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Aetiological factors and perception of anaemia in Tunisian women of reproductive age

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Abstract

Objectives: To identify aetiological factors in anaemia and to explore knowledge, perceptions and attitudes towards anaemia.
Design: Two cross-sectional surveys and sixteen focus group discussions.
Setting: The two regions with the highest prevalence of anaemia in Tunisia, Greater Tunis (GT) and the South West (SW).
Subjects: Two representative samples of 687 (GT) and 729 (SW) women of reproductive age; 108 women were included in focus group discussions.
Results: Among anaemic women, 63·4% in the GT region and 80·2% in the SW displayed iron deficiency (ID). Genetic haemoglobinopathies accounted for 10·0% and 3·6% of the cases of anaemia in the two regions, respectively. After adjustment for confounders, the major factors for iron-deficiency anaemia were low dietary Fe intake (OR = 5·0, 95% CI 3·0, 8·4), drinking tea after eating (OR = 3·4, 95% CI 2·0, 5·7) and pica (OR = 2·1, 95% CI 1·1, 3·9). Most of the women related anaemia to the following causes: malnutrition, lack of hygiene, and their heavy workload and responsibilities in the household. Many women connected anaemia with hypotension. Few established a relationship between ID and anaemia. They had confidence in their doctor for treatment, but many complained they were not given sufficient information. Low dietary Fe intake, inappropriate food practices and inadequate perceptions contribute to the aetiology of anaemia in women.
Conclusions: These results point out to the need for a strategy combining food fortification, Fe supplementation for pregnant women, nutritional education for the general public and at-risk specific target groups, and training of health professionals.

Keywords
Anaemia
Iron deficiency
Women
Perception
Tunisia

In the early 1970s, the first National Nutrition Survey conducted in Tunisia found that anaemia was a main nutritional problem, affecting 30% of pre-school children and 31% of women of childbearing age, with many potential consequences for health[1]. Twenty-five years later, data from a second National Nutrition Survey[2] indicated that anaemia remained a major public health problem for these subgroups of the population. In pre-school children, the prevalence of anaemia at national level was 21·7%, ranging from 13·4% to 34·1% depending on region. In women of childbearing age, the national prevalence was 25·9%, ranging from 19·0% to 35·1%. These relatively high prevalences contrast strongly with the overall improvement in socio-economic and health indicators in Tunisia over the last 25 years, and with the changes that occurred in other nutrition problems during the same period. For instance, the prevalence of stunting in pre-school children underwent a dramatic decrease from 39·5% in 1975 to 8·3% in 1997. However, the prevalence of obesity in adult women increased at an epidemic pace from 8·7% in 1980 to 28·6% in 1997[2]. Currently, men seem to be relatively spared by both anaemia (6·2%) and obesity (6·9%).

High prevalences of anaemia in women and children are not specific to Tunisia but have been reported on an international scale; and anaemia remains endemic in many regions despite the efforts of many governments and institutions[3]. Different explanations have been put forward, one of which is that strategies designed for the control of anaemia put too much emphasis on iron deficiency (ID) as the cause, neglecting the fact that other factors can be involved[3]. Aetiological factors responsible

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for anaemia include other nutrition deficiencies such as folate, vitamin B_{12} or vitamin A deficiencies[4,5], malaria, parasitic infection, congenital haemolytic diseases, use of intra-uterine devices, and infection or inflammatory disorders[6]. Thus it has been stressed that interpretation of Hb values is of utmost importance, especially with respect to assessment of the prevalence of ID[7].

Knowledge of the relative importance of the different determinants of anaemia is necessary for the design of effective strategies to control anaemia and ID, particularly in developing and emerging countries. In addition, a number of nutritional practices are known to contribute to the appearance of nutritional anaemia. These practices do not always depend on knowledge but also on other individual or collective factors (attitudes, cultural norms).

