Original article

Iron Deficiency Anaemia among Women of Reproductive Age in Nine Administrative Regions of Ethiopia

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Abstract

Background: Iron deficiency anaemia (IDA) is one of the most common causes of nutritional problem, and is of great public health significance affecting children, adolescents and women of reproductive age world wide. The magnitude of IDA in the general population of Ethiopia has not yet been well documented.

Objective: To estimate the magnitude of IDA among women of reproductive age in nine administrative regions.

Methods: A cross-sectional study of analytical nature was conducted in 270 clustered villages drawn from 9 administrative regions of the country between June and July 2005. A total of 22,861 women of reproductive age (15-49 years) were examined clinically for pallor and 5% of these subjects were systematically selected and assessed further for their haemoglobin (Hgb) and serum ferritin (SF) status.

Results: The prevalence rate of clinical anaemia, anaemia, ID (iron deficiency) and IDA were 11.3%, 30.4%, 49.7% and 17.0% respectively. The majority of anaemic women were in the category of mild (19.3%) to moderate (10.3%) and severe anaemia was 0.9%. A significantly higher proportion of clinical anaemia [26.7% (95% CI: 24 to 28%)], anaemia (Hgb) [79.4% (95% CI: 72 to 86%)], ID [65.1% (95% CI: 72 to 86%)] and IDA [58.0% (95% CI: 55 to 76%)] was observed in Afar signifying distinct regional variation. The most affected age groups were those between 36-49 years and the difference noted was statistically significant.

Conclusion: This study substantiates the existence of mild to moderate form of IDA among women of reproductive age and underlines the need for iron supplementation to all reproductive women during the antenatal period with more attention to the most affected regions. [*Ethiop.J.Health Dev.* 2008;22(3):252-258]

Introduction

Iron Deficiency Anaemia (IDA) is one of the most common nutritional disorders and it has public health importance in developing countries like Ethiopia (1). It is the most common cause of nutritional anaemia in adolescents and women of reproductive age (2). About 2 billion people are iron deficient, with half of them manifesting clinical signs of anaemia (3, 4). The economic and social consequences of iron deficiency anaemia, as yet un-quantified, are thought to be enormous including a significant drain on health care, education resources and labour productivity, and reduced physical and mental capacity of large segments of the population (5-6).

Although the most important determinant factor of iron deficiency anaemia is poor bioavailability of dietary iron in most developing countries, intestinal parasites, especially hookworm infestation are reported to be a major cause - other causes include malaria and congenital haemolytic diseases (6-7).

The aetiology of anaemia in Ethiopia is not well established and the information available is limited in representativeness of the whole country. Various researchers came up with different conclusions despite the problem being among the ten top morbidities reported by most health institutions in the country (8). Some studies in the past have documented the problem as being rare in Ethiopia attributed to consumption of "*teff*" a cereal which has high iron content mainly due to contamination with the soil (9-12) while others have concluded the issue as is a mild to moderate public health problem (13-18).

Although the magnitude of IDA in Ethiopia has not yet been well documented nationwide, limited data is available on the prevalence rate of IDA among pregnant and lactating women in the rural communities, which showed a prevalence rate of 18.7% (14). In a more recent study conducted in urban slum communities of Addis Ababa administrative region, a prevalence rate of 22.3% was reported in lactating women suggesting that iron deficiency anaemia is of moderate public health problem in the country which is in conformity with one of the earlier study reported by Hofvander (15-16).

Because Ethiopia has a wide range of agro-climatic conditions, a wide variety of cereals, root crops and enset (E*nset ventricosum*) are grown - some of these yields consumed are not fully exploited by the general population. There seems to be dependency on a single crop, resulting in shortage of minerals and vitamins implying that the bioavailability of much of the iron in the average Ethiopian diet is restricted, presumably affecting the iron status of the community (14).

In view of the discrepancies and non-conclusive results available in the country, we studied the magnitude of clinical anaemia, anaemia, iron deficiency and iron deficiency anaemia among women of reproductive age in nine administrative regions of the country.

