

HOOKWORM ANEMIA IN THE ADULT POPULATION OF JAGAPATI VILLAGE, BALI, INDONESIA

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Abstract. A cross sectional study was conducted in Jagapati Village, Bali to assess some characteristics of hookworm anemia among the adult population. Hookworm anemia was defined as an iron deficiency anemia in heavily infected individuals (EPG > 2,000). WHO criteria for anemia and criteria of Herberg for iron deficiency were used. In this study, 15 cases of hookworm anemia were found among 454 total samples (3.3%), or among 123 cases of iron deficiency anemia (12.2%). The age varied between 16-69 years with male to female ratio of 1 : 2.8. Twelve cases were found with symptoms and signs of anemia, 1 case with full blown hookworm anemia, and 2 cases were asymptomatic. The hemoglobin level was found to be 4.5-12.9 g/dl, with 12 cases (80.0%) being classified as mild anemia, 2 cases (13.3%) as moderate anemia, and 1 case as severe anemia. The mean serum iron level was 39.6 mg/dl, mean transferrin saturation was 11.1%, and mean serum ferritin level was 9.6 ng/dl. Hypoalbuminemia was found in 9 cases (60.0%), eosinophilia in 8 cases (53.3%), and low serum folic acid level in 5 cases (38.5%). High total serum IgE level was found in all but one case, with mean total serum IgE level of 3,739 U/ml. The intensity of hookworm infection was moderate in 11 cases (73.3%) and severe in 4 cases (26.7%). It could be concluded that hookworm anemia was characterized by iron deficiency anemia with eosinophilia, high serum total IgE level, hypoalbuminemia and moderate to severe hookworm infection.

INTRODUCTION

Hookworm infection and iron deficiency anemia are the two important public health problems in developing countries, especially in tropical areas. One single hookworm of the anthropophilic species *Ancylostoma duodenale* or *Necator americanus* causes loss of blood of 0.05-0.15 ml/day into the lumen of the intestine, which can eventually lead to depletion of the iron stores (Roche and Layrisse, 1966; WHO, 1987). In tropical countries hookworm infection constitutes one of the commonest etiologic factors of iron deficiency anemia (Gilles, 1985; WHO, 1987).

Hookworm anemia is defined by WHO as an iron deficiency anemia in heavily hookworm infected individuals with intensity of infection exceeding that of critical worm burden (WHO, 1987). The critical worm burden may vary locally depending on age, sex, iron intake, and species of the hookworm (Gilles, 1985). Results of many studies have suggested that, in given endemic areas, roughly one third of all anemias could be attributed to hookworm infection (Roche and Layrisse, 1966; Bakta, 1993).

This study aimed to assess the prevalence and characteristics of hookworm anemia in the adult population of one village in Bali.

MATERIALS AND METHODS

A field work was carried out in Jagapati Village, Subdistrict of Abiansemal, Regency of Badung, Province of Bali, Indonesia, in January-December 1992. The Village of Jagapati is located in the southern lowland of Bali, 150 meters above sea level. Its total population is 1,895 people, consisting mostly of traditional farmers who work in rice fields.

The total samples of the study were 454 randomly selected adult people (> 12 years). Physical examination was done on all samples. Venous blood was taken from each sample for examination of complete blood count by Technicon H-1, serum iron and TIBC by the method as recommended by ICSH, serum ferritin by ELISA, total IgE serum by ELISA, and serum folate by RIA technique. Fecal samples were examined by Kato-Katz thick smear method

and test tube cultivation technique of Harada Mori for species identification.

Hookworm anemia was defined as iron deficiency anemia in hookworm infected individuals with EPG (egg per gram of feces) > 2,000. WHO'S criteria of anemia (Hb < 13 g/dl for men and Hb, < 12 g/dl for women) and Hercberg's criteria of iron deficiency (serum iron < 50 mg/dl, transferrin saturation < 16% and serum ferritin < 20 ng/dl), were used (WHO, 1968; Hercberg and Galan, 1992).

RESULTS

Of the 454 samples, hookworm infection was found in 391 persons, giving a prevalence rate of 86.1%. *N. americanus* was found in 332 cases (98.2%), *A. duodenale* in 4 cases (1.2%), and combination of the two species in 2 cases (0.6%). The mean EPG was 533.4. Severe infection (EPG > 5,000) was found in 6 cases (1.6%), moderate infection (EPG 1,000-5,000) in 43 cases (11.5%), and light infection (EPG < 1,000) in 326 cases (86.9%).