The purpose of the present study was to identify factors associated with anaemia in women of reproductive age in two regions of Tunisia. Knowledge, perceptions and practices related to anaemia were also analysed in order to develop an appropriate information and education programme.

Subjects and methods

Context and location

A cross-sectional survey was conducted between June and September 2000 in each of two regions that had the highest prevalence of anaemia in the last national nutrition survey: the Greater Tunis (GT) region and the South West (SW). GT is mainly an urban area (2 million inhabitants of whom 93 % live in urban areas and 7 % in rural areas) and includes the capital city; SW is more rural with 500 000 inhabitants of whom only 67 % live in urban areas.

Subjects

The sampling scheme was designed by the National Institute of Statistics. The national population and employment survey database of 1999 was used to select the two independent samples according a two-stage sampling stratified by residence and age group (range 15–49 years). The national prevalence[2] of 26 % for anaemia was used to calculate the size sample. This was expected to provide a prevalence estimate within the 95 % CI and an error margin of 0·05. The total number of eligible subjects was calculated to be 690 women in the GT region and 730 in the SW. Six hundred and eighty-seven (99·6 %) and 729 (99·8 %) non-pregnant women participated in the survey in the GT region and SW, respectively. The study protocol was reviewed and approved by the Ethics Committee on Human Research of the National Nutrition Institute. After being thoroughly informed about the purpose, requirement and procedures of the survey, all participants gave their consent to take part in the study, which was held at community centres, primary health-care centres and hospitals.

Socio-economic and clinical assessment

Data on household socio-economic status, level of education and occupation, medical history, obstetric history, parity and use of contraceptive methods were collected by questionnaire.

Blood sampling

After a 12 h overnight fast, 15 ml of blood was collected from each woman for laboratory analysis: (i) 2 ml of blood was placed in tubes with EDTA as anticoagulant and used the same day for the determination of red blood cell indices; (ii) 5 ml of blood was placed in tubes with EDTA and later used to identify haemoglobinopathies; and (iii) the remaining 8 ml of blood was placed in Fe-free glass tubes, promptly centrifuged and the serum decanted into Fe-free glass tubes for the determination of iron status (serum ferritin, SF), vitamin B_{12}, folate and C-reactive protein (CRP) concentrations. All samples were kept at 4–5°C and sent to the laboratories for analysis and/or frozen at −20°C. These assays were performed by the Clinical Biology Laboratory of the National Nutrition Institute and the Biochemistry Laboratory of the Tunis Children's Hospital.

Hb and prevalence of anaemia

Red blood cell count, Hb, mean corpuscular volume (MCV) and mean corpuscular Hb content (MCHC) were measured with an electronic counter (Coulter Counter, model T540; Beckman, Fullerton, CA, USA) which was calibrated regularly according to the manufacturer's specifications using controls provided by Beckman Coulter (Coulter® 4C® Plus Cell Control).

To assess the prevalence of anaemia, the international criterion advocated by the WHO (Hb < 120 g/l) was adopted[8]. WHO criteria for grading the severity of anaemia (mild, Hb = 100–120 g/l; moderate, Hb = 70–100 g/l; severe, Hb < 70 g/l) were used[9].

Aetiological factors for anaemia

The following aetiological factors were assessed in women found to be anaemic.

Iron deficiency

The best indicator for detecting ID is SF measured in the absence of infection[8]. In Tunisia, infectious and parasitic diseases such as malaria, schistosomiasis, diphtheria, HIV/AIDS and tuberculosis are extremely rare[10,11]. This determined the choice of the tests used to assess ID in anaemic women. Low Hb (<120 g/l) and SF (<15 μg/l) concentrations and reduced MCV (<80 fl) were considered jointly to define iron-deficiency anaemia (IDA)[8]. To avoid the possible effect of inflammation on iron metabolism indicators, elevated CRP concentration (≥6 mg/l) was also applied to define inflammation. SF was determined by immunoenzymometric assay (kit from Biochem Immunosystems, Allentown, PA, USA), which

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was calibrated according the international control OMS 80/602. CRP was measured by immunoturbidimetric assay (Synchron CX7 analyser from Beckman; kit from Biochem Immunosystems).

