Research Journal of Biological Sciences 2 (2): 118-126, 2007

Anaemia and Iron Deficiency Anaemia During Pregnancy in an Agricultural Region of Morocco: Effects of Dietary Intake and Iron Supplementation

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Abstract: This study aimed to estimate the prevalence of Iron Deficiency Anaemia (IDA), after a supplementation strategy applied to combat IDA in Moroccan pregnant women and to establish the association between iron status, diet and pregnancy outcome. The study was conducted on an agricultural community of pregnant women. Information about socio-economic status, iron supplement use and dietary habits were recorded. Blood samples were collected to determine Haematocrit (Ht), Haemoglobin (Hb) and Serum Ferritin (SF) levels and pregnancy outcome characteristics were registered. Anaemia and IDA prevalence were high and most of women had either depleted or low iron stores. Energy and nutrient intakes assessment showed that iron and folate consumption was below the two-third of the RDA. Intakes of meat, energy and calcium were lower and that of tea was higher in anaemic compared to non-anaemic women. Women with IDA presented the poorer diet. There was no significant differences of hb, ht and SF means in women who were iron supplemented (37.1% of the population) and those who were not. Newborns from anaemic and IDA mothers had lower Birth Weight (BW) than nonanemic women, however no correlation could be found between BW and haematological parameters or nutrient intakes. The results show also that anaemia and IDA affected mostly women with low socio-economic status and poor diet. The study data indicate the necessity to increase women awareness and argue for an adequate strategy such as food fortification to eradicate iron deficiency anaemia.

Key words: Iron deficiency anaemia, dietary intake, supplementation, pregnancy, Morocco

INTRODUCTION

Anaemia currently affects pregnant women, nevertheless in proportions higher in developing compared to industrialized countries (World Health Organization, 1992).

Anaemia may have several origins (such as iron, folate or vitamin B12 deficiencies, inflammation, infection…), but the most commonly described is iron deficiency anaemia.

Foetal iron needs increase over pregnancy, making the mother's requirements enhanced from 0.8 msg day^{-1} at the beginning to <7.5 mg day^{-1} at the end of pregnancy (Viteri, 1997). If iron requirements are not covered by the mother's diet, the foetus takes iron needed from the mother's iron stores. This may induce Iron Deficiency Anaemia (IDA), mainly if the mother enters pregnancy with low iron stores. IDA results often from a poor intake of iron-containing foods and depends on intakes of factors, enhancing or inhibiting iron absorption (Lynch, 1997; Hallberg and Hulthén, 2000).

Among the several adverse effects attributed to the mother's anaemia and IDA are: tiredness, reduced physical and mental performance and reduced immune functions. The effects of anaemia and IDA on pregnancy outcome have been reviewed (Scholl and Hediger, 1994; Scholl and Reilly, 2000; Allen, 2000). They are generally adverse to birth outcome, increasing the risk of prematurity, low birth weight and perinatal mortality, mainly when occurring in the first stages of pregnancy. Furthermore, maternal iron status has been shown to condition the iron status of newborn (Dop *et al*., 1992; Gaspar *et al*., 1993) and even infants aged 3 to 12 months (Kilbride *et al*., 1999).

To avoid adverse effects of anaemia and IDA during pregnancy, different strategies are developed.

In Morocco, anaemia has been recognized as a public health problem. A national survey (Institut National d'Administration Sanitaire, 1995) reported a high prevalence of anaemia in pregnant women (45.5%). Another regional study conducted in Doukkala region even showed a higher prevalence of anaemia (57.5%) in pregnant women (Belahsen *et al*., 1999-2000).

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From a nutritional point of view, national data showed that daily iron intake was insufficient to cover the iron needs (Direction des Statistiques, 1984-85).

It is the reason why interventions were conducted by the ministry of public health to combat iron deficiency, principally consisting in supplementing pregnant women. Indeed, iron supplements (sometimes iron and folate) are systematically distributed to all pregnant women attending health centres.

