IDPAS # 1235

International Journal of Food Sciences and Nutrition (1997) 48, 265–270

Prevalence of anaemia in pregnant women during the last trimester

M.J. Msolla and J.L. Kinabo

Sokoine University of Agriculture, Department of Food Science and Technology, PO Box 3006, Morogoro, Tanzania

Anaemia is a very common condition during pregnancy. This is particularly so in developing countries where the level of intake of iron rich foods is low; malaria and other intestinal parasites are common. This study was conducted to determine the prevalence of anaemia and the type of anaemia existing in pregnant women in Morogoro municipality. The effect of anaemia on infant birth weight was also examined. Twenty randomly selected pregnant women in their last trimester of pregnancy were studied. The subjects were recruited from the three maternal and child health clinics in the municipality. The subjects were not taking iron, folate or vitamin B12 supplements at the time of the study. Blood samples were collected from subjects during their routine visit to maternal and child health clinics. A series of determinations was conducted to determine haemoglobin concentration (Hb); packed cell volume (PCV); red blood cells count (RBC); serum iron (SI); and total iron binding capacity (TIBC). The effect of anaemia on the weight of new born babies was examined by calculating the correlation coefficient of birth weight and haematological indexes. The mean values (SD) of haematological indexes were as follows: Hb 8.7 ± 1.5 g/dl; PCV 30.4 ± 5.1%; RBC 2.5 ± 0.6 × 10^2/l; mean corpuscular haemoglobin concentration (MCHC) 28.9 ± 4 g/dl; mean corpuscular volume (MCV) 151.5 ± 120 fl and mean corpuscular haemoglobin (MCH) 35.2 ± 7.9 pg. The results have shown that 95% of the subjects were anaemic at the time of the study. All subjects were suffering from iron, folate and vitamin B12 deficiencies. This suggests that all subjects had a combination of microcytic and megaloblastic anaemia. The results have also shown that there was a positive correlation ($r = 0.76$; $P = 0.01$) between Hb concentration and weight of the infants at birth. Subjects who had Hb concentration of below 7.4 g/dl delivered infants that were weighing below 2500 g (mean birth weight of 2160 ± 228 g). For those who had an Hb concentration of above 9.5 g/dl delivered infants weighing more than 3000 g (mean 3142 ± 329 g). The mean birth weight of the infants born to anaemic subjects (Hb < 7.9 g/dl) was significantly lower compared to that of infants born to non-anaemic subjects. This observation suggests that anaemia had a significant influence on the birth weight of the infant. This could also be an indication of poor food security in general. Major causes of anaemia were identified as being poor dietary intake of iron rich foods and probably poor utilisation due to diseases such as malaria. All women had basic knowledge on anaemia. Most of the information was obtained from maternal and child health clinics (76%), schools (15%) and radio programmes (4%). However, despite their awareness on anaemia, the women were still anaemic. The main reason was lack of economic access to appropriate foods.

Correspondence to J.L. Kinabo.

0963-7486/97/040265-6

Introduction

Anaemia is one of the four major nutritional problems of public health significance in the world. Other problems include protein-energy malnutrition, vitamin A deficiency and iodine deficiency. Anaemia affects more than half of all pregnant women world wide (WHO, 1993). According to the WHO data, anaemia is a contributing factor in more than half of the 500 000 deaths which occur each year due to complications of pregnancy and child birth. In Africa, over 250 million adults, majority being women of the reproductive age (14–45 years) are anaemic (IDFNA, 1992); and it is the main cause of about 20% of maternal deaths. In Tanzania, anaemia is a direct cause of maternal mortality and obstetric admissions in hospitals (Kavishe, 1993).

According to the WHO definition (1968), a woman is considered to be anaemic when the concentration of Hb in the blood falls below 11 g/dl. Severe anaemia is considered when the level of Hb is less than 8 g/dl (WHO, 1968). In Tanzania, the prevalence of anaemia varies from 1–100% depending on the population group and geographical location. Pregnant and lactating women and children under 5 years of age constitute the most vulnerable groups (Kavishe, 1991). A recent study (Kitange *et al.*, 1991) conducted in four regions in the country (Kilimanjaro, Morogoro, Dar es Salaam and Mara) showed that the prevalence of anaemia was 21% without gender desegregation, and that men are equally affected. However, it has been shown (Kavishe, 1993) that about 32% of the population are affected, and that out of these, 80% are pregnant and lactating women.