To analyse the causes of ID, a multidisciplinary group with different knowledge of the Tunisian situation elaborated a conceptual framework: the causal model of iron-deficiency anaemia in Tunisia[12]. According to this model, multiple potential factors increase the risk of IDA, e.g. low bioavailability of Fe in the diet, parasitic infections, and poor nutritional practices such as pica and drinking tea after eating. The potential causes of ID were assessed. Fresh stool samples were examined for the presence of vegetative forms of protozoa on the collection day by direct microscopy. After making thick smears using the Kato-Katz method[13], the stools were examined for helminth eggs and preserved in 10 % formol saline (10 % formalin in 0·9 % NaCl). A third examination was performed after concentration of the stools using the Ritchie technique[13]. A food consumption survey, which was based on a 3 d recall method, enabled us to assess daily tea and Fe intake on the one hand, and the bioavailability of Fe on the other. The Tunisian food composition table[14] and, when necessary, the FAO food composition table for Africa[15] or the French Regal table[16] were used to estimate the Fe content of ingested foods. Monsen's method[17] was used to estimate the bioavailability of Fe. It was assumed that only meat, fish and poultry contained haem Fe: respectively 50 %, 40 % and 20 % of Fe in these foods was estimated to be haem Fe, with the remainder being non-haem Fe[18].

Serum folate and vitamin B_{12}

Serum folate was assayed by ion capture (IMxfolates kit; Abbott Laboratories, Eschwege, Germany) and serum vitamin B_{12} by microparticular enzymatic assay (ImxB-12 kit; Abbott Laboratories). The criteria for folate and vitamin B_{12} deficiencies were values below 6.4 nmol/l and 135 pmol/l, respectively[19].

Haemoglobinopathies

Hb electrophoresis was performed to identify potential haemoglobinopathies (a genetic defect that results in abnormal structure of one of the globin chains of the Hb molecule) and thalassaemias (a genetic defect that results in production of an abnormally low quantity of a given Hb chain). Cellulose acetate alkaline electrophoresis was used to separate normal and abnormal Hb fractions (HbA2, HbF, HbS, HbC, HbOrab, HbD, HbG, etc.), as confirmed by: (i) agar citrate acid electrophoresis, enabling identification of factions that migrated to the cellulose acetate like HbD and HbG, on the one hand, and HbC, HbOrab and HbE on the other; and (ii) polyacrylamide thin layer isoelectrofocalisation. A column chromatography method specific for HbA220 and the Prembrey method specific for HbF were also used[21].

Knowledge, perceptions and practices

In order to study women's knowledge, perceptions and practices related to anaemia, focus group research was conducted[22]. The composition of the groups was guided by the quantitative survey design and the results of analysis of the quantitative data. Three criteria were used to compose the groups: (i) anaemic or non-anaemic; (ii) age (<30 years, ≥30 years); and (iii) region (GT or SW). For each category, two focus group discussions were conducted in order to increase validity of the data. In all, sixteen focus group discussions were conducted. A total of 108 women participated, of whom forty-eight were anaemic. Each focus group comprised between six and nine women. The question guide examined women's knowledge and perceptions of anaemia and its symptoms, including perceived causes and consequences, treatments for anaemia, and related food practices. Each focus group discussion lasted approximately two hours. All the discussions were tape-recorded. Tapes were fully transcribed and translated from Arabic to French. Transcripts were coded for emerging categories by teams of two researchers and validated by a second team. The analysis was supported by a software for qualitative research, QSR NUD*IST 4.0 (Non Numerical Unstructured Data Indexing Searching and Theorizing, version 4.0, London, UK).

