Landless agriculture labourer	131	12.16
Other labourer	7	0.65
Others (Owner cultivator/ Landlord / Tenant Cultivator)	28	2.4
Artisans	5	0.46
Service	25	2.32
Business/ Own shop	2	0.19
Other / Student	38	3.53
Not Applicable / House wife	840	78

TABLE 2 DISTRIBUTION OF THE WOMEN BASED ON THEIR PHYSIOLOGICAL STATUS

Categories	Total	NPNL	Pregnant	Lactating	Adolescents
N	1077	372	102	390	213
Percentage	100	34.54	9.47	36.21	19.77

TABLE 3 HOUSEHOLD CHARACTERISTICS OF THE ENROLLED WOMEN

Household Characteristics (n=1077)	N	Percentage
Family type		
Nuclear	633	58.77
Extended	273	25.35
Joint	171	15.87
Number of Family members		
1-4 Members	289	26.83
5-8 Members	718	66.67
>8 Members	70	6.50
Household is electrified (%)	902	83.75
Household has latrine (%)	215	19.96
Water source		
Open well	96	8.91
Tube well	229	21.26
Tap	709	65.83
Pond/Tank	26	2.41
Stream/River/Canal	1	0.09
Hand pump	8	0.74
Open well & Tube well	3	0.28
Open well & Tap	2	0.19
Tube well & Tap	3	0.28

TABLE 4 ENERGY INTAKE OF THE ENROLLED WOMEN

		Category			
Nutrients	Total (n=1075)	Pregnant (n=101)	Lactating (n=388)	Adolescent (n=214)	NPNL (n=372)
Energy (Kcal)	1884 ±623.3	1825 ±574.2	1944 ±645.7	1744 ±633.2	1912 ±592.7
Protein (gm)	56.89 ±19.6	56.44 ±19.1	57.83 ±19.9	54.03 ±20.7	57.48 ±18.6
Lipid (gm)	43.51 ±20.0	39.62 ±19.1	45.99 ±19.5	38.49 ±18.4	44.80 ±20.9
Carbohydrate (gm)	310.24 ±107.8	304.08 ±93.3	319.32 ±113.1	289.56 ±114.2	313.7 ±100.2
Fiber (gm)	30.24 ±20.9	28.14 ±20.3	35.60 ±21.6	21.61 ±17.0	29.92 ±20.5

TABLE 5 MINERAL INTAKE OF THE ENROLLED WOMEN

Nutrients	Total (n=1075)	Category			
		Pregnant (n=101)	Lactating (n=388)	Adolescent (n=214)	NPNL (n=372)
Iron (mg)	27.13 ±11.7	26.03 ±9.9	29.28 ±12.4	23.42 ±10.9	27.17 ±11.1
Zinc (mg)	10.74 ±4.3	10.40 ±3.8	11.48±4.7	9.43±4.0	10.76 ±4.1
Calcium (mg)	595.01 ±317.68	606.53 ±350.03	580.70 ±290.64	576.52 ±313.25	616.54 ±337.61

TABLE 6 VITAMIN INTAKE OF THE ENROLLED WOMEN

Nutrients	Total (n=1075)	Category			
		Pregnant (n=101)	Lactating (n=388)	Adolescent (n=214)	NPNL (n=372)
Vitamin C (mg)	23.38±26.6	21.65 ±24.6	22.66±27.5	24.04 ±29.9	23.81 ±23.8
Thiamine (mg)	1.32±0.50	1.33 ±0.48	1.31 ±0.05	1.33 ±0.61	1.34 ±0.45
Riboflavin (mg)	0.98 ±0.37	0.96 ±0.33	1.03 ±o.39	0.90 ±0.35	0.99 ±0.37
Niacin (mg)	11.71 ±4.99	11.83 ±5.04	11.30±4.53	12.12 ±6.23	11.84 ±4.63
Vitamin B6 (mg)	0.01 ±0.03	o.o1 ±0.03	0.00 ±0.02	0.01 ±0.03	0.00 ±0.02
Folate (mcg)	138.19 ±55.07	133.08 ±46.85	143.73 ±56.47	128.94 ±58.08	138.67 ±53.14
Folic Acid (Mcg)	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Food Folate (Mcg)	138.19 ±55.07	133.08 ±46.85	143.73 ±56.57	128.94 ±58.08	138.67 ±53.14
Folate (Mcg) Dfe	138.19 ±55.07	133.08 ±46.85	143.73 ±56.47	128.94 ±0.14	138.67 ±53.14
Vitamin B12 (Mcg)	0.02 ±0.26	0.04 ±0.31	0.01 ±0.15	0.01 ±0.14	0.03 ±0.36
Retinol (Mcg)	242.04 ±138.19	209.78 ±136.13	250.03 ±129.36	226.18 ±142.28	251.57 ±143.98
Beta Carotene (Mcg)	524.58 ±798.33	466.51 ±343.40	563.79 ±549.20	531.03 ±1505.25	493.23 ±453.74

TABLE 7 BIOCHEMICAL VALUES OF THE BLOOD SAMPLES OF ENROLLED WOMEN

Parameters and details of the kits	n	Mean ± SD	Standard values for women	% samples below /above cut-off value(s)		Loss of sample
Hemoglobin (gm %) Hemocue	369	9.95±1.55 (low)	12 gm%	< 12	94.5%	Nil
STfR (mg/L) (Ramco)	360	10.54±9.69 (high)	< 8 mg/l	< 8	56.33%	8
			> 8 mg/L	>8	43.46%	8
SF (ng/ml) (Roche)	363	25.94±26.96 (normal)	13-150ng/mL	<12.0	35.26%	6
				<15.0	44.90%	
				< 30.0	71.07%	
CRP (mg/L) (Roche)	360	1.71±4.45 (normal)	< 5mg/L	≥ 5.0	8.3%	9
AGP (g/L) (Roche)	360	0.83±0.25 (normal)	0.5-1.2g/L	> 1.20	6.6%	9
Zinc (mg/L) AAS	363	0.78±0.15	0.6-1.2 mg/L	-	-	6
Zinc (µg/dl) AAS	363	77.67±15.10	60-120mcg/dl	< 70.0	32.5%	6
				< 66.0	21.7%	
				< 46.0	0.27%	

