

IRON STATUS OF PREGNANT FILIPINO WOMEN AS MEASURED BY SERUM FERRITIN

Leah A Perlas, Miriam D Kuizon, Rosario T Tajaon and Josefina A Desnacido

Food and Nutrition Research Institute, Department of Science and Technology, Taft Avenue, Manila, Philippines.

Abstract. Iron status of pregnant women at different stages of pregnancy was evaluated by comparing values for hemoglobin (Hb), red cell indices, serum iron (SI), transferrin saturation (TS) and serum ferritin (SF) values with those of a group of non-pregnant women of comparable age and socio-economic status. Mean SF values on the second and third trimesters (9.3 ± 2.60 ng/ml and 7.1 ± 2.19 ng/ml) were significantly lower compared to that in the first trimester (22.6 ± 2.20 ng/ml). These levels were also lower than that found in the non-pregnant controls. The trend was the same for TS. Hemoglobin levels of the pregnant subjects were significantly lower than those of the non-pregnant women. Prevalence of iron deficiency based on $SF < 12.0$ ng/ml and $TS < 16.0\%$ was highest at term and lowest during the first trimester indicating a decrease in iron stores as pregnancy progressed. Sensitivity for each of the iron parameters was computed, and it was found that for the diagnosis of iron deficiency in pregnant women, SF has a greater sensitivity than TS, SI, MCV and MCH.

INTRODUCTION

Most studies on iron status of Filipino pregnant women were based only on hemoglobin (Hb), serum iron (SI), and transferrin saturation (TS) as parameters (Marzan *et al*, 1971; Kuizon *et al*, 1980). However, these parameters become below normal only after iron stores have been exhausted, and no information is provided on the overall changes in iron status (Cook *et al*, 1974). So far, only the study done by Kuizon *et al* (1989) on a sub-sample of the III National Nutrition Survey subjects included SF as a parameter.

There are only a few approaches that can detect changes in iron stores. The most precise quantitative procedure makes use of phlebotomy, and another method measures iron absorption which varies inversely with iron stores (Cook and Skikne, 1982). These procedures, however, cannot be applied to certain segments of the population such as pregnant women.

Recently, radioimmunoassay has been applied in the determination of serum concentration of the iron storage protein, ferritin. Ferritin is found in almost every tissue of the body, principally the cytoplasm of the hepatic and reticuloendothelial cells. Several studies have shown that the concent-

ration of serum ferritin correlates well with body iron stores in normal subjects (Lipschitz *et al*, 1974; Walters *et al*, 1973). Studies in normal pregnant women have likewise shown results consistent with known changes in iron metabolism (Kaneshige, 1981; Ances *et al*, 1979; Kuizon *et al*, 1984).

The purpose of this study was to evaluate the changes in the iron stores in pregnant Filipino women by comparing SF concentration at various stages of pregnancy to that of a group of non-pregnant women of comparable age and socio-economic status. Transferrin saturation and red cell indices were also determined to compare their sensitivity with SF as a measure of iron status.

MATERIALS AND METHODS

The subjects of the study were 88 apparently healthy primigravidas at various stages of pregnancy (28 on first trimester, 30 on second trimester and 30 on third trimester) seeking prenatal consultation at various Health Centers in Metro Manila and 25 pregnant women who were admitted for delivery at different government hospitals. A group of 29 non-pregnant women of the same age and socio-economic status served as controls.

None of the subjects had received any mineral or vitamin supplements prior to their inclusion in the study.

Venous blood sample (about 10 ml) was collected from each subject at approximately the same time in the afternoon. Hemoglobin (ICSH, 1978a) and other red cell indices were determined immediately after collection. Serum samples were kept frozen until analyzed for SI and total iron binding capacity (TIBC) using methods recommended by the ICSH (ICSH, 1978b, 1979). Serum ferritin was determined by the 2-site immunoradiometric assay using a commercially available kit of reagents and control (Ramco Lab Inc, Texas, USA).