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Methods

A total of 270 clustered villages from the 9 administrative regions namely Tigray, Afar, Amhara, Oromiya, South Nation and Nationalities People (SNNP), Benishangul-Gumuz, Harari, Diredawa and Addis Ababa (excluding Gambella and Somali regions for security reasons) representing different food staple diets in proportion to their size of population (PPS) were selected during June/July 2005 using multi-stage cluster-sampling approach.

The sample size estimated for a vitamin A survey assessment was used but the respective mothers/guardians of children were enrolled. The calculation was based on the assumption of 1% prevalence rate of Bitot's spot with 95% confidence level, worst acceptable 0.5% and clustering effect of 2 (3000 for each region and a total of 27000 for the nine regions). In each clustered village, one site was randomly selected and about 100 women aged between 15 and 49 years living in the selected site or a total of 27,000 subjects were enrolled for clinical anaemia examination while 5% of these subjects were systematically selected and assessed for haemoglobin (n=1135) and serum ferritin (n=935) status.

Ethical approval

The study was approved by the Research and Ethical Clearance Committee (RECC) of the Ethiopian Health and Nutrition Research Institute (EHNRI) and informed written consent was obtained from each subject for their participation after the nature of the study was fully explained to them in their local languages by thumbprint or signature in the consent form.

Prior to the survey a five-day intensive training on the objective and method of assessement was given to all health workers drawn from the respective regions at Adama town, and the method of assessment standardized by senior researchers from EHNRI. To maintain data quality, trained supervisors from EHNRI checked the questionnaires for incomplete and doubtful responses in the field.

Clinical anaemia or pallor was considered in this study when there was any degree of paleness of conjunctiva, palm or nail beds and normal otherwise.

Haemoglobin concentration was measured from capillary blood using a portable haemoglobin meter (HemoCue AB, Ängelholm, Sweden). The calibration of the HemoCues was checked daily using control microcuvettes provided by the manufacturer. Anaemia was then defined as Hgb < 11 g/dl in pregnant women and < 12 gm/dl for non-pregnant women (19-20). Adjustment was made for pregnancy and altitude in the field and then converted into the international cut-off recommended by International Nutritional Anaemia Consultative Group (INACG). Severe, moderate, and mild anaemia were defined as Hgb below 7gm/dl, 7-9.9 gm/dl and 9.9-11.9 gm/dl respectively. The threshold criteria used to determine the severity of anaemia as a mild, moderate or severe public health problem was considered when prevalence rate of severe anaemia was 0.1-0.9%, 1-9% and >10% respectively (21).

Venous blood was collected aseptically from the antecubital vein and was alliquoted into tubes without anticoagulants by senior laboratory technicians. Serum was separated and stored frozen at -20 ^{0}C and transported to the EHNRI for later determination. Serum ferritin, which reflects body iron stores, was analysed using an enzyme-linked immunosorbent assay (ELISA) with a fully automated Elecsys 1020 using commercial kits purchased from Boerrhinger Maneheim, Germany at EHNRI. Quality control material purchased from Roche Company was used to ascertain the quality of the tests. Controls for the various concentration ranges were run as single determinations at least once every 24 hours when the test was in use, once per repeated kit, and after every calibration. Values obtained fell within the defined limits. To balance the effect of infection, which could lead to mild elevation of the level of ferritin,a high ferritin cut-off point as recommended by WHO for developing countries was taken. Severe and moderate iron deficiency was considered when SF was < 12 and < 50 μg /L as recommended by WHO (19-20).

Stool samples were collected and examined for ova and parasites microscopically as described by Marita (22). A blood film was also prepared and checked for haemoparasites using Wright's stain (23). At the end of biological sample collections, all the subjects found positive for intestinal and hemo-parasites were treated (results are not shown) free at the expense of the project at the site of the study.