TABLE 8 SEVERITY OF ANEMIA AMONG THE ENROLLED WOMEN

Parameters		Total women N=369	NPNL	Lactating	Adolescent
			% (n)	% (n)	% (n)
Anemic		94.58 (349)	31.98 (118)	39.84 (147)	22.76 (84)
Severity of Anemia	Severe anemic	3.16 (11)	0.54 (2)	1.36 (5)	1.08 (4)
	Moderate anemic	45.56 (159)	14.36 (53)	18.70 (69)	10.03 (37)
	Mild anemic	51.29 (179)	17.07 (63)	19.78 (73)	11.65 (43)
Normal		5.42 (20)	1.08 (4)	2.71 (10)	1.63 (6)

Values in parenthesis represent the total number of women (n)

Figures

FIGURE 1 COMPARISON OF MACRONUTRIENTS WITH THE RDA FOR ALL THE ENROLLED WOMEN

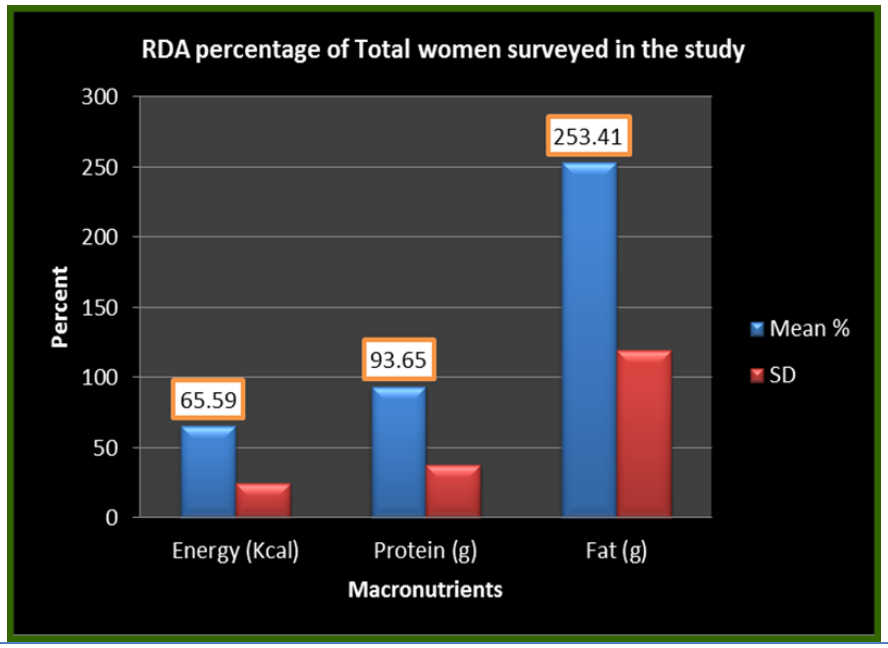

FIGURE 2 COMPARISON OF MICRO NUTRIENTS WITH THE RDA FOR ALL ENROLLED WOMEN

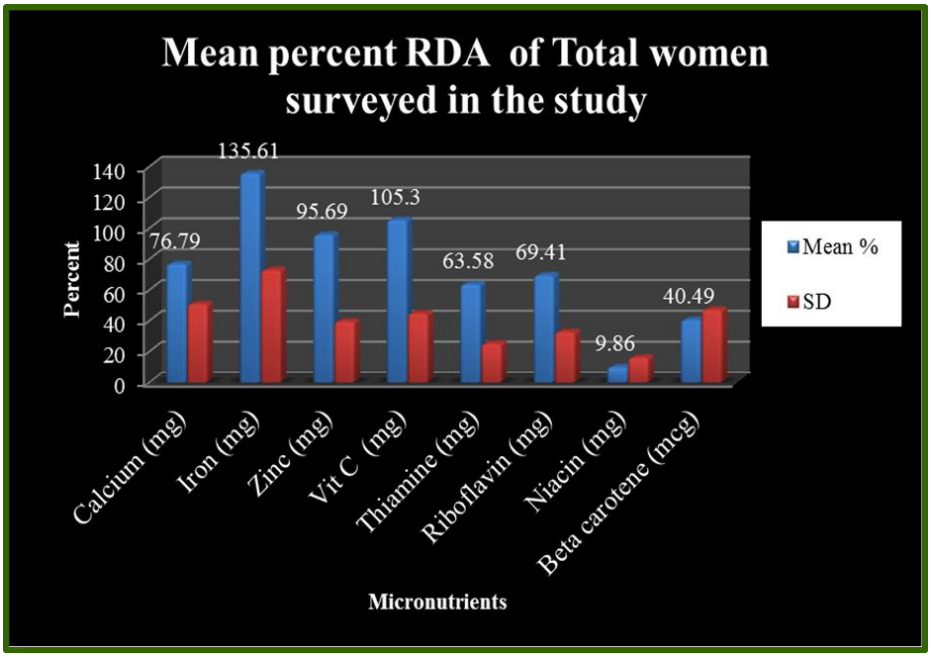

FIGURE 3 FREQUENCY OF HB LEVEL AMONG THE ENROLLED WOMEN