Routine urinalysis and stool examinations for intestinal parasites were also done. Dietary intake using one-day food recall was evaluated for adequacy using the Philippine RDA (SCDA, 1976).

Student's *t*-test was used to determine significant differences between means. A log transformation was used for SF and TS values before statistical treatment.

The sensitivity and specificity of each of the iron parameters were calculated to determine the best parameter for this particular group of subjects. Sensitivity was defined as the percentage of iron-deficient individuals identified by a particular test (a good test gives positive results in deficient subjects) and specificity as the percentage of individuals correctly identified as normal by the same test (a good test gives negative results in healthy subjects) (INACG, 1985). Sensitivity of ferritin is then the ability of SF to identify correctly pregnant women classified as anemic by Hb and iron deficient by TS (true positive) and specificity as the ability of SF to identify correctly pregnant women classified as non-anemic by Hb and non-iron deficient by TS (true negative).

RESULTS

The subjects of the study were comparable in age with a mean of 23.9 ± 2.91 years. Routine urinalysis for infection and stool examination for intestinal parasites were all negative.

Table 1 shows the mean Hb, TS, Sf and prevalence of iron deficiency at different stages of pregnancy. Mean SF values on the second and third

trimester (9.3 ± 2.60 ng/ml and 7.1 ± 2.19 ng/ml) were significantly lower compared to the first trimester (22.6 ± 2.20 ng/ml) ($p < 0.001$). The first trimester value was likewise significantly higher ($p < 0.05$) than the non-pregnant concentration. A similar study by Kaneshige (1981) also showed higher first trimester values. This is in agreement with the results of a study on pregnant women by Kuizon *et al* (1989) where SF values also decreased as pregnancy advanced. Transferrin saturation levels for the second and third trimester pregnant as well as the non-pregnant women were lower compared to the first trimester values. Hemoglobin levels of the pregnant subjects were significantly lower than those of the non-pregnant women who were selected for the study. Except for SF whose concentration was lowest at delivery (6.3 ± 2.2 ng/ml), the hemoglobin and transferrin saturation values were higher compared to the third trimester value.

Prevalence of iron deficiency based on SF (< 12.0 ng/ml) was highest in samples collected in women at delivery (80%) and lowest during the first trimester (21.5%). The non-pregnant prevalence was, however, higher (37.9%) than the first trimester value. The trend for TS was the same as that of the SF. Results also showed that anemia prevalence (Hb < 11.0 g/dl) was higher during the second and third trimester compared to the first trimester and non-pregnant prevalence.

Table 2 shows the mean red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular hemoglobin (MCH) for the subjects. Except for RBC where values for pregnant women were lower than for non-pregnant controls, the mean MCV, MCHC and MCH concentration of the pregnant subjects were all comparable to the non-pregnant controls.

Results of tests for sensitivity and specificity for MCV, MCH, SI, TS and SF are shown in Tables 3 and 4. Serum ferritin was found to have a sensitivity of 91.7% when the proportion of low SF was determined in anemic subjects with low TS (Table 3). Transferrin saturation gave a sensitivity of 50.0% when the proportion of low TS was determined in anemic subjects with low SF (Table 4). Results of this study are in agreement with others (Ances *et al*, 1979; Romslo *et al*, 1983) who found that SF is the most sensitive of the iron parameters.

Table 1

Mean serum ferritin, hemoglobin, transferrin saturation and prevalence of below normal values in non-pregnant control subjects and in women at different stages of pregnancy.