Data were cleaned, entered and analysed using Statistical Package for Social Science (SPSS) version 12. Descriptive statistics were used to show the prevalence rate of socio-demographic characteristics. Cross tabulations were used to see the difference across the regions and associations of different variables. Ninety five percent confidence intervals were computed to assess the presence and degree of association between variables. A p-value of less than 0.05 denoted significance in differences.

Results

Of the 27,000 subjects enrolled, only 22,861 completed the study giving an 89.7% response rate for clinical examination while for biological samples only 1058 women (81.4% response rate) had complete data, therefore the analysis was based on these figures. The overall proportion of women with pallor was 11.3% with wide variations among regions ranging from 3.3 – 26.7%. The highest proportion of pallor was observed in Afar with 26.7% (95% CI:24 to 28%) followed by SNNP (14.4%); Oromiya (13.0%); Benishangul – Gumuz (11.5%;) Dire-Dawa (10.3%); Tigray (9.8%); Amhara (7.2%); Addis Ababa (7.4%) and the least in Harari (3.3%) regions (Table 1).

Table 2 shows the distribution of anaemia and its severity as determined by haemoglobin. As shown, the mean haemoglobin was 12.9 gm/dl ranging from 6 to 22.0 gm/dl with a weighted regional prevalence rate of anaemia of 30.4%. The highest prevalence rate was seen in Afar with 79.4% (95% CI: 72- 86%) followed by Dire-Dawa with 55.7 % (95% CI: 46 – 64%), Oromiya (32.3%), Amhara (31.2%), Tigray (25.8%) and SNNP (25.0%) regions. The prevalence rates are relatively lower in Benishangul-Gumuz (10.5%) and Addis Ababa (7.5%) regions. When the level of anaemia is disaggregated by severity, the majority of anaemic cases were of mild to moderate degree in all the regions with the exception of Afar region where nine severe cases were found and referred to the near health institutions.

Table 1: **Distribution of pallor by regions, Ethiopia, 2005**

Region	N	Pallor	95% CI
Afar	2326	621 (26.7)	24-28%
Tigray	2866	280 (9.8)	8-10%
Amhara	2697	194 (7.2)	6-8%
Addis Ababa	2476	184 (7.4)	6-9%
Oromiya	2496	325 (13.0)	11-14%
SNNP	2428	350 (14.4)	13-16%
B-Gumuz	2641	303 (11.5)	10-12%
Harari	25-2	82 (3.3)	1-4%
Dire-Dawa	2429	249 (10.3)	9-11%
All regions	22861	2588 (11.3)	10-11%

B-Gumuz=Benishengul Gumuz, values in bracket are percentages

Table 2: **Levels of Haemoglobin and its severity by region, Ethiopia, 2005**

Region	N	Haemoglobin level (g/dl)				95 % CI
		<12 (Anaemia)	11.9-10 (Mild)	9.9-7 (Moderate)	< 7 (Severe)	
Afar	126	100 (79.4)	34 (27.0)	57(45.2)	9 (7.1)	72 – 86%
Tigray	120	31 (25.8)	22 (18.3)	9 (7.5)	-	18 – 33%
Amhara	93	29 (31.2)	26 (28.0)	3 (3.2)	-	22 – 41%
Addis Ababa	133	10 (7.5)	10 (7.5)	-	-	03 – 13%
Oromiya	127	41 (32.3)	36 (28.3)	5 (3.9)	-	24 – 40%
SNNP	148	37 (25.0)	30 (20.3)	7 (4.7)	-	18 – 32%
B-Gumuz	133	14 (10.5)	10 (7.5)	4 (3.0)	-	05 – 15%
Harari	140	19 (13.6)	15 (10.7)	4 (2.9)	-	07 – 19%
Dire-Dawa	115	64 (55.7)	36 (31.3)	28 (24.3)	-	46 – 64%
All regions	1135	345 (30.4)	219 (19.3)	117 (10.3)	9 (0.9)	27 – 33%