Anemia was found in 184 cases (40.5%), 123 of which could be classified as iron deficiency anemia, which therefore gave a proportional rate of 66.8%. The prevalence of hookworm anemia among 454 samples was 3.3%, or 12.2% among 123 cases of iron deficiency anemia, or 3.8% among 391 hookworm infected individuals.

The age and sex distribution of the patients is shown in Table 1. The male to female ratio was 1 : 2.8, with a peak age incidence being found in the 60-69 years age group in both sexes.

Most (73.3%) of the hookworm infection in the hookworm anemia cases were moderate in severity (EPG 2,000-5,000), only 4 cases (26.7%) were severe (EPG > 5,000), as shown in Table 2.

Of the 15 cases of hookworm anemia, 2 cases (13.3%) were asymptomatic, 6 cases (40%) with symptoms of anemia such as shortness of breath, weakness, palpitation, headache and tinnitus, 6 cases (40%) with symptoms and signs of anemia such as pallor of mucous membrane and skin, and one case with full blown iron deficiency anemia (Table 3).

The hemoglobin level was found to be 4.5-12.9

Table 1

The age and sex distribution of the 15 cases of hookworm anemia.

Age group (years)	Male	Female	Total
20 - 29	-	1	1
30 - 39	-	2	3
40 - 49	-	2	2
50 - 59	1	1	2
60 - 69	2	4	6
≥ 70	1	1	2
Total	4	11	15

Table 2

The severity of hookworm infection in 15 cases of hookworm anemia.

Hookworm - EPG (egg gram of feces)	No. of cases
2,000 - 3,000	7
3,000 - 5,000	4
> 5,000	4

g/dl. The majority of anemic cases (80%) were light in severity with hemoglobin 8-13 g/dl, 2 cases were moderate with hemoglobin 6-8 g/dl, and only one case was severe with hemoglobin less than 6 g/dl (Table 4).

The red cell index is shown in Table 5. The majority of the hookworm anemia cases had hypochromic microcytic anemia with anisocytosis (red cell distribution width = RDW > 15%).

Table 6 shows the iron status of the patients. All patients were associated with low serum ferritin level, and most of them had low serum iron level and low transferrin saturation.

Data on peripheral blood eosinophil and total IgE serum are shown in Table 7. The mean total serum IgE level was high, and eosinophilia was found in 8 cases (53.3%). A low serum albumin level was found in 9 cases (60%), and low serum folate level in 5 cases (33.3%), as shown in Table 8.

Table 3

The symptoms and signs of 15 cases of hookworm anemia.

Symptoms and signs	No. of cases
Asymptomatic	2
With symptoms of anemia	6
With signs and symptoms of anemia	6
Full blown case	1

DISCUSSION

The prevalence of hookworm infection in the adult population of Jagapati Village was high, comparable with the result of a study carried out in other places in Bali (Bakta *et al*, 1993). Carrol and Walker, (1990) reported a prevalence of hookworm infection in Indonesia to be 52-63%. The most prevalent species found was *N. americanus*. This has also been found in other parts of South-east Asia (Carrol and Walker, 1990). The servery of infection in majority of patients were light. This is a common finding in endemic areas, as reported by Tantular (1984) in East Java, Harinasuta and Charoenlarp (1980) in Thailand, and Cabrera (1983) in the Philippines.

The prevalence of hookworm anemia was 3.3% among the adult population, 3.8% among the hookworm infected patients, and 12.6% among the iron deficiency anemia cases. This means that in an endemic area, although the prevalence of hookworm infection is very high, the infection may not necessarily be the main cause of iron deficiency anemia as there may be other more important causes, such as nutritional factors. This is consistent with the observation that most of the infection intensity was light and that severe infection was mostly aggregated within a small proportion of the population. A study in Jagapati Village, Bakta (1993) found that hookworm infection contributes only about one third of all etiologies of iron deficiency anemia. This is in accordance with the statement of Roche and Layrisse (1966) that in given endemic zones, roughly one third of all anemias could be attributed to hookworm infection as a major contributing factor. However, hookworm infection must still be considered

Table 4

The hemoglobin level of 15 cases of hookworm anemia.