Anaemia may result in death of a pregnant woman, premature births, low birth weight (Brabin *et al.*, 1990) and other malfunctions. Despite a number of studies on anaemia in pregnant women in other areas of the country, very little has been done in Morogoro. In addition, little information is available on anaemia resulting from folate and vitamin B12 deficiency. However, it is likely that such cases occur in substantial numbers and may be as important as iron in causing anaemia.

The objective of this study was to determine the prevalence of anaemia in pregnant women in Morogoro and its effect on the weight of the infants at birth. Attempts have also been made to determine other haematological indexes that are associated with anaemia. It is well recognised that use of isolated Hb or haematocrit alone has its limitations. The major one arises from the fact that there is marked overlap in haemoglobin levels between normal and anaemic individuals (Garby *et al.*, 1969), and haemoglobin determinants lack specificity and sensitivity. A combination of independent variables can give a more clear picture of the prevalence of anaemia. It is for this reason that various variables were included in this study.

Subjects and methods

Study area

The study was conducted in Morogoro Municipality in Tanzania. Morogoro is situated about 200 km west of Dar es Salaam at an altitude of 600 m above sea level. The town is surrounded by a range of mountains and are responsible for the characterisitic weather pattern observed in Morogoro. Morogoro experiences three seasons: short rain season (November–January), long rain season (March–May) and dry season (July–October). Crops grown in Morogoro include maize, sorghum, rice, cassava, yams, beans, peas and a variety of both tropical and temperature fruits and vegetables.

Subjects

Twenty randomly selected pregnant women in their third trimester of pregnancy (i.e. 28–39 weeks) participated in this study. These were recruited from three maternal and child health clinics situated within Morogoro municipality. The three clinics are public owned; they cater for all women irrespective of income, occupation or race. The women were not receiving iron, vitamin B12 or folate supplements at the time of the study. The study was fully explained to them before they could give their consent to participate. The protocol was approved by the ethical committees of the Morogoro Government General Hospital and Sokoine University of Agriculture.

Blood samples

Blood samples were collected from 20 pregnant women in their third trimester and attending at Maternal and Child Health clinics. Ten ml of venous blood were collected in heparinised tubes at the clinic and transported to the laboratory in a cold flask maintained at 10°C within 1 h. At the laboratory, each blood sample was divided into two portions. One portion of 2 ml for the determination of Hb, packed cell volume (PCV) and red blood cells (RBC) was stored at 4°C until use (within 2 days). The other portion of 8 ml was centrifuged immediately at 3000 rpm for 10 min to obtain plasma. The plasma from each sample was divided into two portions and stored at −20°C. These portions were used for the determination of serum iron (SI) and total iron binding capacity (TIBC).

Haemoglobin concentration (Hb)

Hb concentration of the samples was determined using the cyanmethemoglobin method (Cartwright *et al.*, 1948).

Packed cell volume (PCV)

PCV is the volume of red blood cells expressed as a proportion of a given volume of whole blood (1/10). The PCV was measured using a micro haematocrit Hawksley reader (Hawksley & Sons Ltd, Sussex, UK).

Red blood cell (RBC) count

RBC count was done using the Burker Turk Counting chamber (Heubauer Brand, West Germany).

Serum iron

The concentration of iron in serum was determined using Pye Unicam SP 191 Atomic absorption spectrophotometer (Unicam Instruments Ltd, Cambridge, UK). The concentration of iron obtained from the spectrophotometric reading was multiplied by a factor of 2 to obtain the concentration in the original samples.

Because the measurement of the haemoglobin concentration in blood does not distinguish between different types of anaemia, other ratios were derived from the above measurements. These included MCH, MCV and MCHC.

Dietary survey

A 24 h recall method was used to gather information on dietary intake. The subjects were asked to recall the types and approximately the amount of food consumed over the previous 24 h. In addition, they were asked to give reasons as to why some women were anaemic.

Results

Hb concentration

The mean Hb concentration was 8.7 ± 1.5 g/dl. This is lower than the standard value of 11 g/dl recommended by WHO. The results have also shown that 95% of the subjects had Hb levels much less than 11 g/dl.