Parameters	Non-pregnant women n = 29		1st trimester n = 28		2nd trimester n = 30		Pregnant women At delivery n = 25			
	x ± S D	% below normal	x ± S D	% below normal	x ± S D	% below normal	x ± S D	% below normal	x ± S D	% below normal
Serum ferritin ³ , GM (ng/ml)	14.3 ± 2.34	37.9	22.6 ± 2.20	21.4	9.3 ± 2.60*	63.3	7.1 ± 2.19*	73.3	6.3 ± 2.20***	80.0
Hemoglobin (g/dl)	12.8 ± 0.95	17.2	12.0 ± 1.28**	17.8	11.4 ± 0.94***	33.3	10.9 ± 1.32***	36.7	11.9 ± 1.36	16.0
Transferrin saturation ² , GM (%)	22.8 ± 1.41	13.8	28.3 ± 1.30**	3.6	21.4 ± 1.40	20.0	19.1 ± 1.40*	20.0	20.8 ± 1.47	32.0

Significance from non-pregnant value : * p < 0.05
 ** p < 0.01
 *** p < 0.001

¹Hemoglobin : Pregnant < 11.0 g/dl (INACG, 1985)

Non-pregnant < 12.0 g/dl (INACG, 1985)

²Transferrin saturation < 16.0% (INACG, 1985)

³Serum ferritin < 12.0 ng/ml (INACG, 1985)

Table 2

Mean RBC, MCV, MCHC and MCH in non-pregnant control subjects and women at different stages of pregnancy.

	Non-pregnant women n = 29	Pregnant women			
		1st trimester n = 28	2nd trimester n = 30	3rd trimester n = 30	At delivery n = 25
RBC (10 ⁶)	4.22 ± 0.28	4.00 ± 0.40	3.85 ± 0.30	3.69 ± 0.45	3.76 ± 0.40
MCV (fl)	90 ± 2.66	90 ± 2.79	88 ± 2.51	90 ± 2.88	98 ± 6.10
MCHC	34 ± 1.05	33 ± 1.28	33 ± 1.40	33 ± 1.26	32 ± 1.47
MCH (pg)	30 ± 0.80	30 ± 0.96	30 ± 1.01	30 ± 1.14	32 ± 1.65

Table 3

Distribution of laboratory values according to range of hemoglobin and transferrin saturation.

Iron parameters	Hemoglobin								
	< 11.0 g/dl				> 11.0 g/dl				
	Transferrin saturation								
	< 16.0%		> 16.0%		< 16.0%		> 16.0%		
	n	%	n	%	n	%	n	%	
SF	< 12 ng/ml	11	91.7	11	55.0	9	90.0	36	48.6
	< 12	1	8.3	9	45.0	1	10.0	38	51.4
SI	< 60 µg/dl	0	0	0	0	2	20.0	0	0
	< 60	12	100.0	20	100.0	8	80.0	71	100.0
MCV	< 80 fl	0	0	0	0	0	0	0	0
	< 80	12	100.0	20	100.0	10	100.0	71	100.0
MCH	< 27 pg	0	0	0	0	0	0	0	0
	< 27	12	100.0	20	100.0	10	100.0	71	100.0

Sensitivity is the fraction of anemic subjects with low TS identified as abnormal and specificity is the fraction of non-anemic subjects with normal TS identified as normal.

Contrary to the findings of Hershko *et al* (1981) MCV, MCH, and SI all had low sensitivities. Results for specificity test showed that serum ferritin levels were normal in 51.4% of subjects with normal Hb and TS levels.

Table 5 shows the mean iron, protein, energy

and ascorbic acid intake of the subjects. The mean iron intake of the non-pregnant and pregnant subjects were 11.0 ± 6.75 mg and 10.0 ± 6.35 mg respectively, while ascorbic acid intake were 29.7 ± 34.31 mg and 49.8 ± 53.52 mg also for the pregnant and non-pregnant subjects, respectively. The mean intake of iron met only 55.6% of the

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Table 4

Distribution of laboratory values according to range of hemoglobin and serum ferritin.

