PN-HBI-243

MotherCare™

THE PREVALENCE OF ANEMIA IN DEVELOPING COUNTRIES, 1979-1989 AN ANNOTATED BIBLIOGRAPHY

WORKING PAPER: 7A

February 1991

John Snow, Inc., 1616 N. Fort Myer Drive, 11th Floor, Arlington, Virginia 22209 USA
Tel: (703) 528-7474 Fax: (703) 528-7480 Tlx: 272896 JSI WUR

THE PREVALENCE OF ANEMIA IN DEVELOPING COUNTRIES, 1979, 1989
AN ANNOTATED BIBLIOGRAPHY

WORKING PAPER: 7A

February 1991

Elizabeth A. Jordan, MotherCare Technical Assistant
Nancy L. Sloan, Senior Researcher, MotherCare Project

MotherCare Project
1616 N. Fort Myer Dr., 11th Floor
Arlington, VA. 22209

Report Prepared For
The Agency for International Development
Contract #DPE-5966-Z-00-8083-00
Project #936-5966

TABLE OF CONTENTS

PREGNANT WOMEN

AFRICA 3
- Northern Africa 3
- Western Africa 3
- Eastern Africa 6
- Southern Africa 8

LATIN AMERICA AND THE CARIBBEAN 9
- Caribbean 9
- Tropical South America 10

ASIA 12
- Middle South Asia 12
- East Asia 13
- Oceania 14

NORTHERN AMERICA AND EUROPE 14
- Northern America 14
- Northern Europe 15
- Western Europe 16

NON-PREGNANT WOMEN

AFRICA 17
- Northern Africa 17
- Western Africa 17
- Middle Africa 20
- Southern Africa 20

ASIA 21
- Middle South Asia 21
- Eastern South Asia 23
- East Asia 24
- Oceania 24

LATIN AMERICA AND THE CARIBBEAN 25
- Caribbean 25
- Tropical South America 25

NORTHERN AMERICA AND EUROPE 26
- Northern America 26
- Northern Europe 27

AUTOPSY STUDIES 28

REFERENCES 29

LIST OF ACRONYMS

Hb	Hemoglobin
Hct	Hematocrit
PCV	Packed Cell Volume
TS	Transferrin Saturation
FEP	Free Erthrocyte Protoporphyrin
TIBC	Total Iron Binding Capacity
MCV	Nean Corpuscular Volume
EPP	Erythorcyte Protoporphyrin
RBC	Red Blook Cell
MCHC	Mean Corpuscular Hemoglobin Concentration

THE PREVALENCE OF ANEMIA IN DEVELOPING COUNTRIES, 1979-1989
AN ANNOTATED BIBLIOGRAPHY

Elizabeth A. Jordan, Nancy L. Sloan

This report is an annotated bibliography of articles on maternal anemia in refereed journals or in national or regional reports with country specific data published between 1979 and 1989. The following abstracts are presented in two sections, one referring to studies of pregnant women, and the second referring to studies of non-pregnant reproductive age women. Tables 1 and 2 below provide criteria defining iron and folate deficiency for these population groups.

TABLE 1
INDICES FOR THE DIAGNOSIS OF IRON DEFICIENCY

MEASURE	IRON DEFICIENCY	
	PREGNANT WOMEN[1]	NON-PREGNANT WOMEN[2]
Serum Iron	<50 µg/dl	<60 µg/dl
Transferrin Iron Binding Capacity (TIBC)	>360 µg/dl	>400 µg/dl
Percent Transferrin Saturation	<15%	<16%
Free Erythrocyte Protoporphyrin	>70 µg/dl RBC	>70 µ/dl RBC
Serum Ferritin	<12 µg/L	<12 µg/L

TABLE 2
INDICES FOR THE DIAGNOSIS OF FOLATE DEFICIENCY

MEASURE	FOLATE DEFICIENCY	
	PREGNANT WOMEN	NON-PREGNANT WOMAN
Red blood cell folate	<160 µg/L	<160 µg/L
Serum or plasma folate	3 µg/L	3 µg/L

---

[1] Baker SJ, DeMaeyer EM; Nutritional Anemia: Its Understanding and Control with Special Reference to the World Health Organization. AJCN 1979, 32:368-417.

[2] International Nutritional Anemia Consultative Group; Measurement of Iron Status. Washington, D.C.: Nutrition Foundation Inc. 1985. 77 pages.

PREGNANT WOMEN

AFRICA

Northern Africa

1. Toppozada HK, Ghoneim SM; "A Hematologic Study of Pregnant Women in Free and Insurance Hospital Populations." Int J. Gynaecol Obstet 1983, 21:439-42.

This clinic/hospital-based study was conducted in Alexandria, Egypt (dates of the survey were not reported). Data on 631 pregnant women from the Medical Insurance Pregnancy Centre in Alexandria (n insured = 320) and from free (public) government hospitals (n uninsured = 311) was collected. The study only included healthy pregnant women; women with pre-eclampsia, diabetes, hemorrhage, and multiple gestation (twins) were excluded. Blood samples were collected on women cross-sectionally, between 28 and 40 weeks gestation.

Sixty-two percent of insured women were anemic (<11.0 g/dl) with a mean hemoglobin levels of 10.85±0.4 g/dl. Ninety-five percent of uninsured women were anemic and had a mean hemoglobin level of 10.3±0.4. There were no differences between the groups (insured and uninsured) ages (27.6±1.1 vs. 27.5±1.8 years). Differences in parity, 0.5 vs. 2.3, however, were observed in the insured and uninsured respectively. Differences between mean gestation at hemoglobin sample were not reported.

2. WHO; "Report of the African Regional Consultation on Control of Anaemia in Pregnancy." **WHO Afr/MCH/86** 1986:4.

A sample of 222 pregnant women were measured for hemoglobin status in Algeria in 1987. Further details regarding the sample were not supplied. Of these, 41.9% were anemic (Hb <11.0 g/dl).

Western Africa

3. Hercberg S, Galan P, Chauliac M, et. al.; "Nutritional Anemia in Pregnant Beninese Women: Consequences on the Haematological Profile of the Newborn." Br J Nutr 1987, 57:185-93.

This study was a random sample of 126 pregnant women in the initial stages of labor from two public maternity wards in Cotonou, Benin. The dates of data collection and lactation status of the sample are not reported. Sample women did not have a history of iron supplementation.

The prevalence of anemia (Hb <11.0 g/dl) was 55.0% with a mean Hb of 10.5±1.6 g/dl. The proportion of women with low serum ferritin levels (<12 µg/L) was 41% in pregnant with a mean level of 37±60 µg/L and 64±63 µg/L). Iron deficiency (with and without inflammation) was defined as serum ferritin <50 µg/L and either transferrin saturation <16% or erythrocyte protoporphyrin >3 µg/g Hb. Folate deficiency was defined as red blood cell folate <160 µg/L. The prevalence of iron and folate deficiency was 72.5% and 45%. The mean transferrin saturation value was 13.2%±8.4%. P. falciparum was evident in almost the entire sample

Previous Page Blank

(99%). While prevalent (75% Hb AA in the total study sample, which included non-pregnant women), hemoglobinopathies made only a minor contribution to the observed levels of anemia.

4. Jackson RT, Jackson LC; "Biological and Behavioral Contributors to Anemia During Pregnancy in Liberia, West Africa." Hum Biol 1987, 59(4):585-97.

This is a clinic based, observational study of 621 pregnant women recruited at their first visit to the outpatient government antenatal clinic in Monrovia, Liberia. The dates of data collection were not provided. None of the pregnant women in the sample had received iron supplementation during pregnancy. Blood samples were obtained in the third trimester, generally at approximately 6 months gestation.

The mean hemoglobin level of the sample was 9.9±1.3 g/dl, with 78.0% <11.0 g/dl, 47% <10.0 g/dl and 6.6% <8.0 g/dl. Of the 128 women tested for parasitic infestation, 62.5% had whipworm infection, 58.0% had roundworm infection, 30.0% had hookworm infection, and many (12.5%-39.8%, depending on the combinations) had multiple infections. Less than 10% of the population had hemoglobinopathies (Hb AS=7.5%, Hb AC=0.7%, Hs s/β Thalessemia=0.2%).

5. Isah HS, Fleming AF, Ujah IAO, Ekwempu CC; "Anaemia and Iron Status of Pregnant and Non-Pregnant Women in the Guinea Savanna of Nigeria." Ann Trop Med Parasitol 1985, 79(5):485-93.

This cross-sectional, observational study was conducted June - September, 1981, on 95 pregnant women booking delivery at Ahmadu Bello University Hospital, in Zaria, Nigeria. The women were divided into elite (college students and staff presenting as first-time blood donors) and non-elite categories. Twenty-eight percent of women were identified as elite. Blood samples were taken at time of registration for prenatal care.

WHO criteria was used to define anemia (Hb <11.0 g/dl). The prevalence of anemia 37.0% in elite and 51.5% in non-elite pregnant women with iron deficiency anemia prevalent in 22% and 17.7%, respectively. Iron deficiency was defined as having at least two of the following: TS ≤20%, FEP≥ 70 mg/dl, and serum ferritin ≤20 mg/L. Using this definition, 29.6% of the elite and 25.0% of the non-elite women had iron deficiency.

Mean hematologic measures show that hemoglobin levels were lowest in non-elite women, 10.8±1.7 g/dl, as compared to 11.3±1.6 g/dl in elite women. Transferrin saturation levels were 25.8%±10.6% in elite and 26.7%±12.4% in non-elite women. The median serum ferritin was 28.9 mg/L for elite and 33.6 mg/L for non-elite women.

6. Fleming AF, Harrison KA, Briggs ND et al.; "Anaemia in Young Primigravidae in the Guinea Savanna of Nigeria: Sickle Cell Trait Gives Partial Protection Against Malaria." Ann Trop Med Parasitol 1984, 78(4):395-404.

This study was conducted on 234 pregnant, primigravidae women of the Hausa tribe, in a region of Nigeria where malaria is hyperendemic. These women were seen consecutively between January, 1977 and April, 1978 in the antenatal clinic at Ahmadu Bello University Hospital. Blood samples were taken cross-sectionally prior to 24 weeks gestation (mean gestation = 18.5 weeks). By study definition (Hb <11.0 g/dl), 43% of the women were anemic.

Of these women, 25% were iron deficient, and 40% had malaria infection. In comparison, among the non-anemic women, 12.5% were iron deficient and 18.5% had malaria infection. Other hematologic indices of the overall study show that 14% were folate deficient, and 26% had sickle cell trait.

7. Kulkarni AG; "Anaemia and Blood Requirements During Pregnancy in Patients from Guinea Savanna of North of Nigeria." E Afr Med J 1987, 64(1):65-70.

A retrospective review of records of 871 pregnant women who delivered at the Ahmadu-Bello University in Kaduna, Nigeria during a 6 month period in 1983-1984 (not further specified) was conducted. The sample comprised 10 major ethnic groups. All women received iron supplementation during pregnancy.

Between 38% (Yoruba) and 56% (Idoma) of women were recorded to have Hct <33%, with an average of 45.7% of the sample Hct levels below this value. The group mean Hct was 34.7%±5.7%, with a range of 32.4% (Idoma) to 35% (Igbo and Kaje). A substantial proportion (16.3%) of women required blood transfusions (ranging from 14.5% in Yoruba to 21.1% in Idoma women).