B-Gumuz=Benishengul Gumuz; values in bracket are percentages, Mean±SD= 12.9±2.1

The distribution of serum ferritin levels by region is presented in Table 3. The mean SF level was 58ng/ml ranging from 0.70 to 244.0 ng/ml. The overall prevalence rate of iron deficiency determined by serum ferritin was 49.7%. The highest prevalence rate was observed in Afar with 65.1% (95% CI: 72 - 86%) followed by Dire-Dawa (63.9%), Harari (61.8%), Oromiya (55.0%), Tigray (44.2%), SNNP (42.5%) and Amhara (37.5%) regions in descending order. About 9.6% of the women exhibited the severe form of ID (SF<12ng/ml) while 40% were moderately iron deficient (12-49ng/ml). The majority of iron deficient cases fell into the category of moderate deficiency.

Table 4 displays the prevalence rate of iron deficiency anaemia determined by the cut-off points of haemoglobin for anaemia and serum ferritin for iron deficiency as described in the preceding sections. The overall prevalence rate of IDA was 17.0% with marked regional variations. As expected, the highest prevalence rate was seen in Afar with 58.0% (95% CI:55 - 60%) followed by Dire-Dawa, Oromiya and SNNP regions in decreasing order.

Figure 1 shows the distribution of pallor (clinical anaemia), anaemia (low Hgb), iron deficiency (low SF) and iron deficiency anaemia (Hgb and SF) by aggregated age groups into three risk age categories. The most affected group was that between 36-49 years followed by 15-24 and 25-34, and the differences however, was statistically significant for pallor and IDA only (P=0.05).

Table 3: **Serum ferritin levels and severity by region, Ethiopia, 2005**

Region	N	Serum ferritin levels (ng/ml)			95 % CI
		<50 (Iron deficiency)	49-12 (Moderate)	<12 (Severe)	
Afar	81	53 (65.1)	34 (42.5)	18 (22.5)	72 – 86%
Tigray	120	53 (44.2)	50 (41.7)	3 (2.5)	18 – 33%
Amhara	56	21 (37.5)	20 (35.7)	1 (1.8)	22 – 41%
Addis Ababa	121	51 (42.1)	46 (38.0)	5 (4.1)	3 – 13%
Oromiya	91	50 (55.0)	42 (46.2)	8 (8.8)	24 – 40%
SNNP	113	48 (42.5)	45 (39.8)	3 (2.7)	18 – 32%
B-Gumuz	112	38 (34.0)	35 (31.3)	3 (2.7)	5 – 15%
Harari	131	81 (61.8)	49 937.4)	32 (24.4)	7 – 19%
Dire-Dawa	111	71 (63.9)	54 (48.6)	17 (15.3)	46 – 64%
All regions	936	466 (49.7)	375 (40.1)	90 (9.6)	27 – 33%

B-Gumuz=Benishengul Gumuz; values in bracket are percentages
Mean ±SD= 58.3±41.1

Table 4: **Distribution of iron deficiency anaemia by region, Ethiopia, 2005**

Region	N	Iron Deficiency Anaemia	95% CI
Afar	81	47 (58.0)	55 – 76%
Tigray	120	10 (8.3)	36 – 53%
Amhara	56	5 (8.9)	24 – 51%
Addis Ababa	121	8 (6.6)	35 – 52%
Oromiya	91	14 (15.4)	44 – 65%
SNNP	113	14 (12.4)	34 – 52%
B-Gumuz	112	5 (4.5)	34 – 52%
Harari	131	13 (9.9)	55 – 71%
Dire-Dawa	111	43 (38.7)	55 – 72%
All regions	936	159 (17.0)	47 – 53%