Statistical procedures

The data were weighted to correct for differences in selection probabilities, adjusted for persons who were not examined, and then stratified according to age and residence; this being estimated independently by the National Institute of Statistics. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS/PC) statistical software package version 10·0 (SPSS Inc., Chicago, IL, USA). All comparison rates were based on the χ^2 test. Simple logistic regression analysis was performed to identify the independent variables (demographic, socio-economic, obstetric characteristics) that were significantly correlated with the outcome variable (IDA). All variables found to be significant were included in a multivariate analysis model, using the SPSS forward stepwise logistic regression procedure. Results are reported as prevalences and OR with 95 % CI. Significance was set at $P < 0{\cdot}05$.

Results

Sample characteristics

Selected sociodemographic results are presented in Table 1. About one-quarter of women in the GT region and one-third in the SW had received no school education. One-fifth had reached secondary or university level. Only 16·7 % of women in the GT region and 11·1 % in the SW reported working outside the home. Among married women, high parity (four or more children) was more

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frequent in the SW than in the GT region. The average number of children per woman was significantly higher in the SW than in the GT region (4·4 (SD 2·5) *v.* 2·9 (SD 1·6); $P<0·01$). More than one woman out of two in the GT region and close to eight women out of nine in the SW had a low socio-economic status. Red blood cell indices for non-pregnant women were similar in the two regions (Table 2) and no difference was observed between rural and urban women.

Prevalence of anaemia

Anaemia was observed in 28·9% of women in the GT region and in 30·7% in the SW, but there were no significant differences between GT and SW women with respect to the overall prevalence of anaemia, nor in grading. Severe anaemia was rare in the two regions, 1·2% and 0·7%, respectively. In the SW, where one-third of the population is rural, anaemia affected urban and rural women to the same extent, i.e. 30·3% and 27·5%, respectively. Anaemia increased progressively with age in both regions and the highest prevalence was found in women aged 30–35 years (39·2% in the GT region and 39·7% in the SW).

Table 1 Sociodemographic characteristics (%) of the two samples of Tunisian women of reproductive age*

	Greater Tunis (GT) (*n* 687)	South West (SW) (*n* 729)	*P* for comparison (GT *v.* SW)
Age (years)			
15–19	9·7	19·6	<0·0001
20–29	19·9	25·0	
30–39	44·2	29·5	
40–49	26·2	25·9	
Parity			
No children	21·7	39·4	<0·0001
1–3 children	54·4	25·3	
≥4 children	23·9	35·4	
Marital status			
Married	78·8	61·4	<0·0001
Other	21·2	38·6	
Educational level			
None	24·1	31·8	<0·0001
Primary	50·9	42·3	
Secondary	22·2	23·3	
University	2·8	2·6	
Occupation			
Housewife	76·9	81·7	<0·001
Student	6·4	7·2	
Employed	16·7	11·1	
Socio-economic level			
Low	54·9	86·8	<0·0001
Medium	27·5	11·2	
High	17·5	2·0	

*All statistics are weighted to represent women in the two regions, GT and SW, by a method that accounts for the survey design.

Aetiologies of anaemia

Of the entire sample, very few women (3·8% in the GT region and 2·9% in the SW) had an elevated serum CRP concentration (≥6 mg/l) indicating inflammation or infection. Of the anaemic women, only 1·6% in the GT region and 1·5% in the SW presented inflammation associated with their anaemia. These women were excluded from any further statistical analyses. Among anaemic women, 63·4% in the GT region and 80·2% in the SW displayed ID ($P<0·01$) (Fig. 1). Consequently, IDA was more prevalent in the SW than in the GT region (23·9% *v.* 17·5%; $P<0·01$). In the SW, IDA affected urban and rural women to the same extent, i.e. 25·3% and 21·6%, respectively. Low serum vitamin B_{12} and folate concentrations were very rare in women with anaemia (0·4% and 1·3% in the GT region; 0·1% and 0·7% in the SW, respectively). None had combined micronutrient deficiencies (ID associated with folate and/or vitamin B_{12} deficiency) in the GT region and only 0·3% was deficient both in Fe and vitamin B_{12} in the SW.