8. Oluboyede OE; "Iron Studies in Pregnant and Non-Pregnant Women with Haemoglobin SS or SC Disease." Brit J Obstet Gynaecol 1980, 87:989-96.

This clinic based study was conducted on 22 pregnant women attending an antenatal clinic in a university teaching hospital in Ibadan, Nigeria. The dates of the study were not reported. The women in this study were taking both 5 mg of folic acid and 100 mg of paludrine orally every day. Blood samples were taken from half of the sample during the second trimester. Ten women had sickle cell trait, 12 had sickle cell disease, 14 (58% of those with sickle cell disease, and 50% of those with sickle cell trait) had little or no bone marrow iron.

Women with sickle cell trait had slightly lower hemoglobin and hematocrit levels than those with sickle cell disease: 7.3±0.45 g/dl vs. 8.9±0.95 g/dl and 24.2%±1.8% vs. 30.2%±2.0%, respectively. However, other iron status indices would indicate that the women with sickle cell trait were less anemic than those women with sickle cell disease (102±35.2 µg/dl vs. 93.4±15.5 µg/dl serum iron, 452.8±51.7 vs. 514±102.7 total iron binding capacity, 22.5%±10.1% vs. 18.2%±13.3% transferrin saturation, and 154.6±16.4 µg/L vs. 97.0±10.8 µg/L serum ferritin, respectively).

2. WHO: "Report of the African Regional Consultation on Control of Anaemia in Pregnancy." **WHO Afr/MCH/86** 1986:4.

A sample of 162 pregnant women from the suburban area of Dosso, Niger were measured for hemoglobin status in 1981-1982. Further details regarding the sample were not supplied. Of these, 56% had Hb <11.0 g/dl with a mean sample Hb of 10.8 g/dl.

Eastern Africa

9. Gebre-Medhin M, Birgegard G; "Serum Ferritin in Ethiopian Mothers and their Newborn Infants. Relation to Iron Intake and Socio-Economic Conditions." Scand J Haematol 1981, 27:247-52.

Twenty-three non-privileged women were recruited consecutively from the Municipal Clinic in Addis Ababa, Ethiopia for this study. Fifteen privileged women were also consecutively recruited from the University Department of Obstetrics and Gynecology. Additionally, 10 Swedish women from Uppsala were sampled between April and June, 1977 to provide comparative statistics. All study subjects were pregnant women (gestation not further described) from whom hematologic samples were obtained immediately prior to delivery. Only the Swedish comparison group received iron supplementation during pregnancy.

Serum ferritin levels were highest, 98±15 µg/L in non-privileged Ethiopian women, with intermediate values, 72±26 µg/L in privileged Ethiopian women. Swedish women had the lowest serum ferritin values, 44±11 µg/L. Consistently, 33% of privileged and 8% of non-privileged Ethiopian women had serum ferritin levels <28 µg/L; similar data were not provided for the Swedish comparison group. Non-privileged Ethiopian women had mean hemoglobin levels of 14.1 g/dl (range 11-16 g/dl) compared with Swedish women who had mean levels of 12.3 g/dl (range 10-14 g/dl); similar data were not available for privileged Ethiopian women.

10. Liljestrand J, Bergstrom S, Birgegard G; "Anaemia of Pregnancy in Mozambique." Trans Royal Soc Trop Med Hyg 1986, 80:249-55.

Pregnant women from 9 sites in 7 of Mozambique's 10 provinces were studied. A universal sample of pregnant women (n=881) from selected villages was chosen in 6 of the 9 study sites, with the remainder of women chosen from health care centers (Group A). Additionally, 91 pregnant women who, because they were anemic, had been admitted to the Central Hospital of Maputo in their third trimester of gestation were included in the study (Group B1). A group of 207 randomly selected patients at three large suburban maternity units comprised a third study group (Group B2). No further information on survey dates or whether women received iron supplementation was reported. Twenty-two percent of the sample were in their first, 35% in their second, and 43% in their third trimester of pregnancy (of which 7.7% of the total sample were Group B1, all of whom were third trimester patients).

Fifty-eight percent of Group A women had Hb <11.0 g/dl with 12% below 9.0 g/dl. Forty-eight percent of these women had serum ferritin values <12 µg/L, and 17% had malaria. Although the prevalence of anemia was not reported for Group B2 (all of the women in group B1 were anemic), the mean hemoglobin and hematocrit levels were 6.9±1.5 g/dl and 22.0%±4.5% in Group B1 and 10.3±1.4 g/dl and 31.3%±4.3% in Group B2. Group B1 also experienced more hookworm infestation (19% vs. 9%) and recent malaria symptoms (51% vs. 15%) than Group B2. Only a small portion of anemia was explained by folate or vitamin B12 deficiencies, of hemoglobinopathies.

2. WHO: "Report of the African Regional Consultation on Control of Anaemia in Pregnancy." **WHO Afr/MCH/86** 1986:4.

A sample of 1,912 pregnant women from the teaching hospital in Lusaka, Zambia were measured for hemoglobin status in 1986. Further details regarding the sample were not supplied. Of these, 34% were anemic (Hb <11.0 g/dl).

Middle Africa

11. Coulibaly M, Costagliola D, Zittoun J, Mary JY; "Modifications of Hemato-Biological Parameters in Pregnant Women in a Migrating Population in Northern Cameroon: Prevalence of Anemia, Iron and Folate Deficiencies." Int J Vit Nutr Res 1987, 57:173-8.

Between January and March, 1983, all pregnant women within a 10 kilometer radius of two villages (Bere and Koindero) in Northeast Benoue, northern Cameroon, were asked to visit the local health center or school to register for study participation. Ninety women entered the study, of whom 19% were in their first, 42% in their second and 39% in their third trimester.

The prevalence of anemia and iron deficiency were relatively low. Only 8% of women had Hb <11.0 g/dl (mean=12.9±1.6 g/dl), and mean hematocrit levels were 37.6%4.2%. Similarly, the mean serum iron was 79.5±24.8 µg/dl, with 10% considered iron deficient (serum iron <50 µg/dl). All women considered anemic were also iron deficient. Three percent of women had folate deficiency (serum folate <3 µg/ml), and 40% had transferrin saturation <15%.

12. Prual A, Galan P, de Bernis L, Hercberg S; "Evaluation of Iron Status in Chadian Pregnant Women: Consequences of Maternal Iron Deficiency on the Haematopoietic Status of Newborns." Trop Geogr Med 1988, 40:1-6.

One hundred and twelve pregnant women presenting for delivery at the Maternity Ward of N'Djamena, Chad sampled from the health and social security staff were included in this study. Further details regarding dates of data collection, sample selection and lactation status were not described. Study participants had not received iron supplementation.

The mean hematocrit value was 36.7%±6.1%, with 25% of pregnant considered anemic (Hct <33%). Only 11.6% of pregnant women were considered iron sufficient (defined as serum ferritin >120 µg/L and transferrin saturation >16%) and 66.9% were classified as iron deficient (defined as serum ferritin <50 µg/L and transferrin saturation <16%). A large proportion (78.6%) of anemic women were identified as both iron deficient and anemic, although this represents only 19.6% of pregnant subjects. The percent of low levels of transferrin saturation (72.3% <16%, with a mean of 13.6±8.6) is consistent with the proportion of women categorized as iron deficient. The differential between women with low values (<12 µg/L) and group mean values for this serum ferritin (20.5% low and mean of 41.1±72.8 µg/L is diminished from that observed with transferrin saturation.

Southern Africa

13. Lamparelli RDV, Bothwell TH, MacPhail AP, et al.; "Nutritional Anaemia in Pregnant Coloured Women in Johannesburg." S Afr Med J 1988, 73:477-81.

First time attenders of the antenatal clinic at Coronation Hospital, Johannesburg, South Africa, were selected for study between April and June, 1986. Of the 224 study participants, all of whom were black women, 17.9% were in their first, 52.7% were in their second, and the remainder were in their third trimester when sampled. None of these women had received prior iron supplementation during the current pregnancy.

As expected, the percent of women with low Hb (<11.0 g/dl) rose over gestation, with 4.0% in the first (mean Hb=13.1±1.3 g/dl), 17.4% in the second (mean Hb=12.1±1.2 g/dl) and 18.9% in the third (mean Hb=11.7±1.2 g/dl) trimester exhibiting low hemoglobin levels, respectively. Mean PCV, serum ferritin and serum iron also decreased with gestation. Mean PCV values were 39.2±3.3%, 36.9±3.3% and 36.2±3.5% in women in their first, second and third trimesters, respectively. Mean serum ferritin levels were 17.4 µg/L, 11.4 µg/L and 7.5 µg/L in women in their first, second and third trimesters, respectively. Mean serum iron values were 16.6±6.7 µmol/L, 14.5±6.9 µmol/L and 13.1±6.6 µmol/L in women in their first, second and third trimesters, respectively.

The percent of women classified as having depleted iron stores, defined as a normal hemoglobin and transferrin saturation with a low serum ferritin level, was 16% in first, 26% in second, and 40% in third trimester women. This represents a four or larger fold estimate than the proportion of women categorized as having iron deficiency anemia (defined as low hemoglobin, transferrin saturation and serum ferritin levels), with respectively 4%, 3% and 9% of first, second and third trimester women so classified. The prevalence of iron deficiency erythropoiesis (defined as normal hemoglobin levels, with low transferrin saturation and serum ferritin levels) showed little variation by gestation; 16%, 18% and 19% of women in their first, second and third trimester of pregnancy were considered to have iron deficient erythropoiesis, respectively.

14. Baynes RD, Meriwether WD, Bothwell TH, et al.; "Iron and Folate Status of Pregnant Black Women in Gazankulu." S Afr Med J 1986, 70:148-51.

Hematologic samples of 229 first time attenders of the antenatal clinic in the vicinity of Tintswalo Hospital, Acornhoek, Gazankulu, South Africa were obtained during the winter of 1984. No further description of sampling methodology was provided. The mean gestation at initial visit was 5.9 months. Sample women had not received iron supplementation during pregnancy.

Thirty-three percent of women had Hb <11.0 g/dl with a mean of 11.4±1.4 g/dl, mostly associated with folate deficiency. Only 17% of women were considered to be iron deficient (criteria not stated), although this may be an underestimate as folate deficiency tends to mask iron deficiency. Sixty percent of women had serum folate levels <3.5 ng/ml and 48% had serum folate levels <3.0 ng/ml with a mean of 3.5±2.3 ng/ml. Mean Hct, serum ferritin, transferrin saturation and TIBC levels were 36.8%±5.1%, 20.0 µg/L (median value), 22.7%±9.3%, and 74.8±13.5 µmol/L, respectively, with 24% having low (<12 ng/ml) serum ferritin and 28% having low (<16%) transferrin saturation levels.

15. Lamparelli RDV, Van der Westhuyzen J, Bothwell TH, Pienaar L, Baynres RD; "Anaemia in Pregnant Indian Women in Johannesburg." S Afr Med J 1988, 74:170-3.