Iron parameters		Hemoglobin							
		< 11.0 g/dl				> 11.0 g/dl			
		Serum Ferritin							
		< 12.0 ng/ml		> 12.0 ng/ml		< 12.0 ng/ml		> 12.0 ng/ml	
		n	%	n	%	n	%	n	%
TS	< 16 %	11	50.0	1	10.0	9	20.0	1	2.8
	< 16	11	50.0	9	90.0	36	80.0	35	97.2
SI	< 60 µg/dl	0	0	0	0	2	4.4	0	0
	< 60	22	100.0	10	100.0	43	95.6	36	100.0
MCV	< 80 fl	0	0	0	0	0	0	0	0
	< 80	22	100.0	10	100.0	45	100.0	36	100.0
MCH	< 27 pg	0	0	0	0	0	0	0	0
	< 27	22	100.0	10	100.0	45	100.0	36	100.0

Table 5

Mean energy, protein, iron and ascorbic acid intake of the subjects.

	Non-pregnant women		Pregnant women					
	x ± S D	% RDA	1st trimester		2nd trimester		3rd trimester	
	x ± S D	% RDA	x ± S D	% RDA	x ± S D	% RDA	x ± S D	% RDA
Energy (kcal)	1359 ± 498.69	70.4	1418 ± 620.97	61.6	1447 ± 547.32	65.4	1505 ± 426.53	64.2
Protein (g)	51.58 ± 25.00	95.2	49.4 ± 26.16	74.0	50.1 ± 17.39	74.5	57.1 ± 83.95	83.9
Iron (mg)	11.00 ± 6.75	61.1	8.3 ± 3.48	45.9	9.9 ± 5.19	55.1	11.8 ± 8.96	65.9
Ascorbic acid (mg)	29.7 ± 34.31	41.7	53.6 ± 61.78	44.8	46.0 ± 57.48	39.4	49.9 ± 41.30	43.2

DISCUSSION

RDA of 18.0 mg/day for Filipino women during the childbearing years. The ascorbic acid intake met 76.6% of the RDA of 70 mg for the first trimester and 39.9% for the second and third trimester which has a higher RDA of 120 mg/day. Similar results for iron and ascorbic acid intakes were reported by Villavieja *et al* (1989).

The hemoglobin concentration of the pregnant subjects in this study followed the physiological pattern which is expected as normal pregnancy progresses. During normal pregnancy, the total erythrocyte volume increases without the stimulus of extra iron, but the relatively greater increase in plasma volume causes the concentration of hemoglobin to fall as much as 2 g/dl (Hall, 1974; Lind *et al*, 1975).

The higher SF concentration of the first trimester pregnant women compared to the non-pregnant controls may be attributed to the reduced iron requirement since there is a temporary cessation of menstruation and the amount of iron transferred to the fetus is still minimal. From the beginning of the second trimester, there is a major expansion in the maternal red cell mass which continues until the third trimester (INACG, 1978). During this period iron is transported to the developing fetus, therefore maternal body iron stores are expected to decline and a state of latent iron deficiency is manifested (Kaneshige, 1981). This was reflected in the highly significant difference in the mean ferritin level during the second and third from the first trimester concentration.

About 8% of the anemic subjects with low TS were not identified by SF. An increase in SF concentration has been shown to occur in the presence of certain disorders such as infection, chronic disease and liver disease (Lipschitz *et al*, 1974). However, our subjects have no overt signs and symptoms of clinical diseases. In a study in India, normal SF values in the face of low TS and anemia was attributed to concurrent occult infections which was reported not unlikely in anemic women (Kunar, 1989). The presence of low SF in 48.6% of non-anemic subjects with normal TS is due to the fact that in the first stage of iron deficiency where both Hb and TS are still normal, SF is already depleted. In these subjects, there was sufficient iron for erythropoiesis but no stored surplus (Derman *et al*, 1978). Thus, the results in specificity should be interpreted with due consideration that these parameters measure different stages of iron deficiency. In spite of the low specificity of SF shown here, it should not be concluded that it is not a good parameter. Dallman (1982) and Cook and Skikne (1982) even considered low SF as more specific since there is no condition other than iron deficiency in which it is reduced to very low levels. In contrast, SI and TS will rapidly fall in response to fever, infection and inflammation. Another parameter, the erythrocyte protoporphyrin (EP), is elevated not only in iron deficiency but also in lead poisoning in addition to the above conditions. Thus, these authors even recommended using SF in addition to TS and FEP to distinguish iron deficiency from other causes.