The major forms of haemoglobinopathies (homozygote for HbS or heterozygote for both HbS and β-thalassaemia)

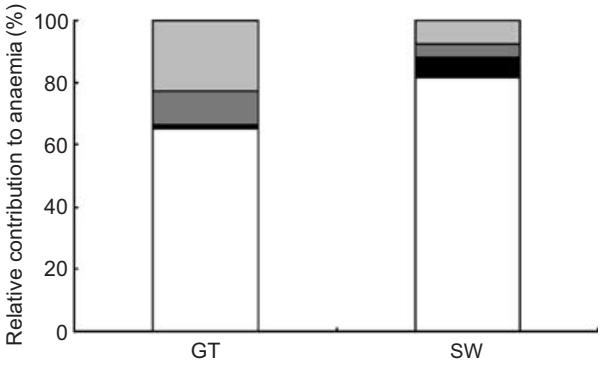

Fig. 1 Proportion of anaemia attributable to iron deficiency (□), folate and/or vitamin B_{12} deficiencies (■), haemoglobinopathies (▩) and other aetiologies (▩) in anaemic women of reproductive age in the Greater Tunis (GT) region (*n* 189) and the South West (SW) (*n* 217)

Table 2 Haematological characteristics of the two samples of Tunisian women of reproductive age*

	Greater Tunis (GT) (*n* 687)			South West (SW) (*n* 729)		
	Mean	SD	Range	Mean	SD	Range
Hb (g/l)	120·42	10·77	40·9, 160·4	120·51	10·76	60·1, 160·4
MCV (fl)	84·44	8·98	37·0, 127·6	84·29	8·49	48·0, 102·0
RBC count (10^6/ml)	4·42	0·43	3·2, 6·5	4·48	0·39	1·4, 6·3

MCV, mean corpuscular volume; RBC, red blood cells.
*All statistics are weighted to represent women in the two regions, GT and SW, by a method that accounts for the survey design.

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were rare. Haemoglobinopathies accounted for 10·0 % of overall anaemia in the GT region and for 3·6 % in the SW (Fig. 1).

Of the entire sample of anaemic women, 22 % in the GT region and 8 % in the SW had neither micronutrient deficiencies (Fe, folate or vitamin B_{12}) nor haemoglobinopathies, nor did they have infection or inflammation. The morphological characteristic of these types of anaemia was normochromic–normocytic, i.e. MCHC > 27 pg and MCV = 80–100 fl.

Risk factors of iron-deficiency anaemia

Prevalence of intestinal parasitism was higher in the SW than in the GT region, but there were no differences between women with IDA and women with other types of anaemia (OTA) (Table 3). Among the parasites identified, only *Entamoeba histolytica* (protozoa), *Ankylostoma duodenale* or *Necator americanus* (hookworm) and *Giardia intestinalis* (flagellate) can lead to chronic haemorrhage and later to IDA[23,24]. However, few women had either hookworm or protozoal infections. The most common parasite infestation was *G. intestinalis*. However, the prevalence of *Giardia* infection was no higher in the IDA group than in the OTA group in the two regions.

By contrast, pica and drinking tea after eating were more prevalent in IDA women than in OTA women (Table 3). The mean daily intake of tea was also higher in the IDA group than in the OTA group, i.e. 1·31 (SD 1·45) *v.* 0·74 (SD 1·05) cups/d in the GT region and 1·69 (SD 1·24) *v.* 0·98 (SD 1·15) cups/d in the SW. It should also be noted that, overall, pica and tea drinking after eating were more widespread in the SW than in the GT region.

Daily dietary intakes of total Fe and of bioavailable Fe were significantly lower in IDA women than in OTA women in the two regions. In IDA women, mean daily dietary Fe intake covered only 70 % of the Recommended Dietary Allowance (RDA) in the GT region and 76 % in the SW[25]. In OTA women, mean daily dietary Fe intake covered almost 100 % of the RDA. Daily dietary intake of bioavailable Fe, calculated according to Monsen's method, was lower in IDA than in OTA women (Table 3).