One hundred pregnant Indian women were sampled at their initial visit to a provincial hospital or private clinics in Lenasia, Johannesburg, South Africa between October, 1986 and June, 1987. There was no further description of sampling methodology. None of these women had received prior iron supplementation during their pregnancy.

As expected, the mean Hb decreased with gestation, with mean hemoglobin levels of 12.5 g/dl, 12.3 g/dl and 11.1 g/dl in women in their first, second, and third trimesters of pregnancy. Mean levels of Hct, serum iron, percent transferrin saturation and median serum ferritin levels also fell over pregnancy. Mean Hct levels were 37.1%, 36.3% and 33.8% in first, second and third trimester women. Mean serum iron values were 12.8 µmol/L, 12.5 µmol/L and 11.0 µmol/L, respectively. Percent transferrin saturation and median serum ferritin levels were 19.9% and 9.1 µg/L in the first, 18.1% and 9.0 µg/L in the second, and 12.2% and 4.3 µg/L in the last trimester of pregnancy. Consistently, total iron binding capacity rose over pregnancy, with mean values of 65.9 µmol/L, 74.4 µmol/L, and 94.0 µmol/L in women in their first, second and third trimesters, respectively.

The percent of women with iron deficiency anemia (criteria not defined) was 4% and 20% in the first and third trimesters; no second trimester women were diagnosed as iron deficient. The percent of women with iron deficiency erythropoiesis rose across trimesters of pregnancy with 30%, 41% and 60% of women so identified in their first, second and third trimesters. However, the percent of women with iron depleted stores declined over gestation (15% in the first, 8% in the second, and none in the third trimester).

LATIN AMERICA AND THE CARIBBEAN

Caribbean

16. Simmons WK, Jutsum PJ, Fox K, et.al.; "A Survey of the Anemia Status of Preschool Age Children and Pregnant and Lactating Women in Jamaica." AJCN 1982, 35:319-26.

A multistage cluster sample of 229 pregnant women was conducted between March 28 and June 23, 1978 which included all parishes on the island of Jamaica. The majority (61.6%) had deficient hemoglobin levels (<11.0 g/dl). Mean hemoglobin levels were 10.4±1.8 g/dl. As expected, hemoglobin levels decreased with gestation, being 11.0±1.8 g/dl, 10.4±1.8 g/dl and 10.4±1.7 g/dl in the first, second and third trimester sample, respectively.

17. Simmons WK, Wynter H, Gallagher P, et.al.; "Haemoglobin Levels in West Indian Antenatals." West Indian Med J 1987, 36:216-24.

A review of all records of initial hematologic parameters for all pregnant women attending the University Hospital of the West Indies (UHWI) in Kingston, Jamaica (n=689), the largest antenatal clinic in Antigua (n=159), and all antenatal records identified from birth records in one year in Montserrat was conducted (n=138). All women were less than 19 weeks gestation at UHWI (mean 16 weeks); the average gestation at booking (initial visit) was 22 weeks in Antigua and Montserrat. Records were reviewed for the entire year of 1984. Women less than

16 years or greater than 34 years old, with sickle cell or of parity greater than 5 were excluded from the UHWI sample.

The mean hemoglobin levels of Jamaican women was 12.4±1.5 g/dl compared to 10.5 g/dl (sd not reported) in Antigua and 10.0 g/dl (sd not reported) in Montserrat. This difference may be partly explained by the fact that Jamaican women were on average 6 weeks earlier gestation than those in Antigua and Montserrat. Only 3.0% of the Jamaican sample had Hb <11.0 g/dl; similar estimates were not calculated for the other islands. Earlier reports from Antigua and Montserrat indicated, respectively, that approximately 60% (1979) and 90% (1980) of pregnant women on these islands had Hb <11.0 g/dl.

18. Bramble D, Simmons WK; "Anaemia in Antenatal Patients in Montserrat." West Indian Med J 1984, 33:92-96.

Records for all pregnant women (n=164) giving birth in 1980 were reviewed. Hemoglobin levels at first antenatal visit (booking) were abstracted. Mean hemoglobin levels were slightly lower (9.7 g/dl, n=46) in the third trimester than in the first or second (both 10.2 g/dl, n=27 and n=97, respectively) trimester sample. The vast majority (82.3%) of women had Hb <11.0 g/dl, with 41.9% and 3.7% having values below 10.0 g/dl and 8.0 g/dl, respectively. While hemoglobin levels were inversely related to age, parity and parasitic infestation, these could not account for the majority of cases of anemia. The prevalence of whipworm, hookworm and ascaris infections was 11.3%, 0.5%, and 2.9%, respectively.

19. Simmons WK, Been H, Gallagher P, Patterson AW; "Anaemia in Antenatals in the Turks and Caicos Islands." West Indian Med J 1987, 36:210-15.

All women (n=1,042) who attended antenatal clinics in Turks and Caicos islands between 1981-1984 were sampled for hemoglobin levels at their initial prenatal visit. Mean hemoglobin levels varied little with age (mean=10.4 g/dl, with a range of 10.2 g/dl at age <19 years to 10.7 g/dl at ≥34 years). The prevalence of anemia (Hb <11.0 g/dl) also changed little over the years with 67.7% of women in 1981 (n=186), 75.8% in 1982 (n=261), 60.5% in 1983 (n=269), and 65.3% in 1984 (n=326) experiencing anemia at first prenatal visit. Gestation at first prenatal visit was not reported, but seems unlikely to account for the large proportion anemic women encountered in this sample.

Tropical South America

20. Giugliani ERJ, Jorge SM, Goncalves AL; "Folate and Vitamin B12 Deficiency among Parturients from Porto Alegre, Brazil." Rev Invest Clin 1984, 36:133-6.

Fifty-one pregnant women attending the Hospital de Clinicas de Porto Alegre with varied SES background were included in this study. Further details regarding the sampling, gestational age, and lactational status of women were not reported. Fifty-one percent of pregnant women took oral supplements containing vitamin B12, however none took folic acid supplements, and iron supplementation was not reported. Blood samples were collected immediately after delivery,

The prevalence of anemia (Hb <11.0 g/dl) was 13.7% Mean red blood cell folate and serum folate values were 191.4±55.5 ng/ml and 3.90±1.55 ng/ml.

21. Mora JO; "Nutritional Status of the Colombian Population." Int J Vil Nurt Res Suppl 1985, 27:19-31.

A random sample consisting of 10,621 men, women and children from the entire non-institutionalized population was selected and studied during 1977-1980. Sample sizes for pregnant women were not reported. The prevalence of anemia was found to be 23.6% (Hct <34%). The prevalence of iron deficiency (% transferrin saturation <16%) exceeded that for anemia.

22. Yepez R, Calle A, Galan P, et.al.; "Iron Status in Ecuadorian Pregnant Women Living at 2,800 m. Altitude: Relationship with Infant Iron Status." Int J Vit Nutr Res 1987, 57:327-32.

Women with normal pregnancies (n=84) delivering at the Isidro Ayora Maternity Hospital in Quito were sampled to estimate the association between anemia, altitude and pregnancy in Quito, Ecuador. Blood samples were collected during the first stage of labor. Women studied had not received iron supplementation during pregnancy.

Although the mean hemoglobin level of pregnant women was 12.4±1.2 g/dl, the proportion of pregnant women considered anemic was surprisingly high, 46.4%, probably attributable to adjustment for altitude which categorized all pregnant women <12.3 g/dl as anemic). Interestingly, while the prevalence of iron deficiency anemia (serum ferritin <50 µg/L with transferrin saturation <16%) was identical to the prevalence of anemia, iron deficiency anemia accounted for 59% of anemia in anemic pregnant women.

Pregnant women had a mean hematocrit of 35.6±4.2, serum iron of 13.9±7.6 µmol/L, total iron binding capacity of 96.7±10.9 µmol/L, transferrin saturation of 14.6%±8.0% and serum ferritin of 32.3 µg/L.

23. Johnson AA, Latham MC, Roe DA; "The Prevalence and the Etiology of the Nutritional Anemias in Guyana.: AJCN 1982, 35:309-18.

A multi-stage, cluster sample of households with individuals attending health centers in 3 of the 6 Ministerial disticts of Guyana was obtained in 103 households on 590 individuals to estimate the distribution of anemia in Guyana. The exact period of data collection was not reported. Results reported here refer only to women 15-44 years of age.

The highest prevalence of anemia (based on WHO criteria) was found among pregnant women (73.7%, n=19), who had a mean hemoglobin level of 10.1±1.2 g/dl, mean Hct of 33.5%±3.8%, with 35.7%, 100% and 18.2% classified as iron (serum iron <50 µg/dl or transferrin saturation <15%), folate (serum folate <3 ng/ml), and vitamin B12 (serum vitamin B12 <80 ng/ml) deficient, respectively.

ASIA

Middle South Asia

24. Agarwal KN; "Pregnancy Anemia and Fetal Outcome," Update Growth. Dept. Pediatrics: Institute of Medical Sciences. Banaras Hindu Univ, Varanasi, 1987.

Hemoglobin levels on pregnant women surveyed in the ICMR 1985-1986 Evaluation of Nation Anemia Prophylaxis Program, India were reported. Sample size and sampling methodology were not reported. The majority of pregnant women surveyed in Bihar (81%) and Uttar Pradesh (87%) were reported as anemic (Hb <11 g/dl). Mean hemoglobin levels increased over pregnancy, presumably due to supplementation received from the National Anemia Prophylaxis Program. First, second and third trimester mean hemoglobin levels in Bihar and U.P. were 8.6±0.8 g/dl and 9.6±1.4 g/dl, 9.2±0.7 g/dl and 9.4±1.6 g/dl, and 9.2±0.7 g/dl and 9.0±1.8 g/dl, respectively.

25. Shukla MK, Verma BL, Saran M, Srivastava RN; "A Longitudinal Study on Anaemia of Pregnancy in a Rural Population of Uttar Pradesh." Indian J Med Res 1982, 75:541-44.

All pregnant women (n=246) ascertained in a door to door survey of 7 villages in Jhansi District between April and November, 1980 were followed longitudinally over pregnancy to describe the incidence and prevalence of anemia during gestation. Mean gestation at identification was not described.

The initial prevalence of Hb <11 g/dl in pregnant women was 67.5% (mean Hb=10.2±1.5 g/dl), with 38.5% and 47.4% of non-anemic women initially identified in their first and second trimesters, respectively, becoming anemic at follow-up 3 months later.

26. Bhargava M, Kumar R, Iyer PU, et. al.; "Effect of Maternal Anaemia and Iron Depletion on Foetal Iron Stores, Birthweight and Gestation." Acta Paediatr Scand 1989, 78:321-22.

Three hundred and eight pregnant women had hemoglobin samples collected during labor in a general hospital in India. Sampling methodology, site, or date of data collection were not reported. Almost one third (30.8%) had hemoglobin levels less than 10 g/dl prior to delivery.

27. Agarwal KN, Ahmed FU, Bahl L, et. al; "Evaluation of the National Nutritional Anaemia Prophylaxis Programme." Indian Council of Medical Research 1989:86-87.

A national, multi-stage, random sample initiated in 1984 collected hemoglobin levels on 3,829 pregnant women with a minimum gestation of 20 weeks who did not receive iron supplementation from the national iron supplementation program in India. The mean hemoglobin level was 9.1±3.8, with 87.5% of pregnant women having Hb values <11.0 g/dl. These levels were not substantially different in women who did and did not receive iron supplementation.

