THE PREVALENCE AND DETERMINANTS OF IRON DEFICIENCY ANEMIA IN RURAL THAI-MUSLIM PREGNANT WOMEN IN PATTANI PROVINCE

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Abstract. This study was conducted in order to describe the type of anemia and risk factors for iron deficiency anemia in Pattani Province, Thailand. A cross-sectional survey was conducted from March to October 1997 in five randomly selected districts, choosing villages in the catchment area of a random sample of 30 out of 57 health centers (HC). All resident eligible pregnant women (PW) at 32-40 weeks of gestation without any overt diseases were selected. Food intake and antenatal health history were assessed by a food frequency questionnaire, health questionnaire and a review of HC records. Of the 180 enrolled PW, the prevalence of iron deficiency (ID), iron deficiency anemia (IDA) and other anemia were 34.4, 37.8 and 7.8%, respectively. PW in the last group were excluded from the analysis of predictors of iron status. Stool samples were obtained from 130 PW. The prevalences of hookworm, *Ascaris* and *Trichuris* were 47, 48 and 25 %, respectively. The number of ante-natal care (ANC) visits ranged from 0-8 with a median of 3 visits. Of those PW who visited, 97% reported receiving iron tablets. The compliance rate with iron tablets was low especially in the third trimester (9-12 %). Ordinal logistic regression showed that the risks for ID and IDA were reduced with statistical significance at a gestational age greater than 34 weeks, with more than three ANC visits, and increased consumption of meat and calories, but increased with hookworm infection. Compliance with iron tablet supplementation did not significantly reduce the risk for ID and IDA. In this study, PW had high percentages of ID and IDA. The risk factors identified in this report require intervention to eliminate them.

INTRODUCTION

Anemia is defined as a significant reduction in hemoglobin concentration, hematocrit, or the number of red blood cells (WHO, 1972). It has been a major health problem affecting all age groups. Lactating mothers and children are at particular risk (FAO/WHO, 1988).

Iron deficiency anemia (IDA) during pregnancy increases the risk of maternal mortality, fetal morbidity and mortality (Marchant *et al*, 2004), preterm delivery and low birth weight (Lone *et al*, 2004).

Iron deficiency develops in three stages: (1) depleted iron stores as reflected by a decrease in serum ferritin concentration; (2) iron deficient erythropoiesis, as reflected by a decrease in serum iron, transferrin saturation and serum ferritin concentration but with a normal hemoglobin concentration; and (3) iron deficiency anemia, as reflected by decrease in serum iron, transferrin saturation, serum ferritin concentration and hemoglobin concentration (Bothwell *et al*, 1979). Some PW, however, may have other underlying causes of anemia, such as chronic infection or hemoglobinopathy.

The southern part of Thailand has the highest prevalence of anemia in Thailand (Ministry of Public Health, 1995). There have been few studies exploring the nature of this problem. The current study was conducted in order to describe the type of anemia with respect to iron storage and to identify risk factors for iron deficiency anemia in this region.

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MATERIAL AND METHODS

Pattani Province is one of five provinces in southern Thailand near the Gulf of Siam, with

an area of approximately 1,940 km^2. The province is well known for its poverty, low education and socio-cultural barriers.

Our cross-sectional survey was conducted from March to October 1997 in five randomly selected districts (Panalae, Yarang, Mayor, Mung and Nongjig) out of nine districts in the Province. A random sample of 30 out of 57 health centers (HC) was chosen. Sixty villages served by these selected HC were randomly chosen based on the requirement of having at least three women at 32-40 weeks gestation. In each selected village, all eligible PW (32-40 weeks gestation) without any overt diseases were invited to join the study. A total of 180 consent PW participated.

Each PW was interviewed at her own home with a structured questionnaire by a trained female Muslim interviewer, holding bachelor's degree in Food and Nutrition. Dietary assessment was based on recall of the previous 4 months. Ninety-two local food items were identified using a semi-quantitative food frequency questionnaire (FFQ). Photographs of various standard portion sizes of the identified foods were used to facilitate assessment. Information included the use of iron supplements during each trimester, the number of visits to the antenatal clinic, receiving iron tablets each visit, and the level of compliance with the iron tablets (regular use or not). In addition, the community health center records of subjects selected were reviewed to extract basic demographic and iron tablet supplementation information.