PCV

The mean PCV value was 30.4 ± 5.1%. The PCV values of about 60% of the subjects were found to be below 33%. For the remaining 40% their PCV values were above 33% (considered to be normal). It was also observed that for subjects who had low haematocrit values, they also delivered infants who had low birth weight.

RBC count

The mean RBC count was 2.58 ± 0.6.× 10^{12}/l. None of the subjects had RBC counts above the normal value of 3.9 × 10^{12}/l, suggesting that all subjects had hypochromic type of anaemia.

MCHC

About 90% of the subjects had MCHC values below 31 g/dl and only 10% of the women had values above 31 g/dl. The mean MCHC value was 29.9 ± 4 g/dl.

Table 1. Haematological results

	Hb (g/dl)	*PCV (%)*	*RBC (×10^{12}/l)*	*MCHC (g/dl)*	*MCV (fl)*	*MCH (pg)*	*TS (%)*
Mean	8.7	30.4	2.6	28.9	26.5	35.2	20.5
SD	1.5	5.1	0.6	4.0	6.4	7.9	1.4
Range	6–11	18–38	1–4	24–44	90–169	19–46	6–71
WHO value (1968)	>11	>33	4–7	>31	<95	27–31	>15

MCV

The mean MCV value was 26.5 ± 6.4 fl and about 95% of the subjects had MCV values above the standard value of 95 fl suggesting megaloblastic type of anaemia.

MCH

The mean MCH value for the sample was 35.2 ± 7.9 pg, suggesting that all subjects had values much higher than the normal value of 27–31 pg. The results have also shown that 70% of the subjects probably had macrocytic anaemia, 15% iron deficiency and another 15% had normal MCH.

Transferrin saturation (TS)

The mean transferrin saturation was found to be 20.5 ± 1.4%, indicating that most subjects had sufficient transferrin saturation.

Infant birth weight

The mean birth weight of the infants was 2722 ± 256 g. There was a significant positive correlation ($r = 0.76$; $P = 0.01$) between the Hb level of the subjects and the birth weights of the infants, suggesting that anaemic subjects gave birth to low birth weight infants. In addition, the mean birth weight of infants born to anaemic subjects (Hb 6.0–7.5 g/dl) was lower than that of infants born to subjects who had a reasonable Hb level (>9.5 g/dl).

Dietary survey

The results of the dietary survey showed that only 19% of the subjects were able to consume protein food during breakfast; 43% during lunch and 76% during dinner. Most of the protein foods were those of plant origin such as beans, cowpeas and pigeon peas. Animal protein intake was very small. Of all the respondents, only 50% consume fruits and vegetables during meal times. The other 50% take fruits as a snack and this is not on a daily basis. In addition, the quantity of fruits and vegetables consumed is very small about 100–150 g/day. This does not provide sufficient nutrients to meet the daily requirements for pregnant women.

Discussion

The objective of the present study was to determine the prevalence of anaemia in pregnant women by examining several hematological indexes in a sample population. The indexes or variables studied included Hb, PCV, RBC, MCH, MCHC, SI, TIBC and TS.

The study has shown that the prevalence of anaemia in the study sample was 80%, suggesting that anaemia is probably a widespread problem in pregnant women in Morogoro municipality. However, when the cut-off point of 11 mg/dl was used, 95% of the subjects were categorised as anaemic, meaning that almost all subjects (19) at the time of blood collection were anaemic.

The determination of PCV has shown that about 55% of the subjects had hypochromic type of anaemia. This suggests that the cells were lacking iron. This observation is similar to that made by Fleming (1989) in Ndola, Zambia and in Nigeria (Dallman, 1989) where about more than 50% of the subjects had PCV values less than 33%.

The results of the RBC count showed that all studied women had hypochromic type of anaemia with mean RBC value of 2.58 ± 0.6 × 10^{12}/l. This value agrees well with the mean MCHC value observed in the present study (28.9 ± 4 g/dl) which also suggests that the RBC were lacking iron in the Hb and therefore the type of anaemia is hypochromic. However, the mean MCV value of 126.5 fl suggests that there was a problem of folate and vitamin B12 deficiency. According to Davidson *et al.* (1979), an MCV value of over 95 fl indicates that the erythrocytes are on average larger than normal; which is a clear indication that folate and vitamin B12 deficiency could be suspected. Vitamin B12 and folate are essential for the maturation of RBC. In the absence of the two micronutrients the cells continue to grow and attain a much larger size. Thus, they are unable to transport oxygen around the body.