28. Agha F, Hasan TJ, Khan RA, Jafarey S; "Iron Stores in Maternal and Cord Blood." Asia-Oceania J Obstet Gynaecol 1988, 14(4):405-9.

Women deliverying full term babies (n=206, aged 15-45) at Jinnah Postgraduate Medical Center, Karachi, Pakistan provided maternal serum and cord blood samples from which hematologic status was assessed. Sampling methodology and dates of data collection were not specified. The prevalence of anemia (Hb <11 g/dl) and iron deficiency (serum ferritin <16 ng/ml) was 69.2% and 38.3%, respectively. Mean values of hematologic parameters were 9.9±0.1 g/dl Hb, 29.4%±0.4% Hct, and serum ferritin 28.9±1.6 ng/ml.

29. Karim SA, Khurshid M, Rizvi JH; "Anaemia in Pregnancy: Occurence in Two Economically Different Clinic Populations of Karachi." J Pak Med Assn 1988, 38:271-2.

Hemoglobin samples were obtained from pregnant women attending their first antenatal clinic at the Civil Hospital (n=213) between May and October 1987 and from the Aga Khan University (n=400) between November 1986 and November 1987. Women on haematinics and drugs known to cause folate deficiency were excluded from the sample. Comparisons of the prevalence of early gestational anemia were made between the study hospitals which service different socio-economic strata. Aga Khan University is a private hospital serving a middle to high socio-economic group, while the Civil Hospital is a public hospital which serves a lower socio-economic population. As expected, the percent of women with hemoglobin levels <10 g/dl (representing the 2.5th percentile of reference data) was considerably higher in women registered at the Civil Hospital (30%) compared to those attending the Aga Khan University Hospital (8%).

East Asia

30. Zhang A, Ge X; "The serum and Red Cell Folate Levels in Pregnant Women in Beijing." Chinese Med J 1986, 99:899-902.

Between December 1984 and January 1985, 225 pregnant workers and cadres aged 20-40 years old seen in the Antenatal Clinic of the Beijing Hospital of Obstetrics and Gynecology were sampled for folate deficiency. Hemoglobin and hematocrit levels were not reported. There was approximately an equal distribution across all trimesters. Although the criteria were not further specified, 27.6% of sampled women were defined as anemic. Folate deficiency (red cell folate <190 ng/ml) was observed in 9.9% of the sample.

31. Ho CH, Yuan CC, Yeh SH; "Serum Ferritin, Folate, and Cobalamin Levels and Their Correlation with Anemia in Normal Full-Term Pregnant Women." Eur J Obstet Gynecol Reprod Bull 1987, 26:7-13.

Full term pregnant women who had Hb >12 g/dl in their first trimester, with no pregnancy complications who did not take hematinics during pregnancy (n=221) were chosen from the Antenatal Clinic of the Veterans General Hospital, Taipei, Taiwan. Dates of data collection and sampling methodology were not specified. At late third trimester, 10.4% of women had Hb <11.0 g/dl with a mean of 12.6±1.4 g/dl, and 51.6% had depleted serum ferritin levels of <20 µg/L with a mean of 23.0±17.7 µg/L). Most (95.7%) anemic women had depleted serum ferritin levels, but few (4.4%) had folate deficiency. Almost half (47.8%) of anemic women had serum ferritin levels <12 µg/L.

Oceania

32. Watson DS, Tozer RA; "Anaemia in Yirrkala." Med J Aust 1986, 144:S13-S15.

A population based study of anemia in Aboriginal adults (≥25 years old) was conducted during the dry season of 1983 in Yirrkala, Australia. Study subjects included 12 pregnant women taking supplemental iron. Half of the pregnant women had hemoglobin levels <11.0 g/dl. All women with hemoglobin levels <11.0 g/dl also had folate deficiency.

33. Buchanan JG, Nixon AD, Pettit JE, et. al.; "Iron Deficiency and Anemia among Indian Women in Fiji." Pathology 1982, 14:269-75.

A random sample of pregnant women aged 14-45 registered in the Health Office of a semi-rural area of Lautoka, Fiji was selected in June, 1979. The lactation and supplementation status of women sampled was not stated. In the sample, 29% of Hindu (total n=14) and 33% of Moslem (total n=27) had hemoglobin levels <11.0 g/dl, with mean hemoglobins of 11.6±1.4 and 11.6±1.7 g/dl, respectively. Nineteen percent of all study subjects, including non-pregnant women, had positive hookworm stool samples.

34. Sill PR, Hill AVS, Igo JD; "Multifactorial Aetiology of Anaemia of Pregnancy in Port Moresby, Papua New Guinea." PNG Med J 1987, 30:193-8.

One hundred pregnant women consecutively booking at any of 5 antenatal clinics in Port Moresby, Papua New Guinea during a one week time period in May, 1985, constitute the sample of this study. Women in the study ranged between 8 and 37 weeks gestation (mean 25.5 weeks) and had a mean hemoglobin level of 9.9±1.6 g/dl (range 5.5-13.7 g/dl) and a mean serum ferritin level of 42.1±41.2 μg/L (range 6.0-260.0 μg/L). Forty-four percent of women had hemoglobin levels <10 g/dl however only 8% had serum ferritin levels <14 μg/L. The presence of concommitant factors which affect iron status was variable. The prevalence of malarial parasites was 7%, 35% of subject were Thalessemia carriers (α-/$\alpha\alpha$ = 25%; α and β = 2%) or had Thalessemia trait
(-α/-α = 8%), and 60% had hookworm infestation (40% with <1,000 ova/g feces and 20% with ≥1,000 ova/g feces). A significant $p<0.05$) inverse association between hemoglobin and hookworm load was observed.

NORTHERN AMERICA AND EUROPE

Northern America

35. Hambidge KM, Krebs NF, Sibley L, English J; "Acute Effects of Iron Therapy on Zinc Status During Pregnancy." Obstet Gynecol 1987, 70(4):593-6.

A clinic based study of 20 healthy pregnant women was conducted. Further details regarding sampling, sites and dates of data collection were not reported. Gestational age ranged from 21-33 weeks, with an average of 27 weeks at the time of hematologic sampling. Mean hemoglobin levels were 12.2±0.2 g/dl, mean hematocrit was 36.5±0.4%, MCV was 93.5±0.8 μg/L, serum iron was 117±12 μg/dl, and serum ferritin was 32.6±6.1 ng/ml. The proportion of women with hemoglobin levels below 11 g/dl was not reported.

36. Serfass RE, Liu JF; "Assessing Iron Status During the Last Trimester of Pregnancy: Erythrocyte Protoporphyrin and Serum Ferritin Determinations." Nutr Rep Internat 1983, 28:1171-8.

Women between 19 and 29 years of age attending outpatient clinics of Broadlawns Medical Center or the Student Health Center at Iowa State University were included in this study. Hematologic samples from 75 women near term (32.3±3 weeks gestation) who had uncomplicated singleton pregnancies. Pregnant women in this study had received 120 mg elemental iron daily supplements, with an estimated 50% compliance rate.

Nineteen percent of the pregnant women sampled had Hb <11.0 g/dl (mean 12.0±1.1), which was consistent with the proportion of women with FEP >100 µg/dl (17%), but was substantially lower than those with serum ferritin values <12.0 µg/dl (36%). Mean hematocrit, FEP, serum ferritin and MCV levels were 35.4±2.4%, 27.7±11.9 µg/dl, 16.7±10.7 µg/dl and 85.4±4.6 μ^3/cell, respectively.

37. Rush D, Leighton J, Sloan NL, et al.; "Review of Past Studies of WIC." AJCN 1988, 48:394-411.

Three studies were published in the 1980's (sample size ranged from 43-204) which described the hematologic status of pregnant women enrolled in the WIC (Women, Infants and Children) special supplementary food program found hemoglobin and hematocrit levels ranged from 12.4-12.9 g/dl and 35.5%-35.8% at the time of WIC enrollment. The prevalence of anemia was not reported. Although low hematologic values are criteria for certification in the WIC program, the reported levels appear to be valid compared to control group levels (Hb 11.9-12.8 g/dl and Hct 35.5%-36.9%).

Northern Europe

38. Milman N, Ibsen KK, Christensen JM; "Serum Ferritin and Iron Status in Mothers and Newborn Infants." Acta Obstet Gynecol Scand 1987, 66:205-11.

A hospital based survey of 85 pregnant women at term was conducted in Denmark. All women received daily multivitamin supplements including 200 mg elemental iron, and folic acid and vitamin B12 from the seventeenth week of gestation until term. Blood samples were collected just prior to delivery. Low prevalence of anemia was observed with 9.4% of women having Hb <12.0 (mean 13.2) g/dl, with 8.5% classified as iron depleted (serum ferritin <15 µg/dl), 9.9% classified as latent iron deficient (serum ferritin <15 µg/dl and transferrin saturation <15%), with 2.4% classified as anemic due to iron deficiency (serum ferritin <15 µg/dl and transferrin saturation <15% and Hb <12.0 g/dl). The sample mean serum ferritin was 21 µg/L and serum iron was 23 µmol/L. No data were presented for prevalence of Hb <11.0 g/dl.

Western Europe

39. Hercberg S, Galan P, Soutre Y, Devanlay M, Dupin H; "Prevalence of Iron Deficiency During Pregnancy in a French Area." Nutr Rep Int 1985, 32(3):719-26.

A sample of continental French (n=359) and migrant (n=443) pregnant women attending antenatal clinics in 6 urban and suburban Parisian maternities was obtained. Women were sampled from various gestational ages, with mean gestational age in the early, middle and late gestation sample was 15±3, 28±3 and 39±3 weeks.

Migrant workers had substantially higher rates of anemia than their continental counterparts; 12.0%, 28% and 37% of migrant women and 1.5%, 9.0% and 9.0% of continental women in their first, second and third trimesters of pregnancy were considered anemic (Hb <11.0 g/dl). Mean hemoglobin and hematocrit values were consistently lower in migrants and generally in women at later gestation. Continental women had mean hemoglobin and hematocrit values of 12.9±0.1 g/dl and 37.9±0.3%, 12.1±0.1 g/dl and 36.2±0.2%, and 12.7±0.1 g/dl and 37.9±0.3% in early, middle and late gestation, respectively. Migrant women had mean hemoglobin and hematocrit values of 12.3±0.1 g/dl and 37.5±0.3%, 11.5±0.1 g/dl and 34.6±0.3%, and 11.4±0.1 g/dl and 35.0±0.2% in early, middle and late gestation, respectively. Serum iron and ferritin levels were also consistently higher in continental than migrant women, although both had U-shaped distributions indicating slight increases in late compared to middle gestation. TIBC values directly increased with gestation and were consistently higher in migrant compared to continental women.

NON-PREGNANT WOMEN

AFRICA

Northern Africa

40. Hercberg S, Galan P, Assami M, Assami S; "Evaluation of the Frequency of Anaemia and Iron-Deficiency Anaemia in a Group of Algerian Menstuating Women by a Mixed Distribution Analysis: Contribution of Folate Deficiency and Inflammatory Processes in the Determination of Anaemia." Int J Epidemiol 1988, 17(1):136-41.