Table 4 presents the results of logistic regression models for IDA. Dietary intake of Fe under 80 % of the RDA, tea drinking after eating and pica were the risk factors identified for IDA, after adjusting for age, parity, parasitic infections, contraceptive method and socio-economic variables.

Perceptions of anaemia

Knowledge of anaemia and its symptoms

As a disease, anaemia is still not well known among Tunisian women. Four coexisting 'definitions' of anaemia were identified by Tunisian women: (i) a lack of iron; (ii) 'poor blood'; (iii) hypotension; and (iv) a variation in the number of white or red blood cells. Although there

Table 3 Risk factors of iron deficiency in anaemic Tunisian women of reproductive age

	Greater Tunis (GT) (*n* 189)					South West (SW) (*n* 217)				
	IDA (*n* 120)		OTA (*n* 69)		*P* for comparison (IDA *v.* OTA)	IDA (*n* 168)		OTA (*n* 49)		*P* for comparison (IDA *v.* OTA)
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Intestinal parasitism (%)	39·2		41·9		0·957	59·4		51·5		0·340
Giardia intestinalis	1·8		5·0		0·352	18·2		18·8		0·983
Entamoeba hystolitica	0·0		0·0		–	0·6		0·0		0·446
Ankylostoma duodenale or *Necator americanus*	0·0		0·0		–	0·0		0·9		0·414
Pica habits (%)	30·5		17·5		0·034	40·5		19·6		0·008
Tea drinking after eating (%)	56·2		35·1		0·004	75·9		44·4		<0·0001
Dietary intake of total Fe (mg/d)	11·2	3·5	15·2	4·8	<0·0001	12·2	3·5	15·8	4·6	<0·0001
Dietary intake of bioavailable Fe (mg/d)	1·8	0·7	2·4	0·8	<0·0001	1·1	0·7	2·5	0·8	<0·0001

IDA, iron-deficiency anaemia; OTA, all other types of anaemia.
*All statistics are weighted to represent women in the two regions, GT and SW, by a method that accounts for the survey design.

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Table 4 Logistic regression model for iron-deficiency anaemia (IDA) *v.* other types of anaemia in anaemic Tunisian women of reproductive age (*n* 406)

Risk factors of IDA	Adjusted OR*	95 % CI	*P*
Tea drinking after eating			<0·0001
No	1·0	–	
Yes	3·4	2·0, 5·7	
Pica habits			0·017
No	1·0	–	
Yes	2·1	1·1, 3·9	
Dietary intake of Fe			<0·0001
≥80 % of RDA†	1·0	–	
<80 % of RDA	5·0	3·0, 8·4	
Parasitic infections			0·948
No	1·0	–	
Yes	1·0	0·6, 1·8	
Contraceptive method			0·860
None	1·0	–	
Intra-uterine device	1·0	0·4, 2·2	
Other	0·9	0·4, 1·8	

*Adjusted for: region, age, parity, educational level, occupation and socio-economic level.
†Recommended Dietary Allowance of FAO/WHO (1988)[25].

is some truth in these definitions, confusions on the meaning of the word exist. Perceived symptoms of anaemia differed according to whether women were directly exposed to this health problem. Non-anaemic women had more difficulty identifying and describing the symptoms of anaemia than anaemic women did. Tiredness, vertigo and pallor were the symptoms most frequently mentioned by anaemic women. Fitful sleep and insomnia were also mentioned by slightly more than half the anaemic women. Many anaemic women said they suffered a lot from the disease. Perception of anaemia symptoms was not influenced by age and only slightly by the region: women of the SW established relationships between tiredness and anaemia much more.