In Morocco, studies specifically focused on iron status, nutritional assessment and outcome during pregnancy are lacking. The objective of this study was therefore to determine the prevalence of anaemia and IDA in an agricultural community of pregnant women in a coastal region of Morocco (Doukkala). The aim was then to evaluate the supplementation program, the relation between iron status and nutritional intakes and the effects of iron status on pregnancy outcome.

MATERIALS AND METHODS

The study was conducted between April and November 2002 on 229 pregnant women, aged 16 to 44 years, at different stages of pregnancy from Doukkala region. The sample included women who visited the Public health centres in urban (n = 145) and rural (n = 84) areas.

Data on the socio-demographic characteristics, health, dietary intake, iron supplements use and reproduction were collected in the pregnant women using a questionnaire. The pregnancy stage was determined either by physical examination (uterine height), or according to the mother's assertion, the date of the last menstrual period being often unknown.

Blood collection and analysis: Blood samples were collected between 08:00 and 10:00 in all the surveyed women who were in a fasting state. They were kept on ice until arrival to the laboratory. Haematocrit was determined using a capillary microhaematocrit reader and haemoglobin concentration was measured by the cyanomethemoglobin method (Dallman, 1984).

The blood was centrifuged at 4°C for 7 min at 4000×g and the serum was frozen at -80°C. Serum Ferritin (SF) was measured in duplicate by turbidimetric latex immunoassay, using commercial kits (Biosystems S.A. Barcelona (Spain)).

Pregnant women were considered to have anaemia if their haemoglobin concentration was <11 g dL^{-1} or their heamatocrit < 33% (in the first and third trimester) and <10.5 g dL^{-1} or 32% (in the second trimester) (Centres for disease control, 1989a). Serum Ferritin (SF) concentration below 12 μg L^{-1} or 30 μg L^{-1}, were considered to reflect iron deficiency or low iron stores respectively (Centres for Disease Control, 1989b; Cook *et al.* 1992) and Iron Deficiency Anaemia (IDA) corresponds to anaemia accompanied by serum ferritin <12 μg L^{-1}.

Dietary intake: Dietary intake was performed in pregnant women, using a Food Frequency Questionnaire (FFQ) containing 101 foods and beverages commonly consumed by this population. The questionnaire was first used to estimate the intake of major food groups. Daily energy and nutrients intakes were calculated by multiplying the relative consumption frequency of each food by the nutrient content of the standard portion size (obtained from the computerized diet Software Bilnut, Nutrisoft) and the quantity of the portion taken by each woman. The nutrient intake was obtained by summing the values for all the food consumed (Thomson and Byers, 1994).

The interest was focused on nutrients known to be involved in anaemia and iron status, such as iron, folic acid and factors enhancing (vitamin C, protein) or inhibiting (calcium, tea) iron absorption.

Pregnancy outcome: Eighty four women were visited after delivery (42 from urban and 42 from rural area) and information about gestation and newborn weights at birth were registered. Delivery was considered as premature when occurring before the 37th week of pregnancy and low birth weight was defined as below 2500 g (WHO, 1995).

As most of rural women delivered at home, the first newborns' weighting was registered during their visit to health centres for vaccine, which generally occurs around the tenth day after delivery. Birth weight was then estimated, taking as reference weight evolution over the first two weeks of life of 105 male and 92 female babies of known weight at birth coming from the same region.

The study protocol was approved by the Ministry of Health.

Statistical tests: All statistical analyses were performed with SPSS 11.0 (SPSS Inc., Chicago, Illinois). ANOVA and Tukey tests were used to determine whether significant differences exist between the different variable means. Spearman or Pearson correlation coefficients were used to determine the association between variables. The level of significance applied to statistical tests was $p<0.05$.

RESULTS

The general characteristics of women enrolled according to area of residence are presented in Table 1.

Most of women were aged between 20 and 40 years (mean age: 27.3±6.6 years) and multiparous (mean parity: 2.71±1.90). The table shows that women were significantly younger and had higher parity in rural than in urban area.