This study was conducted with 254 healthy, non-pregnant women of reproductive age accompanying their children for measles vaccination in the Zibans province of Algeria. The dates of data collection were not given. All women taking iron supplementation were excluded from the study. The mean hemoglobin for these women was 12.6±1.6 g/dl, corresponding to a hematocrit volume of 38.0%±4%. Mean corpuscular volume, percent transferrin saturation and ferritin levels were 84.7±7.1 fl, 13.2%±8.0%, and 25.1±24.8 µg/L, respectively. The means for red blood cell folate and serum folate were 139.4±92.6 µg/L and 5.4±3.3 µg/L respectively.

Iron deficiency was defined as having both the percent ferritin <12mg/L and either transferrin saturation <15%, or MCV <80 fl. Anemia was defined as having a hemoglobin level <12.0 g/dl. By these definitions, 34.4% were iron deficient (with 59% of these being anemic), and 27.3% were anemic. Of the anemic women, 74% anemic due to iron deficiency, and 17% due to inflammation and/or chronic infection. The majority (65.6%) of women had low (<15%) transferrin saturation, 39.5% of women had low (≤12 µg/L) ferritin levels, 18.2% of women had low (<80 fl) MCV, and 37% had low red blood cell folate levels (<100 µg/L).

Western Africa

39. Hercberg S, Chauliac M, Galan P, Devanlay M et al.; "Prevalence of Iron Deficiency and Iron-Deficiency Anaemia in Benin." Public Health 1988, 102:73-83.

This study was conducted between November, 1984 through March, 1985 in South Benin, West Africa. A two-stage random proportional sample of households from 3 rural districts in southern Benin (51 villages, n=1810), and 2 urban districts (n=1158) of Cotonou were selected, included 517 menstruating women.

Hemoglobin levels differed slightly from urban (12.3 g/dl, ranging between 9.5-14.1 g/dl) to rural areas (12.2 g/dl, ranging between 8.5 -14.4 g/dl. Fewer urban (38.9%) than rural (42.4%) women had Hb <12 g/dl for women, but the prevalence of low hemoglobin levels was high in both groups. Iron deficiency was defined as having ≥2 low values for the following indices: transferrin saturation, erythrocyte protoporphyrin, serum ferritin, and MCV. Iron-deficiency anemia was not clearly defined. An almost equivalent percent of women were considered iron deficient (32.8% and 35.4% in the urban and rural sample, respectively), and about two-thirds of these were considered as having iron deficiency anemia (21.1% and 20.3% in urban and rural areas, respectively). Serum ferritin levels were also higher in urban (35.0 µg/L, with 17.2% <12 µg/L) than rural (27.5 µg/L, with 10.7% <12 µg/L) women.

The prevalence of sickle cell trait and malarial infection was 20.7% and 96.5% among the total population studied, which included postmenopausal women and adult men.

3. Hercberg S, Galan P, Chauliac M, et. al.; "Nutritional Anemia in Pregnant Beninese Women: Consequences on the Haematological Profile of the Newborn." Br J Nutr 1987, 57:185-93.

This study was a random sample of non-pregnant, lactating women (n=95) from a district in Cotonou, Benin. The dates of data collection and lactation status of the sample are not reported. Sample women did not have a history of iron supplementation.

The prevalence of anemia (Hb <12.0 g/dl) was 39.0% with a mean Hb of 12.1±1.2 g/dl). The proportion of women with low serum ferritin levels (<12 µg/L) was 13% with a mean level of 64±63 µg/L. Iron deficiency (with and without inflammation) was defined as serum ferritin <50 µg/L and either transferrin saturation <16% or erythrocyte protoporphyrin >3 µg/g Hb. Folate deficiency was defined as red blood cell folate <160 µg/L. The prevalence of iron deficiency was 39%. Mean transferrin saturation values were 18.1%±5.8%. P. falciparum was evident in almost the entire sample (97%). While prevalent in the total study sample (75% Hb AA), which included pregnant women, hemoglobinopathies made only a minor contribution to the observed levels of anemia.

41. Hercberg S, Chauliac M, Galan P et al.; "Relationship Between Anaemia, Iron, and Folacin Deficiency, Haemoglobinopathies and Parasitic Infection." Hum Nutr Clin Nutr 1986, 40c:371-79.

A two stage random sample of households in rural district of Tori Bossito, southern Benin was obtained for this study. Included in the sample were 102 menstruating women whose lactational status was not described.

Sample women had a mean hemoglobin level of 12.1±1.1 g/dl, with 46% having Hb <12 g/dl. These women also had the following mean hematologic values: 18.8%±8.0% transferrin saturation (with 42% having values <16%), 84±7 fl MCV (with 23% microcytic), 3.2±1.2 µg/g Hb EPP (with 28% >3 µg/g Hb), 33±2.7 µg/L serum ferritin (with 19%≤12 µg/L). Iron deficiency was defined as having 2 of the following 4: serum ferritin ≤12 µg/L, EPP >3 µg/g Hb, transferrin saturation <16%, and abnormal MCV (not specified). Thirty-one percent of sample women were categorized as iron deficient, and 20% as having iron deficiency anemia.

Approximately one-third of the sample women had serum folate <3 µg/L (33.7% with a mean of 4.8±3.1 µg/L) and RBC folate <160 µg/L (30.5% with a mean of 239±124 µg/L) levels. While 30.5% were considered to be folate deficient, about 8% were classified as having folate deficiency anemia.

Sickle cell trait was found in 29% of the total sample (of which menstruating women comprise about 20%), 96.5% had malaria infection, and 1% had heavy parasitic infestation.

5. Isah HS, Fleming AF, Ujah IAO, Ekwempu CC; "Anaemia and Iron Status of Pregnant and Non-Pregnant Women in the Guinea Savanna of Nigeria." Ann Trop Med Parasitol 1985, 79(5):485-93.

This cross-sectional study was conducted June - September, 1981, on 66 non-pregnant women of reproductive age in Zaria, Nigeria. All sample women were considered elite (college students and staff presenting as first-time blood donors) and non-elite categories.

The prevalence of anemia (Hb <12 g/dl) was 45.5% with 3% classified as having iron-deficiency anemia. Iron deficiency anemia was defined here as having at least two of the following: TS ≤20%, FEP≥ 70 mg/dl, and serum ferritin ≤20 mg/L. Using this definition, 4.5% of the women had iron deficiency. Mean hemoglobin levels were 12.1±0.9 g/dl. Transferrin saturation and mean serum iron levels were 26.2±8.4% and 17.4±4.9 µmol/L. The median serum ferritin was 57.4 µg/L.

8. Oluboyede OE; "Iron Studies in Pregnant and Non-Pregnant Women with Haemoglobin SS or SC Disease." Brit J Obstet Gynaecol 1980, 87:989-96.

This clinic-based study was conducted of 18 non-pregnant women attending a hematology clinic in Ibadan, Nigeria. The dates of the study were not given. The women in this study were taking both 5 mg of folic acid and 100 mg of paludrine orally every day. Twelve women had hemoglobin sickle cell trait, while 6 had hemoglobin sickle cell disease. Nine women (33% of those with sickle cell disease, and 58% of those with sickle cell trait) had little or no bone marrow iron.

Hematologic measures of these women are somewhat ambivalent in showing that those with sickle cell trait are more anemic than those with sickle cell disease. The hematocrit levels are 25.4%±3.7% vs. 32.8%±4.4%, in women with sickle cell trait compared to those with sickle cell disease. Likewise, the women with sickle cell trait had a total iron binding capacity of 502.0±190.3 µg/dl, and transferrin saturation of 23.5%±18.4%, while those with sickle cell disease had values of 936.6±157 µg/dl and 24.7%±16.3%, respectively. Serum iron levels for those with sickle cell trait was 118±83.7 µg/dl, while it was 108.2±53.1 µg/dl for those with sickle cell disease.

42. Mbofung CMF, Atinmo T; "Zinc, Copper and Iron Concentrations in the Plasma and Diets of Lactating Nigerian Women." Brit J Nutr 1985 53:427-39.

This was a study of 232 lactating women randomly selected from those who recently gave birth in or were attending postnatal clinics at Adeoyo State Hospital, Nigeria. There were 100 non-pregnant non-lactating women of comparable age and socio-economic status in a control group, although no information was given regarding means or source of recruitment.

Slightly over half (50.5%) of the lactating women were anemic (Hb <11.0 g/dl), with mean hemoglobin lower for lactating women versus women in the control group (10.7±0.9 g/dl vs. 11.0±1.1 g/dl). Other hematologic data show that 45% of the lactating women had serum iron less than 600 µg/L, with serum iron lower in lactating women (730±185 µg/L) than women in the control group (890±190 µg/L).

43. Rougereau A, Gore J, N'diaye M, Person O; "Ferritin and Iron Status in Senegalese Women." AJCN 1982, 36:314-8.

This was a cross-sectional study conducted on the western coast of Senegal with 172 non-pregnant women (lactation status unknown) who were attending screening visits in First Medical Care Units. The sample age range was 19-45 years old, and consisted of women from lower the socio-economic strata. More than half (58%) of women had Hb <12.0 g/dl, and 39.5% had Hct <33.0%. Few (5.8%) women had low serum iron values (≤50 µg/dl), with 48.3% having marginal serum iron (51-100 µg/dl). Most (75.6%) had %serum ferritin <20 ng/ml.

Middle Africa

12. Prual A, Galan P, de Bernis L, Hercberg S; "Evaluation of Iron Status in Chadian Pregnant Women: Consequences of Maternal Iron Deficiency on the Haematopoietic Status of Newborns." Trop Geogr Med 1988, 40:1-6.

One hundred and fourteen non-pregnant women sampled from the health and social security staff were included in this study. Further details regarding dates of data collection, sample selection and lactation status were not described. Study participants had not received iron supplementation.

Mean hematocrit values were 39.3%±4.9%, with 23.7% considered anemic (Hct <36%). The proportion of women considered iron sufficient (defined as serum ferritin >12 µg/L and transferrin saturation ≥16%) and iron deficient (defined as serum ferritin <50 µg/L and transferrin saturation <16%) was 58.8% and 30.7%, respectively. Almost half (44.4%) of anemic women were identified as both iron deficient and anemic, representing 10.5% of the subjects. The percent of low levels of transferrin saturation (<16%) was 31.5% with a mean of 19.6%±9.4%.

This study compared data on pregnant and non-pregnant study participants. Unexpectedly, there was little difference in levels of anemia between pregnant and non-pregnant women. However, large differences between these groups were observed in the proportions of women considered iron sufficient and iron deficient. Twice as many pregnant as non-pregnant women were classified as iron deficient. Large proportions of both pregnant and non-pregnant anemic women were identified as both iron deficient and anemic.

Southern Africa

44. Ballot DE, MacPhail AP, Bothwell TH, Gillooly M, Mayet FG; "Fortification of Curry Powder with NaFe(III)EDTA in an Iron-Deficient Population: Initial Survey of Iron Status." AJCN 1989, 49:156-61.