B-Gumuz=Benishengul Gumuz; Values in bracket are percentages

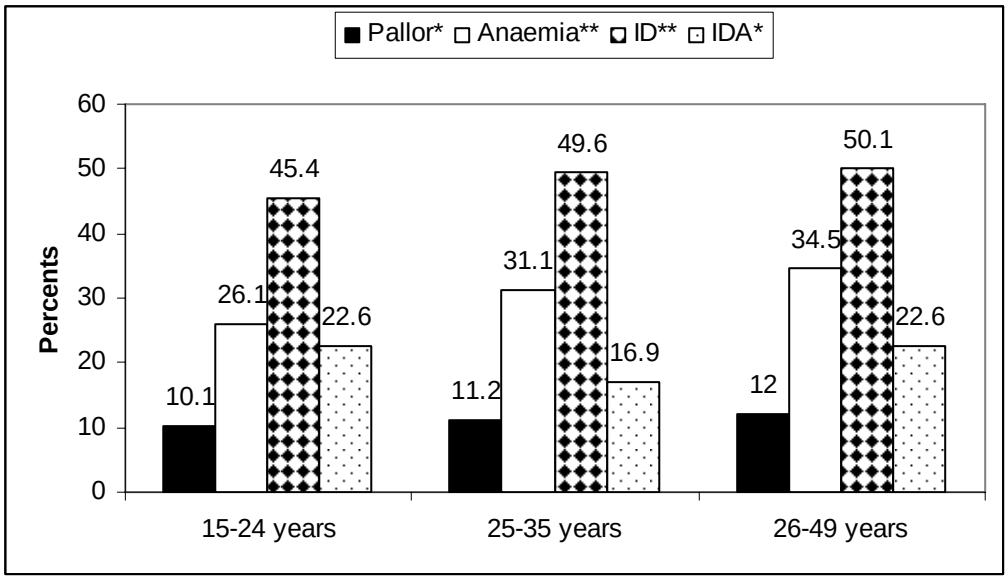

Figure 1: **Distribution of pallor, anaemia, iron deficiency and iron deficiency anaemia by age, Ethiopia, 2005**

**Chi-squared value=5.85; p=0.05 *Not significant

Discussion

This is the first nationwide survey of IDA carried out among women of reproductive age in Ethiopia. The study shows that mild to moderate anaemia (30.4%), iron deficiency (49.7%) and iron deficiency anaemia (17%) are common while severe anaemia is rare (0.9%) with distinct regional variations. Furthermore, the study revealed the predominant age groups affected to be 15 - 24 and >35years.

Anaemia remains a widespread public health problem with major health, social and economic consequences and is often used as a screening test for iron deficiency. Estimation of anaemia and iron deficiency may be made clinically and biochemically and the most common clinical indicator is pallor detection while biochemical indicators /haematological parameters include measurements of haemoglobin or haematocret and serum ferritin concentrations. Pallor examination is a simple and useful indicator particularly among women of reproductive age and preschoolers in whom severe anaemia is most prevalent and in countries where resource is scarce. However, it is insensitive in detecting mild to moderate anaemia and thus measurement of Hgb is essential and a commonly used yardstick for indicating the prevalence rate of anaemia especially in a large community study. This insensitivity was clearly observed in the present study where nearly 50% of the cases unnoticed by pallor were detected by haemoglobin measurement. Nonetheless, when compared with earlier results among children in the former Shoa Region, clinical anaemia detected in the present study is lower probably due to the differences in the study subjects (9) assessed in the former study.

When pallor was compared with the haemoglobin result, almost 2 times more anaemic cases were detected suggesting that haemoglobin reflects the picture of anaemia better than pallor. The higher prevalence rate of anaemia seen in Afar region was in conformity with previously reported finding in the pastoralists (14) and this may be attributed to the type of staple foods consumed such as corn and milk or sorghum and milk which are low in iron content, but rich in phytate which inhibits the bioavailability of iron resulting in poor iron absorption. However, when compared with the most recent 2006 Ethiopian Demographic and Health Survey (EDHS) report of 27% prevalence of anaemia (24), the current study revealed a slightly higher rate probably due to relatively smaller sample size even though the trend is similar. Nonetheless, the overall prevalence rate of 30.4% of anaemia observed in the present study signifies moderate public health problem (with the exception of Afar and Dire-Dawa) deserving of an anaemia control strategy.