The zero sensitivity of MCV and MCH supports the findings of Taylor and Lind (1976). Pregnancy

induces a slight increase in red cell size and this may explain why microcytosis may not be found in pregnant women in whom there is other evidence of iron deficiency.

Assuming that 1 ng ferritin/ml serum is equivalent to 10 mg storage iron (INACG, 1978), the first trimester pregnant subjects had 226 mg iron stores. The second and third trimester groups in this study already had depleted stores since serum ferritin concentration below 12 ng/ml indicates exhausted body stores (INACG, 1978). Even with an increased rate of iron absorption during pregnancy, the intake of this particular group would not be able to meet the amount required for the entire duration of pregnancy. The iron as well as the ascorbic acid intake, which is known to be an enhancer of iron absorption were below the recommended dietary allowance for Filipinos (SCDA, 1976).

About 500 mg storage iron is needed for pregnancy (INACG, 1978), and less than half of this is present in the first trimester subjects. Our results indicate that at the start of pregnancy, iron supplementation should be considered since pregnant subjects already had exhausted stores as shown by their very low serum ferritin concentration. Previous studies have shown that infants born to mothers with depleted iron stores had lower serum ferritin levels indicating that the iron supply to the fetus is reduced in maternal iron deficiency (Kaneshige, 1981; Ances *et al*, 1979; Kuizon *et al*, 1984).

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THE PREVALENCE OF THE INDIRECT HEMAGGLUTINATION TEST FOR MELIOIDOSIS IN CHILDREN IN AN ENDEMIC AREA

Punthip Charoenwong¹, Pagakrong Lumbiganon¹ and Supaporn Puapermpoonsiri²

¹Department of Pediatrics, ²Department of Pathology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002 Thailand.

Abstract The indirect hemagglutination test for melioidosis was studied in 295 children who live in the northeastern part of Thailand. Sixty-seven children (22.7%) were healthy children who came to the well baby clinic. Two hundred and twenty-eight children (77.3%) came to the hospital because of some illnesses other than melioidosis. Eighty-three percent of the children had an IHA titer of at least 1:10 or greater. Twenty-two percent had an IHA titer of 1:80 or greater. The prevalence of positive IHA titer and the mean titer were higher in the older age group. The age of children should be considered when interpreting IHA titer for melioidosis.

INTRODUCTION

Melioidosis, an infection caused by *Pseudomonas pseudomallei* is endemic in Southeast Asia and northern Australia (Howe *et al*, 1971). The disease can occur in all age groups. The clinical manifestations include septicemia and localized infection which can involve almost every organ and can mimic many other diseases. Apart from bacteriological culture which is the definite diagnosis, some serological methods have been utilized to provide rapid and presumptive evidence of infection (Alexander *et al*, 1970). The simplest and most widely used serological test is the indirect hemagglutination antibody test (IHA) (Nigg, 1963).

A study of United States soldiers in Vietnam indicated that the test was highly specific and sensitive (Alexander *et al*, 1970). In endemic areas the background prevalence of antibodies in the population was as high as 47% in one study, so the test should be interpreted carefully (Khupulsup *et al*, 1986). The interpretation of the IHA test in children is even more difficult because most of the serological survey studies were done in adults. Whether a background prevalence of antibodies is also present in children of different age groups is not known.

The purpose of this study is to determine the prevalence of IHA antibody for melioidosis in

children who live in the northeastern part of Thailand where melioidosis is endemic.