Three hundred and twenty-eight non-pregnant women who volunteered to participate in a study of iron fortified curry powder in Chatsworth, South Africa provided baseline serum samples. Further details on dates of data collection, lactation status, and sample selection were not provided. Women had mean hemoglobin levels of 12.4±1.8 g/dl, with a transferrin saturation of 19.3%±11.0%, and a median serum ferritin of 10 µg/L. Fifteen percent of women in the study were identified as have iron deficient stores (defined as a serum ferritin of <12 µg/L, Hb of ≥12 g/dl, and transferrin saturation of ≥16%). Thirty-three percent of women were

classified as anemic, with 26.5% having iron deficiency anemia (defined as serum ferritin of <12 μg/L, Hb of <12 g/dl, and % transferrin saturation of ≥16%). Almost 14% (13.9%) of women had iron deficiency erythropoiesis (defined as serum ferritin of <12 μg/L, Hb of <12 g/dl, and transferrin saturation of <16%).

ASIA

Middle South Asia

45. Huffman SL, Wolff M, Lowell S; "Nutrition and Fertility in Bangladesh: Nutritional Status of Non-Pregnant Women." AJCN 1985, 42:725-38.

A population-based longitudinal study of the hematocrit levels of non-pregnant women from 14 villages in Matlab, Bangladesh was conducted between November, 1975 and October, 1976. The lactation status of these women was not reported. Hematocrit samples were collected by micro (finger prick) method during the first year of the study at bimonthly intervals for a total of 5 intervals. Available data varied between 1,174 and 1,476 blood samples for each study interval.

Mean hematocrit levels were 35% and varied little between study intervals (34.3%±3.8% minimum, n=1,476 compared with 35.6%±3.7% maximum, n=1,174) regardless of season. The proportion of women considered anemic was not reported, however nearly 50% of women had hematocrit levels ≤35%, of whom nearly 6.5% and 15% had very low (<30%) and low hematocrit (<32.6%) levels, respectively. As expected, hematocrit was inversely related to parity.

46. Shah SNA, Bakash A, Rauf A, Ahmad M, Zuthshi ML; "Incidence of Iron Deficiency Anaemia in Rural Population of Kashmir." Ind J Public Health 1982, 26(3):144-54.

A 5% systematic random sample of patients registered at the Chittaranjan Mobile Hospital Government Medical College, Srinagar was conducted. This Mobile Hospital serves four camping areas in Kashmir Valley and Ladakh, India. One thousand adults aged 15-60, including 200 nonpregnant women, were sampled to determine the prevalence of iron deficiency anemia. The reproductive status (including whether the sample contained pregnant or lactating women) and dates of data collection were not reported.

Iron deficiency anemia was defined as Hb <10 g/dl, microcytosis, hypochromia, MCHC <30% with normoblastic response from bone marrow samples in the absence of intracellular stainable iron in the marrow. Although the prevalence of Ascaris Lumbricoides was 38%, the majority (88.5%) of those identified as anemic in the overall sample (n=1,000) were determined to have iron deficiency. Forty-five percent of females were thus defined as anemic due to iron deficiency (mean Hb=9.6±3.7 g/dl), with 11.5%, 12.5% and 21.0% of females determined to suffer mild (Hb 8-10 g/dl), moderate (Hb 6-7.9 g/dl) and severe (Hb <6 g/dl) iron deficiency anemia. By WHO criteria (Hb <12 g/dl), 68.0% of women sampled were anemic. The prevalence of anemia was associated with socio-economic status in the overall sample, with 47.4% of the very poor and only 14.6% of the rich being identified as anemic.

24. Agarwal KN; "Pregnancy Anemia and Fetal Outcome," Update Growth. Dept. Pediatrics: Institute of Medical Sciences. Banaras Hindu Univ, Varanasi, 1987.

Hemoglobin levels on non-pregnant women surveyed in the ICMR 1985-1986 Evaluation of Nation Anemia Prophylaxis Program, India were reported. Sample size and sampling methodology were not reported. The prevalence of anemia (Hb <12 g/dl) in reproductive age women was reported as 57%.

25. Shukla MK, Verma BL, Saran M, Srivastava RN; "A Longitudinal Study on Anaemia of Pregnancy in a Rural Population of Uttar Pradesh." Indian J Med Res 1982, 75:541-44.

Two hundred and forty-six women of similar SES, parity and age to pregnant women (n=246) ascertained in a door to door survey of 7 villages in Jhansi District between April and November, 1980 were sampled as a comparison group in this study. Of the non-pregnant women, 24.8% were initially identified as Hb <12 g/dl (mean=12.3±1.1 g/dl).

47. Agarwal DK, Bhardwaj B, Singla PN, Tripathi AM, Agarwal KN; "Etiology of Maternal and Early Childhood Deficiency Anemia." Indian J Pediatr 1986, 53:389-96.

The prevalence of anemia in one hundred nonpregnant women from Varanasi, India is reported. Most (60%) of the women where households were systematically random sampled from the rural villages of Dharsona and Munari. Twenty percent of the sample whom were randomly selected from women accompanying their children at the Pediatric Clinic in the Department of Pediatrics, Insitute of Medical Sciences, and 20% were systematically random sampled from Sunderpur (an urban slum). The dates of data collection and lactational status of the women were not reported.

Fifty-seven percent of surveyed women were determined to be anemic (<12 g/dl). Substantial differences between mean hemoglobin and hematocrit levels of anemic and nonanemic women were apparent (Hb 10.5±1.0 g/dl vs. 13.1±0.7 g/dl, Hct 31.9%±2.8% vs. 39.4%±2.6%, respectively). The majority (73.8%) of anemic women but only a minority (19.4%) of non-anemic women had evidence of concommittant parasitic infection; Ascaris lumbricoides and Giardia lamblia were each evident in 26% of women, and Ancylostoma duodenale was present in 17% of women.

48. Moser PB, Reynolds RD, Acharya S, Howard MP, Andon MB, Lewis SA; "Copper, Iron, Zinc and Selenium Dietary Intake and Status of Nepalese Lactating Women and Their Breast-Fed Infants." AJCN 1988, 47:729-34.

A comparative study of lactating women in Nepal and Annapolis, Maryland was conducted (dates of data collection not reported). All women were volunteer study participants (Nepal n=26; Annapolis n=23), between 2 and 6 months postpartum (mean 3.8 months) for Nepalese women and between 3 and 6 months postpartum in American women (average not given). The Annapolis volunteers received an average of 51.9 mg supplemental iron per day; the Nepalese women received no iron supplementation. Differences between hemoglobin and hematocrit values for Nepalese and American women were on the order of 10%-12% (Hb 13.4±0.3 g/dl vs. 15.0±0.5 g/dl, Hct 40%±1% vs. 45%±1%, respectively), however serum ferritin values showed a nearly 50% differential (21±3 g/L vs. 41±4 g/L).

28. Agha F, Hasan TJ, Khan RA, Jafarey S; "Iron Stores in Maternal and Cord Blood." Asia-Oceania J Obstet Gynaecol 1988, 14:405-9.

Healthy nonpregnant women (n=32, aged 17-50) at Jinnah Postgraduate Medical Center, Karachi, Pakistan provided maternal serum samples from which hematologic status was assessed. Sampling methodology and dates of data collection were not specified. Mean hemoglobin, hematocrit and serum ferritin values were 12.5±0.2 g/dl, 37.0%±0.5%, and 43.6±5.4 ng/ml, respectively.

Mean values of hematologic parameters were compared between the sample and pregnant women who were also studied. All hematologic levels in pregnancy were significantly ($p<0.01$) lower than those in their nonpregnant counterparts.

49. Hamedani P, Hashmi KZ, Manji M; "Iron Depletion and Anaemia: Prevalence, Consequences, Diagnostic and Therapeutic Implications in a Developing Pakistani Population." Curr Med Res 1987, 10(7):480-85.

Iron status was assessed in 200 adult females in Karachi, Pakistan. The sampling frame, pregnancy status and dates of data collection were not further specified. Fifty percent of women were nulliparous, and all were between the ages of 17 and 35 years old. Most of the sample were considered to be of lower and middle socio-economic status, with 10% categorized as high SES. Thirty percent of women had hemoglobin levels <11.5 g/dl, 54% had serum ferritin values <10 ng/ml (mean=21.5±9.4 ng/ml), 42% had serum iron levels <37 µg/ml (mean=44.8±20.2 µg/ml), and 32% had TIBC levels >400 µg/dl (mean=331.7±133.7 µg/dl).

Eastern South Asia

50. Goh TH, Hariharan M; "Iron-Deficiency Anaemia and Serum Ferritin Levels in Malaysian Women." Med J Malaysia 1986, 41(4):300-4.

Hematologic samples were obtained from nonpregnant women (n=229) at their first visit to the University Hospital Family Planning Clinic, Kuala Lumpur, Malaysia. All study participants were healthy women not using IUDs or birth control pills. None had recently been pregnant and none had received iron therapy in the 6 months prior to the study. No dates of data collection were reported. Fifty-eight percent of women had Hb <12 g/dl (mean=11.7 g/dl), and 26.6% had serum ferritin values <12 µg/L (mean=41.8 µg/L). Although ferritin levels generally increased with hemoglobin, 14.4% of women with Hb ≥12 g/dl had ferritin levels of <12 µg/L.

51. Kuizon MD, Natera MG, Ancheta LP, Platon TP, Desnacido JA, Macapinlac MP; "Assessment of the Iron Status of Filipino Adolescents." SE Asian J Trop Med Pub Hlth 1982, 13(1):81-85.

A random sample of high school students enrolled in Metro Manila, The Philippines was conducted to estimate the prevalence of iron deficiency anemia in children aged 13-19 years old. The dates of data collection were not reported. Of these, 566 were girls (most of whom are presumed not to have been pregnant). Of the female students, 10.1% had Hb <12 g/dl (mean 13.2±1.1 g/dl), 10.7% had FEP levels >160 µg/dl (mean=88±1.1), and 3.5% had serum ferritin levels <12 (mean 43.2±1.2).

East Asia

52. Gao J, Zeng S, Sun B, Fan H, Han L; "Menstrual Blood Loss and Hematologic Indices in Healthy Chinese Women." J Reprod Med 1987, 32:822-6.

Four hundred and twenty-one healthy nonpregnant, non-lactating women aged 18-44 (mean=27.9±5.3 years) were sampled during January-November 1982 in Beijing, China. Further description of recruitment and location was not provided. All women were urban, middle socio-economic status, nonsmokers, not using hormonal contraception, non experiencing amenorrhea, and consuming regular Chinese diets. Of these, 10.4% had Hb <12 g/dl (mean=13.2±1.1 g/dl, ranging between 8.3-16.7 g/dl, with 11.5 g/dl and 14.9 g/dl representing the 5th and 95th percentiles) and 40.9% with serum ferritin levels <16 ng/ml (mean=22.8±18.3 ng/ml, ranging between 1.2 and 180.0 ng/ml, with 3.6 and 55.8 ng/ml representing the 5th and 95th percentiles). Five and one-tenths percent of women sampled had both Hb <12 g/dl and serum ferritin <16 ng/ml.