Severe anaemia as determined by Hgb was rare in all the regions except in Afar and the severity was of mild type when the WHO classification is considered (21). A cross-sectional analytic study conducted in about the same period (2005) among pregnant women in Jimma University Hospital, Jimma town, south-western Ethiopia showed higher (38.2%) prevalence rate of anaemia than the present study further indicates the problem of anaemia is of moderate public health problem when the cut off point set by WHO is considered (25). A slightly different picture suggesting the existence of a severe problem among pregnant women was reported in 1991 by the same university (41.9%) suggesting the cause of anaemia to be nutritional in origin (26) - such a high rate appears to be due to the enrolment of the most vulnerable groups, the pregnant women, as opposed to the current study where all women were enrolled irrespective of their physiological status.

When serum ferritin (SF) was taken into consideration, the prevalence rate was 3 times higher than pallor and nearly 2 times more than haemoglobin results. This happens because haemoglobin could remain within normal range even with a fall in ferritin until the latter is almost depleted indicating that SF is a reliable and sensitive parameter for the assessment of iron status in infection free conditions. As expected, Afar and Dire-Dawa were found to be the most affected although iron deficiency was high in most of the regions, still falling into the category of moderate deficiency.

Although, the prevalence rate of iron deficiency anaemia in the present study (determined by the cut-off points of haemoglobin for anaemia and serum ferritin cut-of points for iron deficiency) of 17.0% is slightly lower than the previously reported figure for lactating and pregnant pastoral women the magnitude is still similar when the staple diet is considered. Such differences are probably attributed to the diet pattern among pastoralists, whose staple food consists of cereals and milk that have inhibitory effect on iron absorption. Furthermore, the high prevalence rates of greater than 40% found in Afar and Dire-Dawa suggests the problem to be dietary as evidenced from various study sources (14, 27).

In the present study, the age group between 36-49 years were found to be the most affected by anaemia, iron deficiency and iron deficiency anaemia. This could be probably explained by cumulative obstetric conditions and pregnancy related exhaustion, including maternal workload - deserves further consideration of the line ministry for various components of control strategy; and calls for an immediate attention by the decision makers during health resource allocation. Secondly, where morbidity and mortality remain the primary outcome of concern, knowledge of the links of anaemia to heightened mortality risk must be internalised by planners. Furthermore, much of the research conducted in Ethiopia on the nature and health consequences of iron deficiency anaemia must be fully communicated and acted upon by policy makers and stakeholders particularly where the problem is highly prevalent.

In conclusion, this is the first nationwide survey of IDA carried out among women of reproductive age in Ethiopia showing that mild to moderate form of anaemia (30.4%), iron deficiency (49.7%) and iron deficiency anaemia (17%) are common while severe form of anaemia is rare (0.9%) with distinct regional variation. Although dietary data are not available, non-heme iron source from their staple diet, heavy menstrual blood loss and parity levels may account for such an effect and thus calls for iron supplementation to all reproductive women during the antenatal period with more attention to the most affected regions.