Hemoglobin level (g/dl)	No. of cases	Percentage
< 6	1	6.7%
6 - 8	2	13.3%
8 - 12.9	12	80.0%

as one of the important factor in the etiology of tropical iron deficiency anemia (WHO, 1987).

The signs and symptoms of hookworm anemia varied from asymptomatic to full blown iron deficiency anemia. This depends on the severity of the anemia. In this study we found that the majority of patients had mild anemia, often asymptomatic. One case manifested as a full blown hookworm anemia with signs and symptoms of anemia, signs of iron deficiency: atrophy of the papilla of the tongue and spoon nail (koilonychia), enlargement of parotid gland, severe hypochromic microcytic anemia, low iron stores, and severe hookworm infection.

More than two thirds of the anemic cases could be classified as hypochromic microcytic anemia, a characteristic of iron deficiency anemia. Normochromic normocytic anemia could be found in the initial stage of iron deficiency anemia (Lee, 1993).

Hookworm infection causes chronic blood loss which lead to iron depletion (Pawloski *et al*, 1991). This is shown in the iron status of the patients. All patients were iron depleted as shown by low serum ferritin and transferrin saturation. Low serum iron was found in only 75% of cases. The sensitivity and specificity of serum iron examination is lower compared with serum ferritin. This is due to the fact that low serum iron level could be also caused by chronic infection and inflammation (Hoffbrand and Pettit, 1993).

More than half of the patients had eosinophilia. This is a common finding in helminth infection. Nutman *et al* (1987) found eosinophilia in 55% cases of hookworm infection, in 15% cases of *T. trichiura* infection, and in 4% cases of *A. lumbricoides* infection. Eosinophil is an important effector cell in the human immune response against helminth infection (Weller, 1991). High serum total IgE level was found

Table 5

The red cell index of 15 cases of hookworm anemia.

Red cell index	No. of case	Percentage
MCV < 80 fl	10	66.7%
MCH < 27 pg	10	66.7%
MCHC < 31%	13	86.7%
RDW > 15%	12	80.0%

MCV : mean corpuscular volume
MCH : mean corpuscular hemoglobin
MCHC : mean corpuscular hemoglobin concentration
RDW : Red cell distribution width

Table 6

The iron status of 15 cases of hookworm anemia.

Mean serum iron	: 39.6 mg/dl
Serum iron < 50 mg/dl	: 12 cases (80.0%)
Mean transferrin saturation	: 11.1%
Transferrin saturation < 16%	: 14 cases (93.3%)
Mean serum ferritin	: 9.6 ng/ml
Serum ferritin < 12 ng/ml	: 15 cases (100%)

in all but one patient, with a mean total serum IgE level which was higher compared to the normal value of healthy Indonesian adult: 200 IU/ml (Tjokronegoro *et al*, 1990). IgE is the most important antibody resulting in helminth infection, involving in the antibody dependent cell mediated cytotoxicity (ADCC) process. The "eosinophil-mast cell-IgE axis" is the main factor related to immune response against hookworm infection (Butterworth, 1984).

Hookworm anemia was associated with a somewhat lower mean total serum protein level, and a low serum albumin. Hookworm infection causes loss of blood plasma into the small intestine which can lead to hypoalbuminemia (WHO, 1987). Low serum folate level is found in some severe hookworm infected patients. Hookworm may disturb the absorption of this vitamin in the gut (Pawloski *et al*, 1991).

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Table 7

The eosinophil count and serum total IgE of 15 cases of hookworm anemia.

Eosinophils		Serum total IgE*	
< 0.4 × 10 ³ /μl	> 0.4 × 10 ³ /μl	< 200U/ml	> 200U/ml
7 cases (46.7%)	8 cases (53.3%)	1 case (6.7%)	14 cases (93.3%)

* Mean serum total IgE = 3,739 U/ml

Table 8

Serum albumin and serum folic acid level of 15 cases of hookworm anemia.

Serum albumin		Serum folic acid	
< 3.5 g/dl	> 3.5 g/dl	< 3 ng/ml	> 3 ng/ml
9 cases (60.0%)	6 cases (40.0%)	5 cases (33.3%)	10 cases (66.7%)

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