Haematological parameters: Table 2 shows haemoglobin (hb), haematocrit (ht) and Serum Ferritin (SF) values according to maternal characteristics. Mean hb, ht and SF were respectively 11.82±1.89 g dL^{-1}, 33.1±4.1% and 25.0±18.7 μg L^{-1} and a high positive correlation was established between hb and ht values ($p<0.001$; $r = 0.56$). The results show a significant decrease of ht ($p<0.001$) and hb ($p<0.05$) means at the second trimester of pregnancy, but no difference was found between the second and the third trimesters. There was no significant difference for SF values between pregnancy stages.

Table 1: Characteristics of moroccan pregnant women according to area of residence

Sample characteristic	Total	Urban	Rural
Age (years), mean±SD	27.3±6.6 (n = 229)	28.1±6.9 (n = 145)	25.9±5.9 (n = 84)
Age groups (years),(%)		63.3	36.7
< 20	11.4	11.0	11.9
20 -40	82.9	81.4	85.7
40	5.7	7.6	2.4
Pregnancy stage(%)			
First trimester	19.7	23.5	13.1
Second trimester	46.7	44.8	50.0
Third trimester	33.6	31.7	36.9
Mean pregnancy number	2.71±1.91	2.41±1.50	3.23±237
Parity (%)			
Primiparous	35.4	35.9	34.5
Multiparous	64.6	64.1	65.5

SD: Standard Deviation

Means of hb and ht values were significantly lower in rural compared to urban population. However it was not the case for SF. Also no significant influences of age and parity were observed on all haematological parameters.

Anaemia, Iron Deficiency (ID) and Iron Deficiency Anaemia (IDA): The prevalence of anaemia, iron deficiency, low iron stores and iron deficiency anaemia according to maternal characteristics are presented in Table 3.

The results show that the prevalence of anaemia based on hb and ht was 26.7 and 47.2% respectively. Prevalence of anaemia increased over pregnancy stages from 11.4 or 17.8% at the first to 32.9 or 62.3% at the third trimester (reference to hb or ht respectively).

There were twice more cases of anaemic women in rural than in urban area.

In most of women (70.1%), iron stores were either depleted (18.9%) or too low to cover iron needs during pregnancy (51.2%).

ID prevalence increased in women over pregnancy from 13.2% at the first to 21.9% at the third trimester. It

Table 2: Mean of haemoglobin, hematocrite and serum ferritin according to maternal± characteristics

	Pregnancy stage (trimesters)			
Sample characteristics	First	Second	Third	Total
hb mean	12.61±1.83	11.69±1.86	11.53±1.87	11.82±1.89
ht mean	35.6±3.6	32.8±4.0	32.1±3.9	33.1±4.1
SF mean	23.7±11.9	24.3±13.1	26.9±27.6	25.0±18.7
Area of residence				
Urban hb	12.68±1.57	12.17±1.47	11.73±1.84	12.15±1.64
ht	35.6±3.4	33.9±2.8	32.6±4.2	33.9±3.6
SF	21.5±11.8	24.7±13.2	20.8±12.6	22.9±12.8
Rural hb	12.39±2.56	10.95±2.17	11.23±1.91	11.24±2.16
ht	35.4±4.2	31.1±4.9	31.3±3.2	33.1±4.1
SF	29.7±10.6	23.7±13.1	33.4±36.6	28.2±25.0
Age groups				
< 20 years hb	12.09±0.12	11.73±1.92	11.26±1.69	11.61±1.76
ht	36.5±2.1	32.9±3.4	31.9±4.7	32.8±4.1
SF	17.3±10.1	20.9±13.2	23.1±15.5	21.2±13.3
20-40 years hb	12.53±1.89	11.67±1.87	11.57±1.93	11.81 ±1.92
ht	35.5±3.6	32.7±4.0	32.1±3.8	33.1±4.1
SF	23.9±11.2	24.9±13.1	28.0±29.1	25.7±19.5
> 40 years±hb	13.65±1.41	13.02±0.00	11.14±0.75	12.84±1.58
ht	36.0±4.1	38.0±0.0	32.5±2.1	35.3±3.6
SF	25.5±22.5	34.1±0.0	9.9±3.1	21.7±17.3
Parity				
Primiparous hb	13.14±1.30	11.24±1.95	11.58±1.73	11.62±1.87
ht	36.7±3.0	32.1±4.7	32.3±3.9	32.7±4.4
SF	22.8±9.7	23.5±13.5	21.9±14.7	22.7±13.4
Multiparous hb	12.46±1.95	11.92±1.79	11.48±2.01	11.92±1.90
ht	35.3±3.7	33.1±3.6	31.9±3.8	33.3±3.9
SF	24.0±12.7	24.8±13.0	31.3±34.9	26.4±21.2