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References

1. ACC/SCN (1991) Statement on Iron Deficiency Control. June 1990, Dublin.
2. WHO. Nutritional anaemia's. WHO technical report series No. 405. Geneva: WHO, 1968.
3. WHO. Nutritional anaemia's. WHO technical report series No. 503. Geneva: WHO, 1972.
4. Demayer E, Adiels TM. The prevalence of anaemia in the world. World Health Stat. Q. 1985;38:302-16.
5. Viteri FE. Iron supplementation for the control of iron deficiency in population on risk. Nutr. Rev. 1997;55:165-209.
6. Fairbanks VF. Iron in medicine and nutrition. In: Shils ME, Olson JA, Shike M, eds. Modern nutrition in health and disease. 8th ed. Philadelphia, pa, USA: Lea & Febiger, 1994:185-213.
7. Yip R, Dallman PR. Iron. In: Ziegler EE, Filer LJ ,eds. Present knowledge of nutrition. 7th ed. Washington, DC: International Life Sciences Institute Press, 1996:277-92.
8. Ministry of Health, Planning and Programming Department. Health and Health Related Indicators. FMoH 1999. Addis Ababa, Ethiopia.
9. WoldeGabriel Z, West CE, Gebru H, et al. Inter-relationship between Vitamin A, iodine, and iron status in school children in Shoa Region, Central Ethiopia. Br. J. Nutr. 1993;70:593-607.
10. Gebremedihin M. Rarity of anaemia of pregnancy in Ethiopia. Scand. J. Haematol. 1976;16:168-175.
11. Gunnar Almgard. High content of iron in teff, Eragrostis Abysinia Link; and some other crop species from Ethiopia. Result of contamination. Ann. Afric. Coll. Sweden. 1963;29:215-220.
12. Gebre-Medhin M, Birgegård G. Serum ferritin in Ethiopian mothers and their newborn infants. Relation to iron intake and socio-economic conditions. Scand. J. Haematol. 1981; 27(4): 247-52.
13. Hofvander, Y. Haematological investigation in Ethiopia, with special references to a high Iron intake. Acta. Med. Scand. 1969;184:1-74.
14. Haidar J, Nekatibeb H, Urga K. Iron deficiency anaemia in pregnant and lactating mothers in rural Ethiopia. East Afri. Med. J. 1999;76(11):618-622.
15. Haidar J, Nelson M, Abiud M, Ayana G. Malnutrition and Iron Deficiency Anaemia in Urban Slum Communities form Addis Ababa, Ethiopia. East Afri Med J. 2003;80(4):191-94.
16. Haidar J, Nelson M, Abiud M, Ayana G. Daily Versus Weekly Iron Supplementation and Prevention of Iron Deficiency Anaemia In Lactating Women. East Afri. Med. J. 2003;80(1):11-16.
17. Adish AA, Esrey SA, Gyorkos TW, Johns T. Risk factors for iron deficiency anaemia in preschool children in northern Ethiopia. Public Health Nutr. 1999;2(3):243-52.
18. Zein A. Zein. The prevalence of anaemia among populations living at different altitudes in Northwestern Ethiopia. Ethiop. Med. J. 1987;25(3):105-11.
19. International nutritional anaemia consultative group (INACG). Iron deficiency in infants and child hood. New York, Nutrition Foundation, 1979.
20. International nutritional anaemia consultative group (INACG). Measurements of iron status. New York, Nutrition Foundation, 1985.
21. WHO. Guidelines for the control of iron deficiency in countries of the eastern Mediterranean, Middle East and North Africa. A report based on a joint WHO/UNICEF consultation on strategies for the control of iron deficiency Anaemia. Document WHO-EM/NUT/177, /G/11.96. WHO, Geneva.
22. Kruger M, Badenhorst CJ, Mansvelt EPG, Laubscher JA, Spinnler Benade AJ. Effects of iron fortification in a school feeding scheme and antihelminthic therapy on the iron status & growth of 6 to 8 year old school children. Food & Nutrition Bulletin. 1996;17:11-21.
23. Cheesebrough M. Medical laboratory manual for tropical countries. First edition, volume 1, Stephen Austin and son Ltd, Hertford; 141-142.
24. Ethiopian Demographic and Health Survey 2005, Central Statistics Agency, Addis Ababa, Ethiopia 2006.

25. Belachew T, Legesse Y. Risk factors for anaemia among pregnant women attending antenatal clinic at Jimma University Hospital, Southwest Ethiopia, Ethiop. Med. J. 2006;44(3):211-20.
26. Desalegn S. Prevalence of anaemia in pregnancy in Jimma town, South-western Ethiopia. Ethiop. Med. J. 1993;31(4):251-8.
27. Zein ZA. Haematocrit levels and anaemia in Ethiopian children. East. Afr. Med. J. 1991;68(6):412-19.