MATERIALS AND METHODS

Children age 0 to 15 years old, who came to the Department of Pediatrics, Srinagarind Hospital, Khon Kaen University, Khon Kaen during March-June, 1988 were enrolled into the study. There were 2 groups of subjects. The first group was healthy children 0-18 months of age who attended the well baby clinic for routine immunization and at that time were enrolled in either the hepatitis B vaccine or rubella vaccine trial projects. The blood samples drawn from these children were also tested by IHA for melioidosis. The other group of children were those aged 0 to 15 year-old who were admitted to the hospital due to various illnesses. The exclusion criterion was patients who were diagnosed as melioidosis by bacteriological culture results.

Data collection of both groups of children included age, sex, parents' occupation, source of utility and drinking water. The medical history and physical examination of children in the first group were done by the investigators (PC, PL). The same information including the bacteriological culture results of the second group were obtained from the medical records. History of previous illness within 1 year, immunosuppressive therapy and blood or blood products administration within 3 months were also noted.

Correspondence to : Pagakrong Lumbiganon, Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.

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The IHA test for melioidosis was performed by the method described by Khupulsup *et al* (1986). In brief, melioidin antigen was prepared from 25 strains of locally isolated *P. pseudomallei*. These strains were cultured in glycine broth at 37°C for 2 weeks before an autoclaved extraction. Melioidin antigen were diluted to the optimal concentration and coated on to sheep red blood cells (SRBC). To determine the IHA titer, serum was first inactivated at 56°C for 30 minutes and non-specific antibody was absorbed by non sensitized SRBC. A 0.05 ml aliquots of serial 2-fold dilutions of absorbed serum starting from 1:10 were mixed in U-tube microtiter plates with equal volumes of the sensitized SRBC. The IHA titer were read after the mixture was left at room temperature for 2 hours. Positive and negative controls were also included.

The statistics used were Chi-square or Fisher's exact test and simple regression analysis as required.

RESULTS

Two hundred and ninety-five children were enrolled in the study. There were 172 males and 123 females. The ages ranged from 1 day to 15 years old. The mean age was 66 months. Fifty percent of the children lived in Khon Kaen Province. The remainder were from other provinces in the northeastern part of Thailand. Parents of 105 children (40.9%) were farmers. Fifty-one percent of the parents obtained their drinking water from natural sources *eg* rain water, digging wells, river, etc. Nineteen percent of them usually drank tap water. The sources of utility water were from digging wells, ditches and rivers in sixty-two percent while the rest used tap water.

There were 67 children (22.7%) in the first group. All were in good health as judged by history and physical examination. The second group comprised 228 (77.3%) children who had various illnesses (Table 1). Twenty-two percent and 17% of the children had previously received blood or blood products transfusion and immunosuppressive agents, respectively.

The distribution of IHA antibody titers in 295 children is shown in Table 2. Ninety-eight children (17%) had non detectable IHA antibody to melioidosis. Two hundred and 46 children (83%) had IHA antibody titers ranging from 1:10 to 1:640.

Table 1
Diagnosis of 228 hospitalized children*.

Disease	No. %
Hematologic disease and malignancy	97
Infectious disease	53
Neurological disease	37
Cardiovascular disease	11
Gastrointestinal disease	8
Respiratory disease	7
Urological disease	5
Miscellaneous	24

* Some children had more than 1 diagnosis

Table 3 shows the number of children in each age group who had IHA antibody titers $\geq 1:80$. None of the 12 neonates had IHA antibody titers $\geq 1:80$. Children aged 1-11 months old, 1-4 years old, 5-9 years old and 10-15 years old had IHA antibody titers of $\geq 1:80$ in 5%, 23%, 24% and 36%, respectively. The means and standard deviations of titers of children in each age group are shown in Table 3. The mean titers and the percentages of children who had titers $\geq 1:80$ were higher in older children with statistically significant differences ($p < 0.05$).

Table 4 shows the number of children who had an IHA titer of $< 1:80$ and $\geq 1:80$ according to the presence or absence of underlying diseases (tumor, hematologic diseases and malignancy), previous immunosuppressive therapy and blood or blood product administration during the past 3 months. There were no statistically significant associations between these factors and titers of $< 1:80$ and $\geq 1:80$ ($p > 0.05$).