Ten milliliters of blood was drawn by nurses from a nearby hospital with eight milliliters being kept in a special test tube for serum iron (SI), total iron binding capacity (TIBC), transferrin saturation (TS) and serum ferritin (SF); and two milliliters were kept in a bottle containing ethylene diamine tetraacetic acid (EDTA) as an anticoagulant for performing a complete blood count (CBC). One drop of blood was smeared on a slide for microscopic study of red blood cell morphology. The participant was asked to provide a fresh stool sample, which was kept in a specific plastic bottle. Blood and stool specimens were transported to the laboratory at the university hospital, and analysed within two hours.

Hemoglobin level (Hb), hematocrit (Hct), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCH) were measured using the hematology Analyser Technicon HI*E, Technicon Instruments Ltd, USA. A serum ferritin level was measured by ELISA using an automated chemical analyser Hitachi 704. Reagents were supplied with reference values. SI and TIBC were measured according to the specific recommendations of the International Committee for Standardization in Hematology. Transferrin saturation was calculated as the ratio of SI to total iron binding capacity x 100. The morphology of all blood films was read and recorded by a hematologist (M.P).

Stool samples were examined for hookworm and other helminthic ova within two hours of collection using Kato's cellophane-covered thick-smear method (Kato and Miura, 1954) and recorded as positive or negative.

To gain further insight, a qualitative documentary review of routine local health statistics and in-depth interviews were undertaken with key informants, including the women, village leaders, and HC staff. Participant observations were carried out by the principal investigator participating in the daily life of the pregnant women at their home, in the local markets, village food shops and mobile food market.

Descriptive statistics were used to summarize personal characteristics, hematologic findings and compliance with iron tablets for all of the 180 PW. The main outcome variable was iron status, which was classified into normal, iron deficiency without anemia (Hb ≥11g/dl and SF<10 μg/l) and iron deficiency anemia (Hb <11g/dl and SF<10 μg/l). Other forms of anemia were excluded from analysis. Thus, analysis of predictors of anemia was done in 166 PW. Cross tabulation between iron status and various independent variables was followed by a test of trend since the outcome was a 3-level ordinal variable (normal, ID and IDA). Variables with p-values below 0.2 from this tabulation were included in ordinal logistic regression for multivariate analysis. Major independent variables of interest were dietary iron intake, hookworm infestation, antenatal care utilization, and iron tablet intake.

RESULTS

Background information of the PW is summarized in Table 1. They were generally poor compared to average Thai women.

Their hematological findings are summarized in Table 2. As expected, IDA and ID were very common. In addition, from red blood cell morphology and hematology studies, there were five cases of hereditary elliptocytosis (HE), two with evidence of hemolytic anemia. Nine PW had abnormal Hb levels and were thalassemia carriers (heterozygote), one was heterozygous for HbE (Hb type AE, with HbE in the range of 20-25%), two α-thalassemia heterozygotes (Hb type A+A2, Hb A2 less than 35; two β-thalassemia heterozygotes (Hb type A+A2, Hb A2 more than 3.5). The remaining four cases were possibly complicated by folate deficiency. These 14 subjects were excluded from the analysis of predictors of iron status.

Of 166 PW eligible for analysis of predictors. 130 gave stool samples, and of these 46.8% had hookworm, 48.4% had ascariasis, 24.6% had trichuriasis and 22.3% had no parasitic infestation. Thirteen point eight percent of PW had all three parasites.

Of these 166 women, 160 had visited a doctor or health care worker. The distribution of visits is summarized in Table 3. The number of ANC visits ranged from 0-8 with a median of three visits. Of the PW who visited the health center, 97% reported receiving iron tablets.

Compliance with iron tablets was low, especially in the third trimester. The majority (60%) of PW believed that iron tablet supplementation

Table 1
General characteristics of the study subjects (N = 180).