Hb: Haemoglobin (g dL^{-1}); Ht: Haematocrit (%); SF: Serum Ferritin (μg L^{-1})

Table 3: Prevalence of anaemia, iron deficiency, low iron stores and iron deficiency anaemia according to maternal characteristics

	Anaemia		Iron Deficiency	Low iron stores	Iron deficiency Anaemia	
	Reference to hb	Reference to ht	SF<12 μg L^{-1}	12 μg L^{-1}<SF <30 μg L^{-1}	Reference to hb	Reference to ht
Total population	26.7	47.2	18.9	51.2	16.7	25.3
Pregnancy stage						
First trimester	11.4	17.8	13.2	65.8	33.3	33.3
Second trimester	28.7	48.6	19.2	47.5	17.9	26.5
Third trimester	32.9	62.3	21.9	48.4	13.0	22.5
Area of Residence	20.4	36.6	20.7	52.9	48.8	29.5
Urban rural	36.9	65.5	16.3	16.7	16.7	21.6
Mother's age						
< 20 years	26.9	38.5	28.0	48.0	14.3	55.6
20-40 years	27.1	49.0	17.1	52.4	17.4	22.6
> 40 years	14.3	28.6	33.3	33.3	0.0	0.0
Parity						
Primiparous	32.1	48.1	24.0	49.3	21.7	35.3
Multiparous	23.8	46.6	15.9	52.4	12.9	19.7

Hb: Haemoglobin; Hat: Haematocrit; SF: Serum Ferritin

Table 4: Mean nutrient intakes and corresponding percentage of Recommended Daily Allowance (RDA) of the pregnant women

Energy and nutrient intakes	Mean±SD	%of RDA
Energy (kcal day^{-1})	3003.8±781.8	120.1±31.3
Iron (mg day^{-1})	17.9±5.3	66.3±19.6
Folate (μg day^{-1})	428.1±145.4	71.3±24.2
Protein (g day^{-1})	112.3±40.0	187.2±66.6
Vitamin C (mg day^{-1})	131.3±119.2	154.4±140.2
Calcium (mg day^{-1})	93436±454.5	93.5±45.4

was also more prevalent when pregnancy occurred at ages below 20 years or above 40 years, in urban compared to rural population and in primiparous compared to multiparous women.

The results also show that IDA concerned 16.7 and 25.3% of anaemic women on the basis of hb and ht respectively and it was more prevalent in primiparous than multiparous women.

Food and nutrient intakes in anaemic and iron deficient anaemic women: Table 4 shows the means of energy and nutrient intakes and the equivalent values expressed as percentage of Recommended Daily Allowance (RDA) in this population. The results indicate that intakes of energy, protein and vitamin C were sufficient, while iron and folate were consumed at rates below the two-third of the RDA.

Table 5 compares major food groups consumption and nutrient intakes of anaemic and nonanaemic women and those with or without IDA. In order to avoid any influence of iron supplementation on haematological parameters, this part of the study included only unsupplemented population.

The results indicate lower intakes of all food categories and all selected nutrients in anaemic compared to nonanaemic women, the difference being significant for meat ($p = 0.021$) energy ($p = 0.026$) and calcium ($p = 0.032$). In the opposite, tea consumption was significantly higher in anaemic than in nonanaemic women ($p = 0.034$) and was negatively correlated with either hb ($r = -0.333$, $p<0.01$) or ht ($r = -0.269$, $p<0.01$) values.

The results show also that women with IDA generally presented lower mean values of food and nutrient intakes and higher tea consumption compared to those without IDA, but except for tea consumption, no significant difference could be noted.