Perceived causes of anaemia

All categories taken together, a large majority of women thought that 'malnutrition' causes anaemia. However, this was seldom related to a lack of Fe in the diet. Malnutrition was depicted by most women as a non-balanced diet, associated with a lack of financial resources and a poor standard of living. These women would like to vary their diet but cannot afford to.

Another large group of women were convinced that poor hygiene in the home, consumption of contaminated foods (parasites, microbes) or of impure water contributes to the appearance of the disease.

Many women (anaemic and non-anaemic, <30 and ≥30 years) considered that tiredness due to work, domestic work and taking care of their children and husband, could cause anaemia.

A large majority of anaemic women were aware that multiple and successive pregnancies, abortions, abundant menstrual blood loss, and contraception (intra-uterine devices) are important factors in the appearance of anaemia.

Only a few women thought that eating clay, earth or coal could cause anaemia in children or pregnant women. This association was stronger, however, in the SW.

Finally, a large number of women, mostly from the SW, were convinced that the hot climate, dry land, the lack of rainfall and of greenness could cause anaemia. But drinking tea after eating was never mentioned as a possible cause of anaemia.

Prevention and treatment of anaemia

Both diet and drugs were mentioned as treatments of anaemia. It should be noted that the women (anaemic and non-anaemic) often said that it is the medical doctor who decides on both dietary recommendations and medical treatment of anaemia, as he has the knowledge required. As could be expected, women suffering from anaemia spoke much more about medical treatment of anaemia than non-anaemic women. According to these women, medical treatments appear to be followed (blood transfusion, Fe supplementation) but nutritional advice does not always result in behavioural changes. This was often linked with financial constraints, most often in the SW region where women placed more emphasis on drugs to fight anaemia. The treatment most often mentioned by women to combat tiredness was rest, but some said they drink sweetened water or milk when they are very tired. However, many women said they do nothing.

Attitudes, practices and food knowledge

Women showed contradictory reactions when confronted with anaemia. First, there were those who felt frightened and anxious. Others refused to consider themselves as anaemic and denied being sick.

The focus group discussions often centred on the perceived effects (positive or negative) of food on anaemia. In particular, specific questions were asked about tea, orange juice, lemonade (sweetened lemon juice mixed with water) and meat. A little over 50 %, mainly those suffering from anaemia, attributed positive effects to tea because tea would increase the quantity of blood. Anaemic women in the SW and women over 30 years of age expressed more favourable opinions about tea. In the two regions, many women thought that the effect of green tea differs from that of black tea: green tea causes hypotension and black tea increases the quantity of blood.

Regarding orange juice, all categories of women believed it had positive effects (the number of positive statements was nine times higher than negative ones). On the other hand, regarding the effects of lemon juice, the proportion was inverted and more women credited it with more negative effects than positive. However, considerably fewer opinions were expressed about lemon juice.

Overall, the majority of women thought that foods of animal origin (meat, fish and liver) are nutritious, excellent for health and good for those suffering from tiredness and anaemia. A very small number of women believed

that meat does not improve the status of people with anaemia. In the SW, many women declared that chicken had no nutritive value. Some even went as far as saying that it was the cause of their anaemia.

Leguminous plants (lentils, chickpeas and beans) were appreciated by almost all women, who thought that people who have anaemia or feel tired should eat them. A lot of women thought that milk and dairy products are nutritious for all age categories, in particular for anaemic or tired people. Vegetables and starches, most of all spinach and parsley, were mentioned by many women as fortifying foods, which can prevent and even treat anaemia and tiredness.

By the end of the focus group discussions, many women expressed the desire to better understand anaemia. They complained of their lack of information on the subject, in particular by medical personnel.