Oceania

32. Watson DS, Tozer RA; "Anaemia in Yirrkala." Med J Aust 1986, 144:S13-S15.

A population based study of anemia in Aboriginal adults (≥25 years old) was conducted during the dry season of 1983 in Yirrkala, Australia. Study subjects included 231 nonpregnant women. The lactation status of the remaining female participants is not reported. Approximately 27% of the sample had Hb <12.0 g/dl. The majority (77%) of observed anemia was attributed to iron with or without folate deficiency. All women (11%) with hemoglobin levels <11.0 g/dl also had folate deficiency.

33. Buchanan JG, Nixon AD, Pettit JE, et. al.; "Iron Deficiency and Anemia among Indian Women in Fiji." Pathology 1982, 14:269-75.

A random sample of non-pregnant women aged 14-45 registered in the Health Office of a semi-rural area of Lautoka, Fiji was selected in June, 1979. The lactation and supplementation status of women sampled was not stated. In the sample, 40% of Hindu (total n=92) and 32% of Moslem (total n=213) women had hemoglobin levels <12.0 g/dl, with mean values of 12.0±1.7 g/dl and 12.3±1.5 g/dl, respectively.

The percent of anemic women of all women studied, including 41 pregnant women, classified as iron deficient (defined as MCV <27 pg and serum iron <10 µmol/L and serum transferrin >4.0 g/L and serum ferritin <26 µg/L) was 22.5%, however 63.0% of non-anemic women were also classified as iron deficient. Nineteen percent of all women had positive hookworm stool samples.

LATIN AMERICA AND THE CARIBBEAN

Caribbean

16. Simmons WK, Jutsum PJ, Fox M, et.al.; "A Survey of the Anemia Status of Preschool Age Children and Pregnant and Lactating Women in Jamaica." AJCN 1982, 35:319-26.

A multistage cluster sample of lactating (n=423) women was conducted between March 28 and June 23, 1978 which included all parishes on the island of Jamaica. The majority of lactating (58.7%) women had deficient hemoglobin levels (<12.0 g/dl). Mean hemoglobin levels were 11.8±1.7 g/dl in lactating women.

Tropical South America

20. Giugliani ERJ, Jorge SM, Goncalves AL; "Folate and Vitamin B12 Deficiency among Parturients from Porto Alegre, Brazil." Rev Invest Clin 1984, 36:133-6.

Thirty healthy non-pregnant women of reproductive age and "good" socio-economic status were included in this study. Further details regarding the sampling, gestational age, and lactational status of women were not reported.

The prevalence of anemia was not reported for the sample. Mean red blood cell folate and serum folate values were 249.4±66.6 µg/L and 4.92±1.82 ng/ml.

21. Mora JO; "Nutritional Status of the Colombian Population." Int J Vil Nurt Res Suppl 1985, 27:19-31.

A random sample consisting of 10,621 men, women and children from the entire non-institutionalized population was selected and studied during 1977-1980. Sample sizes for non-pregnant women aged 18-44 were not reported. The prevalence of anemia was found to be 17.1% (Hct <37%). The prevalence of iron deficiency (transferrin saturation <16%) exceeded that for anemia (17.4%).

22. Yepez R, Calle A, Galan P, et.al.; "Iron Status in Ecuadorian Pregnant Women Living at 2,800 m. Altitude: Relationship with Infant Iron Status." Int J Vit Nutr Res 1987, 57:327-32.

Female medical students (n=32) living in Quito were sampled to estimate the association between anemia, altitude and pregnancy in Quito, Ecuador. No data were reported regarding the lactation status of the sample.

Non-pregnant women had mean hemoglobin levels of 14.8±0.7, and none were considered anemic (<13.3 g/dl, given the adjustment for altitude). Interestingly, while the prevalence of iron deficiency anemia (serum ferritin <50 µg/L with transferrin saturation <16%) was identical to the prevalence of anemia in the sample. The mean hematocrit value was 44.0%±3.1%, serum iron was 19.2±5.4 µmol/L, total iron binding capacity was 63.6%±8.2%, transferrin saturation was 30.2%±8.1% and serum ferritin was 36.0%.

These data were compared to pregnant women delivering at the Isidro Ayora Maternity Hospital in Quito, and all were highly statistically different between pregnant and non-pregnant women. These differences, however, cannot be attributed to differences due to pregnancy, as vast socio-economic differences exist between the prenant (poor and lower middle class) and non-pregnant (professional women of middle and upper middle class) women studied.

23. Johnson AA, Latham MC, Roe DA; "The Prevalence and the Etiology of the Nutritional Anemias in Guyana.: AJCN 1982, 35:309-18.

A multi-stage, cluster sample of households with individuals attending health centers in 3 of the 6 Ministerial disticts of Guyana was obtained in 103 households on 590 individuals to estimate the distribution of anemia in Guyana. The exact period of data collection was not reported. Results reported here refer only to women 15-44 years of age.

Lactating women had the second (to pregnant women) highest prevalence of anemia (65.0%, n=40), who had a mean hemoglobin level of 11.2±1.7 g/dl, mean Hct of 36.4±4.3%, with 18.2%,71.4% and 12.5% classified as iron, folate and vitamin B12 deficient, respectively (criteria for all women is identical regardless of gestational and lactational status or age). As expected, non-pregnant, non-lactating females had lower levels of anemia, although these still represented a high prevalence (54.8%, n=84); the mean hemoglobin in this group was 11.2±1.4 g/dl, with a mean Hct of 37.1%±3.6%, and 11.9%, 80.0% and 16.7% classified as iron folate and vitamin B12 deficient.

NORTHERN AMERICA AND EUROPE

Northern America

53. Bindra GS, Gibson RS; "Iron Status of Predominantly Lacto-Ovo Vegetarian East Indian Immigrants to Canada: A Model Approach." AJCN 1986, 44:643-53.

Women aged 18-39 who were of Indian descent (many from Punjab) who had emigrated to Ontario, Canada between 1970-1975 were studied. None of the 38 women sampled were pregnant or lactating. Mean hemoglobin values (13.1±1.6 g/dl) indicate low levels of maternal anemia (Hb <12.0 g/dl). Other indices of hematologic status were consistent with this, including mean hematocrit (39.5%±3.3%), serum iron (81.8±70.2 µg/dl), TIBC (375.2±118.6 µg/dl), transferrin saturation (22.8%±17.3%) and serum ferritin (14.8 ng/ml).

54. Cook JD, Skikne BS, Lynch SR, Reusser ME; "Estimates of Iron Sufficiency in the U.S. Population." Blood 1986, 68(3):726-31.

Results were presented from the nationally representative, multi-stage cluster NHANES-II survey conducted during 1976-80. This publication presents data on 937 white, premenopausal women (whose gestational and lactational status is not reported) between the ages of 18-44. This survey estimates that 7.5% of sample women had Hb <12.0 g/dl (mean 13.3±1.0), but that 10.% had iron deficiency based on multiple criteria. Individual indices of iron deficiency varied, with 21.3% having serum ferritin <13 µg/L (mean 37±38 µg/L), 14.5% with transferrin saturation <15% (mean 27%±12%) and 12.1% with FEP levels >70 µg/dl (mean 55±20 µg/dl). Estimated iron stores in these women were 309±346 mg.

55. Meyers LD, Habicht JP, Johnson CL, Brownie C; "Prevalence of Anemia and Iron Deficiency Anemia in Black and White Women in the United States Estimated by Two Methods." AJPH 1983, 73(9):1042-9.

Hemoglobin data were analyzed for a nationally representative cluster survey of women 18-44 years old who participated in NHANES-I. This survey included data on 2,074 white and 742 black women from the United States, and was conducted between 1971-1974. Large discrepancies in hemoglobin were observed with 4.5% of white and 20.4% of black women considered anemic (Hb <12.0 g/dl). The magnitude of this discrepancy reflects nutritional rather than genetic differences in hemoglobin levels between black and white American women.

36. Serfass RE, Liu JF; "Assessing Iron Status During the Last Trimester of Pregnancy: Erythrocyte Protoporphyrin and Serum Ferritin Determinations.: Nutr Rep Internat 1983, 28:1171-8.

Women between 19 and 29 years of age attending outpatient clinics of Broadlawns Medical Center or the Student Health Center at Iowa State University were included in this study. Hematologic samples from 26 non-pregnant women who were not lactating were collected. Non-pregnant women had not received iron supplementation.

Four percent of nonpregnant women had Hb <12.0 g/dl (mean 13.3±0.5 g/dl) and none had FEP >100 µg/dl (mean 27.7±11.9 µg/dl), but 27% had serum ferritin values <12.0 µg/dl (mean 16.7±10.7 µg/dl). Mean hematocrit and MCV levels were 39.2±1.2% and 82.7±2.6 μ^3/cell, respectively.

Northern Europe

38. Milman N, Ibsen KK, Christensen JM; "Serum Ferritin and Iron Status in Mothers and Newborn Infants." Acta Obstet Gynecol Scand 1987, 66:205-11.

A hospital based survey of 163 healthy nonpregnant female blood donors was conducted in Denmark. No further data were provided on sampling or location of study. No women had Hb <12.0 (mean 13.4) g/dl, but 12.9% classified as iron depleted (serum ferritin <15 µg/dl). The sample mean serum ferritin was 24 µg/L, transferrin saturation was 31%, and serum iron was 17 µmol/L.

56. Wickham CP, Broin SD, O'Rourke A, Condren LT, Scott JM, Kevany JP; "Haemopoietic Nutrient Status of Young Nulliparous Women." Ir J Med Sci 1985, 154:51-8.

One hundred and six nulliparous volunteers aged 16-25 years were sampled for hematologic status in Dublin, Ireland. Details regarding sampling, place and date of survey were not further described. Twenty-six percent of the sample had taken occasional dietary supplements, and 12% were taking antiovulants.

A substantial percent (40%) of women had Hb <12.0 g/dl (mean 11.8±1.4, n=68), and serum ferritin levels <12 µg/L (36%, with a mean of 25.0±22 µg/L, n=97). Fewer women had low RBC folate levels (4% <100 µg/L, mean 202±81 µg/L, n=102) and serum folate values (5% <2.0 µg/L, mean 4.9±2.2 µg/L, n=104).

AUTOPSY STUDIES

57. Gautier du Defaix H, Puente R, Vidal B, Perez E, Vidal H; "Liver Storage Iron in Normal Population of Cuba." AJCN 1980, 33:133-36.

Necropsy liver tissue samples were collected from 127 male and 34 female cases of acute traumatic death autopsied at the Instituto de Medicina Legal, Havana. Only people with necropsy showing no liver changes or other disease that might alter the state of iron nutrition were collected.

Nonheme hepatic iron stores were 215.0±86.3 µg/g (n=5), 115.0±51.4 µg/g (n=23), and 189.0±91.6 µg/g (n=6) in females younger than 20, 20-46, and older than 46 years old, respectively. Overall mean nonheme liver stores were 142.6±91.6 µg/g in females sampled. Of females less than 20, 20-46 and greater than 46 years old, 0%, 8.7% and 16.6% had very deficient (<50 µg/g) and 20.0%, 34.8%, and 16.6% had deficient (<100 µg/g) liver stores, respectively. The average proportion of females autopsied with very low and low liver stores was 8.8% and 29.4%. These results are not significantly different from studies in the U.S., Sweden and Australia.