Supplementation effects: Among the women sample enrolled, only 85 i.e., 37.1% were using iron supplements (150 mg as $FeSO_4$), either daily (43.5%) or weekly (56.5%). Over pregnancy, the percentage of women being supplemented increased (22.2, 34.6 and 49.3% in the first, the second and the third trimester respectively).

Table 6 shows haematological status of women iron supplemented or not. Taking each pregnancy trimester separately, no significant difference appeared in hb, ht or SF mean values between supplemented and unsupplemented women.

Unsupplemented population exhibited significant lower values of hb and ht in the second and the third trimesters compared to the first trimester, as it was described in the whole population. This was not the case anymore in the supplemented group.

Considering the whole population, unsupplemented women showed a higher prevalence of ID and IDA, but a lower prevalence of anaemia with significantly higher values of hb ($p=0.024$) and ht ($p=0.061$) than supplemented women.

Table 7 shows the haematological parameters according to the mode and the length of supplementation, which could be exactly known only for 46 women. It appeared that only few women 13.4% were supplemented

Table 5: Food and nutrient intakes in anaemic, nonanemic, IDA and not IDA women

Food groups and nutrient intakes	Anaemic n = 45	Nonanaemic n = 61	P-value	IDA n = 13	Not IDA n = 85	P-value
Cereals (g day^{-1})	582.1±154.2	563.8±138.4	0.524	522.7±156.4	587.7±138.9	0.126
Red meat (g day^{-1})	32.3±35.2	50.7±58.5	0.063	27.2±22.7	42.1±52.2	0.316
Poultry (g day^{-1})	25.8±26.5	33.2±34.2	0.229	20.3±31.1	32.2±32.1	0.215
Sea foods (g day^{-1})	27.2±27.2	38.9±37.7	0.079	33.6±41.9	33.2±32.1	0.971
Whole meat (g day^{-1})	60.9±46.9	94.4±86.9	0.021	49.9±35.6	82.9±78.6	0.141
Eggs (g day^{-1})	39.4±43.6	35.0±47.0	0.627	30.5±29.7	34.8±39.7	0.710
Vegetables (g day^{-1})	436.3±187.6	516.7±249.0	0.072	387.5±183.7	505.3±233.1	0.085
Fruits (g day^{-1})	164.6±191.8	246.7±298.5	0.110	191.0±172.6	211.8±280.3	0.796
Tea (cups day^{-1})	3.2±2.4	1.7±1.5	0.000	3.5±2.1	2.3±2.0	0.048
Energy (kcal day^{-1})	2836.9±860.2	3191.7±756.8	0.026	2687.0±787.0	3080.0±808.8	0.105
Iron (mg day^{-1})	17.7±5.9	19.0±5.0	0.215	17.8±5.2	18.7±5.4	0.597
Folate (μg day^{-1})	409.8±149.2	448.0±163.4	0.216	381.9±161.5	442.4±159.2	0.206
Protein (g day^{-1})	110.5±43.5	120.5±42.8	0.238	120.9±52.0	116.5±42.5	0.731
Vitamin C (mg day^{-1})	119.4±120.9	148.5±148.3	0.279	88.9±47.1	144.8±148.9	0.184
Calcium (mg day^{-1})	822.8±399.3	1016.4±494.3	0.032	787.8±343.5	961.1±487.5	0.221

