PREVALENCE OF SOIL-TRANSMITTED HELMINTH INFECTIONS IN THE RURAL POPULATION OF BALI, INDONESIA

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Abstract. The objectives of this cross-sectional study were to identify the prevalence of soil-transmitted helminth infection in the rural population of Bali and its relation to age, gender, and geoclimatic conditions. The subjects of study were derived from four villages of different geoclimatic conditions, namely wet lowland, dry lowland, wet highland and dry highland, by a multistage, stratified random sampling technique, based on age and gender of the target populations. The technique of Kato-Katz thick smear was used to determine presence of worm eggs in stools, and modified Harada Mori fecal culture technique was used to identify the species of hookworm larvae in stools. The data were analysed descriptively as well as statistically using χ^2 test. Of 2,394 completely examined and analysed samples, the results showed as follows: The prevalences of *Ascaris lumbricoides, Trichuris trichiura*, hookworms and *Strongyloides stercoralis* were 73.7%, 62.6%, 24.5%, 1.6%, respectively. Of 2,082 infected samples, 33.1% were single infections and 66.9% were mixed infections. Among the mixed infections, dualfection was most frequent (47.8%), followed by single infection (33.1%), triplefection (18.3%), and quadrifection (0.8%). A combination of *A. lumbricoides* and *T. trichiura* was predominant in dualfection, while in triplefection a combination of *A. lumbricoides*, *T. trichiura*, and hookworms was most frequently identified. The prevalence in males was not statistically different, except for hookworms where it was higher in males than in females. The differences of prevalence of infection according to age groups for *A. lumbricoides*, *T. trichiura* and hookworms proved to be highly significant, but not with *Strongyloides stercoralis*. The prevalence of hookworm infection increased steadily with age to reach its maximum (37.7%) in adulthood (> 18 years), while *A. lumbricoides* and *T. trichiura* reached the highest prevalence level in elementary school age (77.3% and 70.7% respectively). The highest prevalence of *S. stercoralis* infection was found also in elementary school age, but it was not statistically significant. In wet highland the prevalence of infection of *A. lumbricoides* was 87.6%, *T. trichiura* 82.4%, hookworms 44.5%, and *S. stercoralis* 3.3%; these were significantly higher compared to the prevalence of infection in other areas (wet lowland, dry highland, dry lowland).

INTRODUCTION

The main causes of intestinal parasitic infections comprise five species of the soil-transmitted helminths (STHs), namely *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Necator americanus*, *Trichuris trichiura*, and *Strongyloides stercoralis*. Infections with the first four species are highly prevalent in many regions of the world and they cause the tenth most common infections affecting the world population. The global estimation of people infected with soil transmitted helminth infections is as follows: *A. lumbricoides* 1,100-1,300 million, hookworm 1,000 million, *T. trichiura* 500-1,000 million, and *S. stercoralis* 50 -100 million (WHO, 1987).

The Island of Bali, one small province of the large tropical archipelago of Indonesia, lies at 115º longitude East by 8º 30′ latitude South, just east of Java Island and west of Lombok Island. It has a population of 2,715,840, 80% of which live in the rural areas, where they earn their living mainly by rice farming (Office of Bali Province Statistics, 1991). A mountain range runs across the middle of the island from east to west, dividing the land into lowlands (0-500 m), which cover 56% of the island, and highlands (>500 m) which cover the remaining 44% of the island. The annual rainfall is high (1,540-2,249 mm/year) in the southern lowlands and highlands and low (≤900 mm/year) in the northern lowlands and highlands (Suweta, 1982). Generally, the hygiene-sanitation condition is poor, with more than 62% households having no latrines (Widjana *et al*, 1993). Several other factors may contribute to the high prevalence of STH infections, among others: type of soil, amount of rainfall, temperature, humidity, and other sociobehavioral variables (Belding, 1965).