Another parameter studied was TS. This parameter showed that only eight women (40%) had severe anaemia compared to 11 (55%) so categorised by the Hb measurement.

Although Hb and PCV are used interchangeably, they tend to give different pictures as far as prevalence of anaemia is concerned. Both Hb and PCV define the advanced stage of iron deficiency and that they provide a quantitative measure of the severity of iron deficiency once the anaemia has developed. In the present study, the mean Hb was 8.7 g/dl and mean PCV was 30.4%. This is suggestive of iron deficiency, hence microcytic anaemia. However, Hb measurements during pregnancy particularly during the last trimester may be misleading because of the increase in plasma volume and change in cell mass due to hemodilution.

The results of MCV and MCH suggest that there was deficiency of both folate and vitamin B12. This caused enlargement of the RBC, hence megaloblastic anaemia.

MCV is a measure of the size of the circulating RBC and gives an indication of the level of haemoglobin synthesis. When folate and vitamin B12 are lacking in the diet, RBC grow big in size and become unable to transport oxygen. In the present study, about 85% of the subjects had megaloblastic anaemia. However, when MCH is used, only 65% of the subjects are classified as having megaloblastic anaemia, suggesting that there was reduced haemoglobin synthesis in the subjects.

The study has also shown that hematological indexes or iron status affects birth weights of infants. In this study, iron deficiency and/or anaemia was probably one of the factors that contributed to babies being born with low birth weights (Table 2). This is because during anaemia, there is impaired delivery of haemoglobin and thus, oxygen to the uterus, placenta and the developing foetus. The effects accounts for the risk of low birth weight, pre-term delivery and still births. Similarly, anaemia may cause poor tolerance to heavy blood loss and surgical interventions at delivery.

Other studies conducted in developing countries have shown that severe anaemia during pregnancy is a cause of low birth weight. For example, a study by Macgregor (1963) showed that the incidence of low birth weight was 42% in severe anaemia group (Hb <7.4 g/dl). In another study conducted in Ivory Coast (Reinhardt, 1978), the mean birth weight of infants born to anaemic women was significantly lower than that of infants born to women who were not anaemic (2881 g vs 3070 g). In the present study, for severe anaemia cases (mean Hb 6.9 ± 0.5 g/dl), the mean birth weight of the infants was 2160 ± 228 g. This is significantly lower than 2500 g considered to be low birth weight by the WHO. In addition, severe anaemia cases accounted for about 25% of all the subjects studied (Table 2). This suggests that anaemia is probably a very serious problem in Morogoro.

Results of the dietary survey showed that, there was inadequate intake of iron rich foods (animal foods). The diet is predominantly of

Table 2. Haematological indexes and infant birth weight

Subject no.	*Hb (g/dl)*	*PCV (l/l)*	*RBC (×10¹²/l)*	*MCV (fl)*	*MCH (pg)*	*MCHC (g/dl)*	*Birth weight (g)*	*Maternal age (years)*
1	7.4	27	1.8	150	41	27	2400	20
2	8.5	28	2.4	118	36	30	2600	35
3	7.0	26	1.5	169	45	27	2200	30
4	7.8	28	2.3	123	31	28	2500	24
5	7.8	28	2.5	112	34	28	2500	24
6	11.3	38	2.6	143	43	30	3600	27
7	7.2	29	2.2	130	32	25	2300	30
8	6.2	18	1.5	120	41	34	1800	24
9	10.9	24	2.1	117	53	44	3500	20
10	6.6	23	3.4	169	19	29	2000	27
11	9.1	34	2.3	147	39	27	2700	18
12	10.9	38	2.8	137	39	29	3400	23
13	9.3	34	3.4	99	27	27	2800	25
14	9.1	35	3.9	90	24	26	2800	18
15	8.3	30	3.1	97	27	28	2600	22
16	9.5	32	2.7	120	35	30	3000	38
17	9.7	34	2.7	127	36	29	3100	27
18	10.5	36	2.8	131	38	29	3300	26
19	8.7	34	3.0	113	29	26	2700	28
20	8.9	32	2.7	119	33	28	2700	25

plant foods largely carbohydrate foods. Very little of vegetables, legumes and fruits is consumed. This is unfortunate considering that Morogoro is endowed with a large variety of vegetables and fruits. When the respondents were asked whether they had any knowledge on anaemia regarding its causes and prevention, all respondents admitted that they have knowledge on anaemia. However, despite their knowledge on anaemia, most subjects were anaemic. The reason put forward was that they lack economic access to appropriate foods.