IDA: Iron Deficient Anaemic

Table 6: Haematological characteristics of women supplemented or not with iron

	Supplemented	Not supplemented
Anaemia prevalence (%)		
Reference to hb	35.3	20.1
Reference to ht	54.1	43.1
ID prevalence (%)	14.3	21.4
IDA prevalence (%)		
Reference to hb	4.3	4.6
Reference to ht	10.0	13.0
Haematological parameters		
First trimester		
Mean hb (g dL^{-1})	11.66±2.51 (n = 10)	12.88±1.53 (n = 34)
Mean ht (%)	35.1± 3.8 (n = 10)	35.7±3.6 (n = 34)
Mean SF (μg L^{-1})	24.1±11.8 (n = 7)	23.6±12.1 (n = 31)
Second trimester		
Mean hb (g dL^{-1})	11.42±2.05 (n = 37)	11.83±1.75 (n = 70)
Mean ht (%)	32.2±5.0 (n = 37)	33.1±3.4 (n = 70)
Mean SF (μg L^{-1})	24.8±12.4 (n = 34)	24.0±13.5 (n = 65)
Third trimester		
Mean hb (g dL^{-1})	11.42±1.87 (n = 38)	11.63±1.89 (n = 39)
Mean ht (%)	31.9±4.3 (n = 38)	32.3±3.4 (n = 39)
Mean SF (μg L^{-1})	29.8±38.1 (n = 29)	24.5±14.1 (n = 35)
Total population		
Mean hb (g dL^{-1})	11.45±2.01 (n = 85)	12.03±1.80 (n = 143)
Mean ht (%)	32.4±4.6 (n = 85)	33.5±3.6 (n = 143)
Mean SF (μg L^{-1})	26.8±26. (n = 70)	24.0±13.3 (n = 131)

ID: Iron Deficiency, IDA: Iron Deficiency Anaemia; Hb: Heamoglobin; Ht: Haematocrit; SF: Serum Ferritin

Table 7: Haematological parameters according to the supplementation way and length

Supplements administration	Length of supplementation	hb Mean±SD	hb n	ht Mean±SD	ht n	SF Mean±SD	SF n
Continuous	< 60 days	11.26±2.45	15	32.9±5.7	15	37.2±49.8	15
	60-120 days	10.16±3.27	2	30.5±3.5	2	25.7±3.7	2
	120 days	10.54±2.91	3	33.7±3.5	3	40.3±16.3	2
Intermittent	< 60 days	12.11±1.38	20	33.3±3.0	20	23.5±13.6	16
	60-120 days	11.65±0.84	4	31.7±1.5	4	32.5±29.6	3
	120 days	12.03±0.67	2	33.5±0.7	2	13.7±3.9	2
All	< 60 days	11.57±1.92	35	33.1±4.3	35	30.1±36.0	31
	60-120 days	11.15±1.77	6	31.3±2.1	6	29.8±21.3	5
	120 days	11.14±2.24	5	33.6±2.5	5	27.0±18.2	4

Hb: Heamoglobin; Ht: Hematocrit; SF: Serum Ferritin

during more than 60 days. Moreover, no significant difference could be found in hb, ht and SF values with different length of supplementation and no correlation could be made between these haematological parameters and the length of supplements use. The same observations were made when taking each trimester of pregnancy separately (results not shown).

Table 8: Pregnancy outcome according to maternal characteristics

	Weight at birth		Prematurity		Perinatal death	
Maternal characteristics	Mean±SD	n	(%)	n	(%)	n
Total population	3.51±0.62	65	9.8	82	7.3	82
Area of residence						
Urban	3.57±0.60	38	7.3	41	0.0	41
Rural	3.44±0.65	27	12.2	41	14.6	41
Anaemic±±						
1st trimester	3.62±0.67	3	0.0	3	0.0	3
2nd trimester	3.24±0.64	15	20.0	20	20.0	20
3rd trimester	3.61±0.64	14	0.0	18	0.0	18
All	3.43±0.65	32	9.8	41	9.8	41
Nonanaemic						
1st trimester	3.31±0.74	6	30.0	10	20.0	10
2nd trimester	3.53±0.61	15	5.6	18	0.0	18
3rd trimester	3.83±0.42	10	0.0	11	0.0	11
All	3.59±0.59	31	10.3	39	5.1	39
SF<12 μg L^{-1}						
1st trimester	3.00±0.00	1	50.0	2	50.0	2
2nd trimester	3.55±0.63	6	12.5	8	12.5	8
3rd trimester	3.71±0.94	4	0.0	5	0.0	5
All	3.56±0.71	11	13.3	15	13.3	15
SF : 12-30 μg L^{-1}						
1st trimester	3.31±0.29	4	40.0	5	0.0	5
2nd trimester	3.46±0.59	14	11.8	17	5.9	17
3rd trimester	3.75±0.26	12	0.0	14	0.0	14
All	3.55±0.47	30	11.1	36	2.8	36
SF > 30 μg L^{-1}						
1st trimester	3.55±1.25	3	0.0	5	20.0	5
2nd trimester	3.04±0.77	7	20.0	10	20.0	10
3rd trimester	3.76±0.74	6	0.0	8	0.0	8
All	3.41±0.87	16	8.7	23	13.0	23
IDA						
Yes	3.38±0.64	7	10.0	10	10.0	10
No	3.52±0.64	51	10.8	65	7.7	65