Characteristic	Mean	SD
Age (years)	27.1	6.3
Years of education	3.9	2.9
Family income/ month (baht)	5,468	3,168
Age at first marriage	18.4	2.9
Gestation (weeks)	34.9	2.6
Parity	1.9	2.0
Birth interval (years)	2.7	2.6

Table 2
Hematological findings (N= 180).

Parameter	Cut-point	Mean ± SD	Min-Max	N	Percentage below cutoff value (%)
Hb (g/l)	110 g/l	105.3 ± 1.3	6.9-13.4	180	45.2
Hct (%)	33%	33.3 ± 3.8	22.9-41.1	180	
SF (μg/l)	less than 10 μg/l	10.5 ± 12.0	0.0-99.8	178[a]	28.3
SI (μmol/l)	less than 9 μmol/l	10.8 ± 7.1	3.0-54.7	178[a]	46.4
TIBC (μmol/l)	27-80.5 μmol/l	66.3 ± 9.2	34.4-85.2	178[a]	
TS	less than 15%	15.6 ± 10.0	3.9-76.0	178[a]	36.7
MCV (fl)	less than 85 fl	85.4 ± 7.9	63.6-103.1	180	59.0
MCH (pg)	less than 27 pg	27.0 ± 3.2	17.1-34.5	180	
RDW (%)		14.7 ± 1.9	12.1-28.0	180	
Hemoglobin typing					
A+A2				164 (91.1%)	
A+E				16 (8.9%)	
Iron status					
Normal				36 (20%)	
Iron deficiency				62 (34%)	
Iron deficient anemia				68 (37.8%)	
Other anemia				14 (7.8%)	

[a] Two blood specimens hemolyzed

Table 3
Pregnant women health center attendance and iron tablet consumption (N=160)[a].

Month of gestation	Number(%) of PW who visited doctor/ health care staff	Received iron tablets		Frequency of taking iron tablets [b]		
		Yes	No	Daily	Sometimes	Never
2	12 (8)	12	-	-	3	9
3	49 (31)	48	1	8	14	26
4	71 (44)	68	3	9	26	33
5	95 (59)	92	3	17	36	39
6	111 (69)	106	5	24	43	39
7	125 (78)	121	4	14	30	77
8	90 (56)	88	2	8	14	68

[a]6 PW did not visit a HC
[b]Among PW who visited a HC and received iron tablet supplementation
Total N = 160 (PW with at least one visit)

Table 4
Breakdown of iron status group by key independent variables[a] (N= 166).

Variables	N	ID	IDA	P-value for trend
Socio-demographic variable				
Age				0.01
26 years or less	13	31	42	
>26 years	23	31	26	
Income spent on food (baht)				0.09
<2,000	26	50	41	
2,000 or more	10	12	27	
% expenditure on food				0.12
60% or less	29	57	49	
>60%	7	5	19	
Health center utilization				
First physical check				0.001
16 weeks or earlier	28	47	34	
>16 weeks	8	15	34	
Number of physical checks				0.01
>4 times	18	35	50	
4 times or fewer	18	27	18	
Iron tablet supplementation use				0.01
Not regular use	22	49	57	
Regular use	14	13	11	
Food consumption increased				0.18
Yes	9	32	29	
No	27	30	39	
Consumption of meat per meal				0.001
<12 g	19	52	57	
12 g or more	17	10	11	
Total calorie consumption per day				0.02
1,769 cal or less	29	58	65	
>1,769 cal	7	4	3	
Hookworm infestation [b]				0.25
None	17	30	22	
Yes	14	19	28	

[a] Only those with p-values for trend <0.2; [b] Only 130 PW gave stool samples

Table 5
Final ordinal logistic regression model prediction status of pregnant women.