58. Loh TT, Chang LL; "Hepatic Iron Status in Malaysians and Singaporeans." SE Asian J Trop Med Pub Hlth 1980, 11(1):131-136.

Liver specimens were sampled from deceased individuals who died of trauma or acute diseases unrelated to the liver. The age, pregnancy status and sample frame were not specified. One hundred and thirty-three samples were collected in Malaysia and 142 in Singapore, or which 82 were female. The prevalence of hepatic non-heme iron <5 µg/100 g liver tissue (indicative of subclinica iron deficiency) in adult females was 16.7% in Malaysian, 19.0% in Chinese, and 35.7% in Indian women.

REFERENCES

24. Agarwal KN; Pregnancy Anemia and Fetal Outcome, Update Growth. Dept. Pediatrics: Institute of Medical Sciences. Banaras Hindu Univ, Varanasi, 1987.

27. Agarwal KN, Ahmed FU, Bahl L, et. al; Evaluation of the National Nutritional Anaemia Prophylaxis Programme. Indian Council of Medical Research 1989:86-87.

47. Agarwal DK, Bhardwaj B, Singla PN, Tripathi AM, Agarwal KN; Etiology of Maternal and Early Childhood Deficiency Anemia. Indian J Pediatr 1986, 53:389-96.

28. Agha F, Hasan TJ, Khan RA, Jafarey S; Iron Stores in Maternal and Cord Blood. Asia-Oceania J Obstet Gynaecol 1988, 14(4):405-9.

44. Ballot DE, MacPhail AP, Bothwell TH, Gillooly M, Mayet FG; Fortification of Curry Powder with NaFe(III)EDTA in an Iron-Deficient Population: Initial Survey of Iron Status. AJCN 1989, 49:156-61.

14. Baynes RD, Meriwether WD, Bothwell TH, et al.; Iron and Folate Status of Pregnant Black Women in Gazankulu. S Afr Med J 1986, 70:148-51.

26. Bhargava M, Kumar R, Iyer PU, et. al.; Effect of Maternal Anaemia and Iron Depletion on Foetal Iron Stores, Birthweight and Gestation. Acta Paediatr Scand 1989, 78:321-22.

53. Bindra GS, Gibson RS; Iron Status of Predominantly Lacto-Ovo Vegetarian East Indian Immigrants to Canada: A Model Approach. AJCN 1986, 44:643-53.

18. Bramble D, Simmons WK; Anaemia in Antenatal Patients in Montserrat. West Indian Med J 1984, 33:92-96.

33. Buchanan JG, Nixon AD, Pettit JE, et. al.; Iron Deficiency and Anemia among Indian Women in Fiji. Pathology 1982, 14:269-75.

54. Cook JD, Skikne BS, Lynch SR, Reusser ME; Estimates of Iron Sufficiency in the U.S. Population. Blood 1986, 68(3):726-31.

11. Coulibaly M, Costagliola D, Zittoun J, Mary JY; Modifications of Hemato-Biological Parameters in Pregnant Women in a Migrating Population in Northern Cameroon: Prevalence of Anemia, Iron and Folate Deficiencies. Int J Vit Nutr Res 1987, 57:173-8.

6. Fleming AF, Harrison KA, Briggs ND et al.; Anaemia in Young Primigravidae in the Guinea Savanna of Nigeria: Sickle Cell Trait Gives Partial Protection Against Malaria. Ann Trop Med Parasitol 1984, 78(4):395-404.

52. Gao J, Zeng S, Sun B, Fan H, Han L; Menstrual Blood Loss and Hematologic Indices in Healthy Chinese Women. J Reprod Med 1987, 32:822-6.

57. Gautier du Defaix H, Puente R, Vidal B, Perez E, Vidal H; Liver Storage Iron in Normal Population of Cuba. AJCN 1980, 33:133-36.

9. Gebre-Medhin M, Birgegard G; Serum Ferritin in Ethiopian Mothers and their Newborn Infants. Relation to Iron Intake and Socio-Economic Conditions. Scand J Haematol 1981, 27:247-52.

20. Giugliani ERJ, Jorge SM, Goncalves AL; Folate and Vitamin B12 Deficiency among Parturients from Porto Alegre, Brazil. Rev Invest Clin 1984, 36:133-6.

50. Goh TH, Hariharan M; Iron-Deficiency Anaemia and Serum Ferritin Levels in Malaysian Women. Med J Malaysia 1986, 41(4):300-4.

35. Hambidge KM, Krebs NF, Sibley L, English J; Acute Effects of Iron Therapy on Zinc Status During Pregnancy. Obstet Gynecol 1987, 70:593-6.

49. Hamedani P, Hashmi KZ, Manji M; Iron Depletion and Anaemia: Prevalence, Consequences, Diagnostic and Therapeutic Implications in a Developing Pakistani Population. Curr Med Res 1987, 10(7):480-85.

41. Hercberg S et al. Relationship Between Anaemia, Iron, and Folacin Deficiency, Haemoglobinopathies and Parasitic Infection. Hum Nutr Clin Nutr 1986, 40c:371-79.

39. Hercberg S et al. Prevalence of Iron Deficiency and Iron-Deficiency Anaemia in Benin. Public Health 1988, 102:73-83.

3. Hercberg S et. al. Nutritional Anemia in Pregnant Beninese Women: Consequences on the Haematological Profile of the Newborn. Br J Nutr 1987, 57:185-93.

40. Hercberg S et al. Evaluation of the Frequency of Anaemia and Iron-Deficiency Anaemia in a Group of Algerian Menstuating Women by a Mixed Distribution Analysis: Contribution of Folate Deficiency and Inflammatory Processes in the Determination of Anaemia. Int J Epidemiol 1988, 17(1):136-41.

31. Ho CH et al. Serum Ferritin, Folate, and Cobalamin Levels and Their Correlation with Anemia in Normal Full-Term Pregnant Women. Eur J Obstet Gynecol Reprod Bull 1987, 26:7-13.

45. Huffman SL et al. Nutrition and Fertility in Bangladesh: Nutritional Status of Non-Pregnant Women. AJCN 1985, 42:725-38.

5. Isah HS et al. Anaemia and Iron Status of Pregnant and Non-Pregnant Women in the Guinea Savanna of Nigeria. Ann Trop Med Parasitol 1985, 79(5):485-93.

4. Jackson RT & Jackson LC; Biological and Behavioral Contributors to Anemia During Pregnancy in Liberia, West Africa. Hum Biol 1987, 59(4):585-97.

23. Johnson AA et al. The Prevalence and the Etiology of the Nutritional Anemias in Guyana.: AJCN 1982, 35:309-18.

29. Karim SA et al. Anaemia in Pregnancy: Occurence in Two Economically Different Clinic Populations of Karachi. J Pak Med Assn 1988, 38:271-2.

51. Kuizon MD et al. Assessment of the Iron Status of Filipino Adolescents. SE Asian J Trop Med Pub Hlth 1982, 13(1):81-85.

7. Kulkarni AG. Anaemia and Blood Requirements During Pregnancy in Patients from Guinea Savanna of North of Nigeria. E Afr Med J 1987, 64(1):65-70.

15. Lamparelli RDV et al. Anaemia in Pregnant Indian Women in Johannesburg. S Afr Med J 1988, 74:170-3.

13. Lamparelli RDV et al. Nutritional Anaemia in Pregnant Coloured Women in Johannesburg. S Afr Med J 1988, 73:477-81.

10. Liljestrand J et al. Anaemia of Pregnancy in Mozambique. Trans Royal Soc Trop Med Hyg 1986, 80:249-55.

58. Loh TT & Chang LL. Hepatic Iron Status in Malaysians and Singaporeans. SE Asian J Trop Med Pub Hlth 1980, 11(1):131-136.

42. Mbofung CMF & Atinmo T. Zinc, Copper and Iron Concentrations in the Plasma and Diets of Lactating Nigerian Women. Brit J Nutr 1985 53:427-39.

55. Meyers LD et al. Prevalence of Anemia and Iron Deficiency Anemia in Black and White Women in the United States Estimated by Two Methods. AJPH 1983, 73(9):1042-9.

38. Milman N et al. Serum Ferritin and Iron Status in Mothers and Newborn Infants. Acta Obstet Gynecol Scand 1987, 66:205-11.

21. Mora JO; Nutritional Status of the Colombian Population. Int J Vit Nurt Res Suppl 1985, 27:19-31.

48 Moser PB et al. Copper, Iron, Zinc and Selenium Dietary Intake and Status of Nepalese Lactating Women and Their Breast-Fed Infants. AJCN 1988, 47:729-34.

8. Oluboyede OE. Iron Studies in Pregnant and Non-Pregnant Women with Haemoglobin SS or SC Disease. Brit J Obstet Gynaecol 1980, 87:989-96.

12. Prual A et al. Evaluation of Iron Status in Chadian Pregnant Women: Consequences of Maternal Iron Deficiency on the Haematopoietic Status of Newborns. Trop Geogr Med 1988, 40:1-6.

43. Rougereau A et al. Ferritin and Iron Status in Senegalese Women. AJCN 1982, 36:314-8.

37. Rush D et al.; Review of Past Studies of WIC. AJCN 1988, 48:394-411.

36. Serfass RE & Liu JF. Assessing Iron Status During the Last Trimester of Pregnancy: Erythrocyte Protoporphyrin and Serum Ferritin Determinations.: Nutr Rep Internat 1983, 28:1171-8.

46. Shah SNA et al. Incidence of Iron Deficiency Anaemia in Rural Population of Kashmir. Ind J Public Health 1982, 26(3):144-54.

25. Shukla MK et al. A Longitudinal Study on Anaemia of Pregnancy in a Rural Population of Uttar Pradesh. Indian J Med Res 1982, 75:541-44.

34. Sill PR et al. Multifactorial Aetiology of Anaemia of Pregnancy in Port Moresby, Papua New Guinea. PNG Med J 1987, 30:193-8.

19. Simmons WK et al. Anaemia in Antenatals in the Turks and Caicos Islands. West Indian Med J 1987, 36:210-15.

16. Simmons WK et.al. A Survey of the Anemia Status of Preschool Age Children and Pregnant and Lactating Women in Jamaica. AJCN 1982, 35:319-26.

17. Simmons WK et.al. Haemoglobin Levels in West Indian Antenatals. West Indian Med J 1987, 36:216-24.

1. Toppozada HK & Ghoneim SM. A Hematologic Study of Pregnant Women in Free and Insurance Hospital Populations. Int J. Gynaecol Obstet 1983, 21:439-42.

32. Watson DS, Tozer RA. Anaemia in Yirrkala. Med J Aust 1986, 144:S13-S15.

2. WHO: Report of the African Regional Consultation on Control of Anaemia in Pregnancy. **WHO Afr/MCH/86** 1986:4.

56. Wickham CP et al. Haemopoietic Nutrient Status of Young Nulliparous Women. Ir J Med Sci 1985, 154:51-8.

22. Yepez R et.al.; Iron Status in Ecuadorian Pregnant Women Living at 2,800 m. Altitude: Relationship with Infant Iron Status. Int J Vit Nutr Res 1987, 57:327-32.

30. Zhang A & Ge X. The serum and Red Cell Folate Levels in Pregnant Women in Beijing. Chinese Med J 1986, 99:899-902.