SF: Serum Ferritin; IDA: Iron Deficiency Anaemia, n = number of available data

Pregnancy outcome: Table 8 represents outcome characteristics according to area of residence and maternal haematological characteristics. Mean estimated Birth Weight (BW) was 3.51±0.62 kg with lower (but not significantly) values in rural compared to urban population. Globally, 7.2% of newborns were underweighted (<2.5 kg). Delivery at home was common in rural area, concerning 48.8% of women and engendering the difficulty to record weights at birth. Prematurity was higher in rural compared to urban area and perinatal death (14.6%) occurred only in rural newborns.

Data show that anaemic mothers generally had newborns with lower BW mean (NS) than nonanaemic mothers.Depleted (SF < 12 μg L^{-1}) or low (SF between 12 and 30 μg L^{-1}) iron stores of the mother in the first trimester of pregnancy were accompanied by lower weights at birth than in the second or the third trimester. Lower BW mean (NS) were also observed in women with IDA. However no correlation could be established between BW and haematological parameters (hb, ht, SF) or any nutrient intake.

DISCUSSION

The present study indicates that in spite of the efforts made by the ministry of health, pregnant women in this agricultural region of Morocco still presented a high prevalence of anaemia, similarly to most of developing countries (Mounkaila *et al.*, 1994; Karimi *et al.*, 2002; Marti-Carvajal *et al.*, 2002), but in lesser proportions than in others like South India (Abel *et al.*, 2001).

The main cause of anaemia is generally attributed to iron deficiency, with serum ferritin level as the current indicator of iron stores. Our study indicates that iron deficiency concerned about 20% of women; however most of women had limited iron stores (SF between 12 and 30 μg L^{-1}).

It appears that socio-economic level of women had an evident impact on anaemic status, since rural population, sometimes in very precarious situation, showed a considerably higher prevalence than their urban counterpart. Furthermore and as described in other studies (Mounkaila *et al.*, 1994; Abel *et al.*, 2001) anaemia and ID frequency increased with gestational age. Young pregnant women are generally more exposed to a risk of anaemia (Scholl *et al*., 1992). In our sample women aged less than 20 years presented a higher frequency of ID than those between 20 and 40 years, although they did not show significant lower averages of hb, ht and SF.

Surprisingly multiparity, reported before (Marti-Carvajal *et al*., 2002) to be associated with a decrease of iron stores was without effect in the present study.

Different studies showed relationship between iron status and dietary intakes in pregnant women. Scholl *et al*. (1992) showed that IDA women, early in pregnancy, had significant lower intakes of energy and iron than normal women. Vitamin C has been reported to be lesser consumed in anaemic compared to nonanaemic pregnant women (Ma *et al*., 2002) and lower SF concentrations have been associated with higher calcium intake (Robinson *et al*., 1998).

Similarly, our results show that pregnant women with anaemia and iron deficiency anaemia presented the poorer diet, whatever food categories. This was particularly the case of meat which provides highly bioavailable iron. This was accompanied by low dietary intakes of energy and nutrients known to improve iron status such as iron, folate and vitamin C. The present study shows also that tea, the local traditional drink, had a significant harmful effect on iron status. Overall, although calcium intake was poorly consumed, anaemia and IDA were probably due to concurrent low intakes of iron and iron absorption enhancers, as well as high intakes of tea.

On the other hand, oral iron supplementation has often been reported to reduce anaemia and to improve iron status (Svanberg *et al*., 1976; Hemminki *et al*., 1991; Haram *et al*., 2001). However as reviewed by Beard (2000), the efficacy of iron supplements depends on their composition, the applied dose (low or high) and the way they are administered (daily or weekly). It also depends on whether women were anaemic or not at pregnancy entry and on the initial iron stores.