The results of the present study suggest that there is probably high prevalence of iron deficiency and/or anaemia in Morogoro municipality and that iron deficiency with or without anaemia has an effect on birth weight of infants. This is because subjects who had low Hb gave birth to babies of low birth weights, suggesting that iron deficiency with or without anaemia is an important public health problem in Morogoro municipality. This calls for a much bigger study involving a larger sample size. However, in the mean time the following immediate actions are recommended to improve the situation. Some of the measures may include:

1. routine iron, folate and vitamin B12 supplementation to pregnant women to improve the haematological indexes;
2. improved household food security through diversified production and consumption of fruits, vegetables and animal foods;
3. proper cure and prevention of diseases such as malaria and worms;
4. formulation of proper nutrition messages for all women (adolescent, young and pregnant) on the importance of micronutrients in the diet.

Furthermore, studies are needed to determine the absorption of iron from Tanzanian diets and to determine the effectiveness of iron supplementation during pregnancy. This would allow the development of a more sensitive and accurate routine method for assessing anaemia in a large population.

Acknowledgements—The authors would like to thank the subjects for participation, the Authorities of the three Maternal and Child Health clinics who kindly allowed us to conduct the study at their premises and H.I. Mafazy, S.R. Mzuzuri and E. Kafui for technical assistance, and lastly Sokoine University of Agriculture for financial support.

References

Brabin BJ, Ginny M, Sapau S, Gahne G & Piano J (1990): Consequences of maternal anaemia on outcome of pregnancy in a malaria endemic area in Papua New Guinea. *Ann. Trop. Med. Parasitol.* **84**, 11–24.

Cartwright GE, Huguley CM, Jr, Ashen-Brucker H, Fay J & Wintrobe MM (1948): Studies on free erythrocyte protoporphyrin, plasma iron, and plasma copper in normal and anemic subjects. *Blood.* **3**, 501–520.

Davidson S, Passmore R, Brock JF & Truswell AS (1979): *Human Nutrition and Dietetics*, 7th edn, pp. 342–352. London: Churchill Livingstone.

Dallman PR (1989): Iron deficiency: does it matter? *Int. Med.* **226**, 367–372.

Fleming AF (1989): The aetiology of severe anaemia in pregnancy in Zambia. *Ann. Trop. Med. Parasitol.* **83**, 37–49.

Garby L, Irnell L & Werner I (1969): Iron deficiency in women of fertile age in a Swedish community III. Estimation of prevalence based response to iron supplements. *Acta Med. Scand.* **185**, 113–117.

International Decade on Food and Nutrition for Africa (IDNFA) (1992): Nutritional Anaemia Report, p. 20.

Kavishe FP (1991): The control of micronutrient, the experience of Tanzania. In *Proceedings of Ending Hidden Hunger.* Montreal, Canada.

Kavishe FP (1993): Nutrition relevant actions in Tanzania. Food and Nutrition Centre Monograph Series No 1.

Kitange HM, Swai ABM, Kilima PM, Masuki G, Albert KGMM & Mclarty DG (1991): Anaemia is a major public health problem in Tanzania. *Health Po. Pl.* **8**(4), 413–424.

Macgregor MW (1963): Maternal anaemia as a factor in prematurity and perinatal mortality. *Scot. Med. J.* **8**, 134–140.

Reinhardt MC (1978): Maternal anaemia in Abidjan: its influence on placenta and newborns. *Helv. Paediatr. Acta* **33** (Suppl. 41), 43–63.

WHO (1968): Nutritional anaemia report of WHO scientific group. *Wld Health Org. Tech. Rep.* **405**, Geneva.

WHO (1993): Family Health Technical Report Series No. 1056, Geneva.