Variables	Value	Coefficient /SE	p-value from Wald's test	p-value from likelihood ratio test
Gestation	>34 weeks	-0.89/0.37	0.02	0.007
Antenatal care utilization	>3 times	-0.95/0.37	0.01	0.02
Self assessed compliance with iron tablet supplementation	Non-compliant	0.34/0.42	0.41	0.64
Hookworm infestation	Yes	0.75/0.36	0.04	0.0001
Monthly income spent on food (baht)[a]	1,000-2,000	0.46/0.47	0.32	0.005
	2,001-3,000	1.71/0.64	0.007	
	>3,000	1.59/0.74	0.03	
Weight of meat intake/ day	less than 8 g	-1.35/0.37	0.0001	0.0002
Total calorie intake/ day	less than 1,769 cal	-1.68/0.66	0.01	0.01

[a] Reference group was < 1,000 baht per month

made the mother and fetus healthy and increase blood production. The major reasons for not taking iron tablet supplementation included "already in a good health" (2%), "allergic to iron tablet (vomiting, dizziness, nausea, headache, or diarrhea)" (10%), "do not want to have a big baby" (2%) and "forgot to eat because very busy" (20%).

As seen in Table 4, factors potentially associated with iron status on the initial univariate analysis with p-values <0.2 included socio-demographic variables, reproductive history, health service use, iron-supplementation and food consumption.

From ordinal logistic regression (Table 5) gestation age above 34 weeks, more than three ANC visits, or increased meat and calorie intake, significantly reduced the risk for ID and IDA, whereas hookworm infection significantly increased the risk. Compliance with iron tablet supplementation, however, was not significantly related to ID or IDA.

DISCUSSION

We have confirmed that iron deficiency anemia is highly prevalent in lower southern Thailand where poverty, and low levels of education prevail. Soil transmitted helminthes are extremely common and lead to this problem. Interesingly, compliance with iron tablets was not significantly related to iron status, whereas using antenatal services and increasing protein and calories did predict iron status.

Apart from iron deficiency, hereditary causes of anemia are not uncommon. There are a variety of genetic disorders, making control of iron deficiency anemia more difficult. While iron deficiency is well known to be harmful to pregnancy, iron overload in hereditary anemia has also been demonstrated to cause serious problems (Cohen *et al*, 2004).

Risk factors for iron deficiency anemia are multi-factorial. In our model, late gestation is associated with lower risk. This may be explained by the possibility that women in late gestational may have been more adequately supplemented with iron tablets than those in early gestational. "Dilutional anemia" is also another explanation. During the second trimester, women accumulate water faster than the capacity of red blood corpuscle production (Jepson, 1973). By the third trimester, when hemodynamics are more stable, the dilution effect subsides, resulting in the finding that late gestation is a protective factor. Our results may therefore be misleading.

Antenatal care is aimed at helping PW get through their pregnancy safely, by preventing anemia and low birth weight, and improving nutritional knowledge, especially with regard to the importance of iron supplementation, and appropriate food during pregnancy. In our setting, the protective effect of ANC was demonstrated. Among our subjects, first visits to ANC were rather late. Thus, in terms of IDA prevention, the

local system may not have adequate coverage. The fact that self-assessed level of compliance with iron supplementation was not associated with IDA may be explained by information bias from the responding women. Women aware of the necessities of self-care might under-estimate their compliance while taking the medication. On the other hand, the at-risk group might over-report their compliance.

The prevalence of hookworm infection in the study area was high and plays a significant role in IDA among PW. This finding is similar to that reported by Bondevik *et al* (2000) and Santiso (1997). In Thailand, the hookworm control program is most active in the south where the disease is most prevalent (Nutrition Division, 1997). After more than a decade of the control program, the prevalence among PW is still very high. This illustrates program deficiencies.

Together with many control measures, such as education, latrine construction and promotion of shoes and boot wearing, mass treatment is often used as an adjunct (Chongsuvivatwong *et al*, 1996; Mascie-Taylor *et al*, 1999). Mebendazol given to PW is harmless and effective in reducing perinatal and maternal health risk (de Silva *et al*, 1999; Christian *et al*, 2004), yet in Thailand PW are not given antihelminthics for fear of a teratogenic effect. This mis-belief should be corrected. In hookworm endemic areas, it may be necessary to have stool microscopy as a routine check during pregnancy followed by antihelminthics, if necessary.

Meat and calorie intakes are two important local preventive factors for IDA. Low intake of essential nutrients among PW has been demonstrated (Hartini *et al*, 2003; Piammongkol *et al*, 2004). This problem must be prevented by educational programs and improving socio-economic conditions.

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