Among women enrolled in this survey, only few were supplemented and most of them were supplemented intermittently; great distance of health centres or lack of awareness of the concerned population can be involved. Some women also reported interruption of supplement use because of side effects. The women haematological markers of iron status assessed here were not improved by iron supplements. However, it is difficult to assert that supplementation had no effect since supplemented group did not show significant decrease of hb and ht between the first and the second/or the third trimester as did the group without supplementation.

The inefficacy of supplementation seems to be mainly due to the low compliance of women. The intermittent iron administration applied for nearly half of the population may be also involved as it has been described to be less efficacious than continuous one (Goonewardene *et al*., 2001).

Data on pregnancy outcome showed that women with unfavourable socio-economic status are those presenting the most prematurity and perinatal death cases. Percentage of underweighted newborns was weak; it would certainly be higher if we could exactly know the weight at birth for all women, which was not possible mainly in women who gave birth at home.

Anaemia and IDA have been reported to have different impacts on outcome, depending on pregnancy stages. Early in pregnancy (first and second trimester), most of studies showed adverse effects such as low birth weight and increased perinatal death (Murphy *et al*., 1986; O'Brien *et al*., 2000), or spontaneous preterm delivery (Klebanoff *et al*., 1991). In the third trimester, is controversy on the results of effects of anaemia and IDA on pregnancy (Klebanoff *et al*., 1991; Lao *et al*., 2000; Marti *et al*., 2001).

Our study could not show significant correlations between hb, ht or SF levels and weight at birth, whatever the gestational age. However, newborns from anaemic women had lower birth weight compared to those from nonanemic women. Also, maternal depleted or low iron stores at the first trimester were associated with low BW and high percentage of prematurity and perinatal death. These results show adverse effects of anaemia and iron deficiency on pregnancy outcome, although the criticised available sample size.

Different studies reported that pregnancy outcome is not affected only by low but also by high haemoglobin or serum ferritin levels (Murphy *et al*., 1986; Steer *et al*. 1995; Goldenberg *et al*., 1996; Tamura *et al*., 1996; Xiao *et al*., 2002; Chang *et al*., 2003), especially when occurring in the second part of pregnancy. The authors generally attributed these results to a poor expansion of plasma volume which normally occurs during pregnancy or to sub clinical infections. In our study sample only 14.3% had high levels of hb (>13.5 g dL^{-1}), 9.4% had high SF (>50 μg L^{-1}) and none had high ht (>38%) during the last trimester of pregnancy.

Overall, it seems that the high prevalence of anaemia and iron deficiency in pregnant women from this region of Morocco have different causes, mainly low socio-economic status and therefore inappropriate diet such as low consumption of iron-rich foods or the use of foods with low iron bioavailability. A nutrition education programme should be conducted to improve dietary quality in this population, by encouraging target populations to increase intakes of factors enhancing iron absorption, or at least to decrease those inhibiting it. Adapted dietary treatments have been described to improve iron status of women with iron deficiency (Heath, 2001).

Also supplementation strategy failed to improve iron status in this population, mainly because of low compliance of women. It is necessary to make pregnant women aware of the beneficial effects of supplements, since differences in iron status between unsupplemented and supplemented women usually occur at least 3 months after the beginning of supplementation (Allen, 2000).

Food fortification is a strategy more and more used now reducing IDA in many developing countries (Makola *et al*., 2003; Ramakrishnan, 2004). Looking at the generally low iron stores of women in the present study, the probability to present excessive iron stores is weak. A food fortification strategy could be an interesting approach to combat iron deficiency in this population.

ACKNOWLEDGEMENTS

The authors wish to thank the Medical Delegation of El Jadida province, Ministry of Health, Morocco for their help with data collection. Are also acknowledged the Health Centres and the staff in Mohammed V Hospital for their cooperation and assistance. The Project was funded by IAEA and the Moroccan Ministry of Superior Education and Research.

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