Fifty out of 65 children who had IHA antibody titers for melioidosis $\geq 1:80$ were followed-up. The duration of follow-up ranged from 3 days to 8 months. Eight children were in the first group, all were healthy at the time of follow-up. Forty-two children were in the second study group. Forty of them had no signs or symptoms suggestive of melioidosis. Two children died. The first one, who had an IHA titer of 1:160, was an 11 year-old boy who presented with bronchiectasis and pneumonia.

Table 2

The distribution of IHA antibody titer for melioidosis in children of different age groups.

Age	IHA antibody titer for melioidosis							No ⁺ /No tested (%)
	1:10	1:20	1:40	1:80	1:160	1:320	1:640	
0-29 days	1	-	1	-	-	-	-	2/12 (16.7)
1-11 months	8	4	7	1	-	-	1	21/39 (53.8)
1-4 years	35	35	12	22	5	-	1	110/124 (88.7)
5-9 years	13	18	20	11	5	1	1	69/174 (93.2)
10-15 years	7	11	9	9	5	1	2	44/46 (95.7)
Total	64	68	49	43	15	2	5	246/295

Table 3

Mean IHA titer, standard deviation, number of children who had titer \geq 1:80 classified according to age groups.

Age	Mean titer* (log ₁₀)	Standard deviation	No. titer \geq 1:80/Total no.(%)**
1-20 days	0.2168	0.5224	0/12 (0)
1-11 months	0.7469	0.7691	2/39 (5)
1-4 year	1.2537	0.5843	28/124 (23)
5-9 year	1.4287	0.5493	18/74 (24)
10-15 year	1.5651	0.5763	17/46 (36)

* Simple regression analysis, $p < 0.05$

** Chi-square test, $p < 0.05$

He died despite treatment with penicillin, cloxacillin and gentamicin. The second patient, who had an IHA titer of 1:640, was a 1 1/2 month-old boy who came to the hospital with high fever, lethargy and abdominal distention for 5 days. On admission he had cardiorespiratory arrest and circulatory failure. He died 6 hours after admission. The blood cultures of these 2 patients did not grow any organism.

DISCUSSION

In an endemic area, the cut off titer of IHA antibody for melioidosis at \geq 1:80 is reported to have the specificity and sensitivity of 95% and 70%, respectively (Puapermpoonsiri *et al*, 1989). In our study only 2 out of 12 neonates had detectable IHA titers of 1:10 and 1:40. None had titers \geq 1:80. A study of IHA antibody for melioidosis

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Table 4

Children who had IHA titer < 1:80 and \geq 1:80 classified according to various associated factors.

Associated factors		IHA titer	
		< 1:80	\geq 1:80
Underlying diseases :	Yes	184	58
	No	57	10
Immunosuppressive therapy:	Yes	37	11
	No	188	53
Blood and /or blood product administration :	Yes	53	8
	No	171	51

Chi-square test, $p > 0.05$

of cord bloods from southern Thailand showed that all cord bloods had titers < 1:20 (Appassakij *et al*, 1990). Children under 1 year of age rarely had IHA titers \geq 1:80 (5%). Children over 1 years old had increasing positive IHA titers with titer \geq 1:80 in 23-36%. This may reflect increasing exposure to the organisms which are abundant in soil and water in this area. The age of children might be an important factor when interpreting IHA titer. While other diagnostic approaches such as *P. pseudomallei* antigen detection are under investigation (Wongratanacheewin *et al* 1990), the IHA antibody test is still the only widely used serological method available. Further studies of larger numbers of healthy children in both endemic and non-endemic areas are needed in order to evaluate the prevalence of IHA antibody for *P. pseudomallei* in children.

Our study had some limitations, in that 77.3% of children studied had some kind of illness and many children had received immunosuppressive agents or blood and blood product transfusion. Whether these factors might interfere with the result of the IHA titer remains to be studied, but in our study there were no statistically significant associations between these factors and the IHA titer.

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