Discussion

Our findings confirm that anaemia is still a major public health problem among Tunisian women of reproductive age in both rural and urban areas. ID was identified in more than two-thirds of anaemic women. This is the first study to demonstrate that ID is the major aetiological factor responsible for anaemia in this population. Other micronutrient deficiencies (folate and vitamin B_{12}) were rarely observed. Inflammatory disorders and haemoglobinopathies played a minor role in the pathogenesis of anaemia. Their relative contributions to anaemia represented less than 10 % and 4 % of cases, respectively. Other aetiological factors were responsible for 22 % of anaemia in the GT region and 8 % in the SW. The morphological type of these anaemias (normochromic–normocytic) suggests a central pathology (leukaemia, bone-marrow depression, renal failure, endocrine diseases) or a peripheral mechanism (passive or acquired haemolysis, haemorrhage).

Low dietary Fe intake and the limited contribution of haem Fe to total Fe intake (16 % in the GT region and 9 % in the SW) may partly explain IDA. Low bioavailability due to inhibitors of dietary Fe absorption may be another factor that contributes to the high prevalence of IDA. In support of this hypothesis, a clear relationship was established between some lifestyles and consumption habits and IDA, e.g. drinking tea after eating and pica. Drinking tea mainly after meals is common in Tunisia[26]. Tea contains high concentrations of polyphenols that reduce the bioavailability of non-haem Fe in the diet. Our results show that tea intake was associated with a 3·4-fold higher risk of IDA. Pica (a compulsive eating of non-food substances) is still very frequent among Tunisian women. Silt, earth, coal, soap and soil consumption was associated with higher prevalence of IDA, particularly in women originating from the SW, and could be an important aetiological factor in anaemia in this area particularly because of its negative effect on Fe absorption[27,28].

Intestinal bleeding caused by parasitic infection is another factor that may be responsible for IDA. In Tunisia, two parasites (*Plasmodium falciparum* and *Schistosoma haematobium*) known to lead to haemorrhage and ID have disappeared since the 1980s[29]. *G. intestinalis* was the most common protozoal infestation identified but no significant difference was found in Hb concentrations and iron status between women carrying *G. intestinalis* and those without parasites. Thus, the parasites identified in our study are unlikely to contribute significantly to the prevalence of anaemia in women.

Other factors, such as the level of education, use of intra-uterine devices, closely spaced pregnancies, housing and sanitation, and socio-economic status did not appear to be determining factors in IDA.

There were marked differences in knowledge about anaemia, and its causes and symptoms, between women living in the SW and in the GT region. In the SW, women complained more, described more symptoms, and expressed their experience with the disease much more emotionally than women in the GT region. These differences in reaction may be linked with the social context of each region: in the SW, people live more social lives and anaemia may thus be experienced not only as an individual problem, but also as a collective problem.

Women who did not suffer from anaemia had a more superficial knowledge of its symptoms, particularly in the GT region. The majority of women in the GT region said they knew nothing about the disease, but that they would like to know more about it. Many women associated symptoms of anaemia with those of other diseases, particularly arterial hypotension.

The majority of women thought that malnutrition caused anaemia. Insufficient food intake was most often associated with a poor standard of living. These women were conscious of the fact they should vary their diet and eat Fe-rich foods, but they do not have the money to change their eating habits and have to cope with the food that is available.

Some women believed that inadequate hygiene or eating contaminated food affected by microbes or parasites contributes to the appearance of anaemia. Some women believed that pregnancy, giving birth, breastfeeding, and methods of contraception such as intrauterine devices that cause heavy menstrual bleeding, are responsible for anaemia.

Work and the different types of responsibility (and resulting fatigue and stress) were also perceived as a main cause of anaemia. In the SW, where intermarriage is very common, a large number of women, irrespective of whether or not they suffered from anaemia, believed that anaemia is heritable.

The most important application of these findings will be to help develop an action programme for the

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prevention and control of IDA in Tunisia. Five approaches should be implemented: (i) Fe fortification of flour used for bread-making; (ii) reinforcement of the programme to provide Fe supplements to pregnant and nursing mothers in the framework of the national perinatal programme; (iii) launching of a national education programme about anaemia and ID targeting the general population; (iv) including information about anaemia and ID in school, university and adult education; and (v) setting up a surveillance programme for anaemia and its causal factors.

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