According to previous studies, the prevalences

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of soil-transmitted helminth infections in Bali have been reported to vary from 57% to 82% for *Ascaris lumbricoides*, 21% to 86% for *Trichuris trichiura*, and 9% to 64% for hookworms (Bakta *et al*, 1981; Rai *et al*, 1977; Wartana *et al*, 1981; Hartono *et al*, 1985). This wide variation of prevalence rates may be attributed to differences in the characteristics of the population studied, sites of study, methods of sample selection used, and the techniques used for laboratory diagnosis. Although mortality directly associated with infections with these helminths is relatively low, complications are not uncommon, which in many in-stances may need hospital care. Malabsorption, diarrhea, blood loss, impaired working capacity and retarded growth are some of the important health and social problems that result from the infections (WHO 1981). Having a high prevalence and its various related effects on health and social welfare of the people, soil-transmitted helminth infections are a persistent public health problem in Bali, similar as in Indonesia in general. To overcome this problem, an effective control measure must be undertaken. For this control program, adequate and accurate baseline data are essentially needed to support its planning and design. It was for this latter purpose that this study was undertaken.

The objectives of this study were to identify the prevalence of soil-transmitted helminth infections in the rural population of Bali and to evaluate its relation to age, gender, and geo-climatic conditions.

MATERIALS AND METHODS

The study sites

This cross-sectional study was undertaken in 1992 in four villages, representing the four distinct types of Bali's geoclimatic conditions. These villages are: (1) Belumbang village, located in the sub-district of Kerambitan, 25 km west of Denpasar, capital of Bali. This village is a wet lowland area, located 0-500 m above sea level, with an ecosystem basis of well-irrigated rice fields. Its soil is yellowish lactosol of volcanic debris. Its average annual rainfall is 1,726 mm with 7 months of wet and one month of dry season. Its average humidity and temperature are 75.9% and 27.4ºC respectively; (2) Baturiti village, in the sub-district of Baturiti which is a wet highland area. It is 50 km north of Denpasar; with an elevation of 500 -1,000 m above sea level. Its ecosystem basis consisted mostly of rice fields, with soil of brown andotol type. Its average annual rainfall is 2,857 mm, with no months of dry season. Its average humidity and temperature are 84.1% and 21.7ºC respectively; (3) Kubutambahan village, in the sub-district of Kubutambahan, which is a dry lowland area. It is 100 km north of Denpasar, with an elevation of 0-500 m above sea level. Its ecosystem basis is field-crops, no rice-fields, with brown regosol type of soil. Its average annual rainfall is 980 mm, with 4 months of wet season and 4 months of dry season; and its average temperature is 28ºC; (4) Batur Selatan village, in the sub-district of Kintamani, a dry highland area. It is 70 km northeast of Denpasar; with an elevation of 1,000 m above sea level. Its ecosystem basis consisted of field-crops with no rice fields; with humic type of soil. Its average annual rainfall is 2,129 mm with 6 months of wet season and 5 months of dry season. Its average humidity and temperature are 86.5% and 18.7ºC respectively.

Sampling method

The population samples were selected from four villages having different geoclimatic condi-

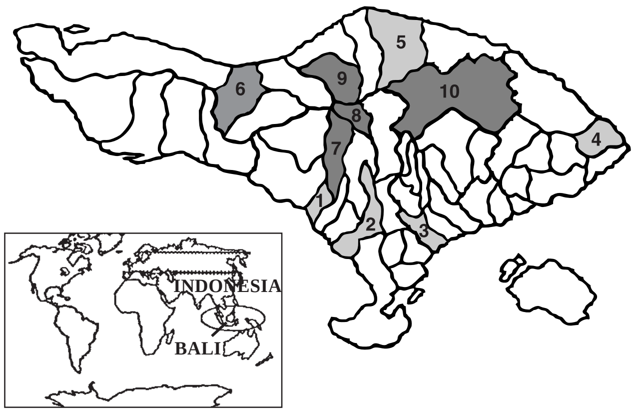

Fig 1–Map of Bali showing the four sites of study.

I. Wet Lowland	:	1. Kerambitan
		2. Mengwi
		3. Sukawati
II. Dry Lowland	:	4. Abang
		5. Kubutambahan
		6. Seririt
III. Wet Highland	:	7. Penebel
		8. Baturiti
IV. Dry Highland	:	9. Sukasada
		10. Kintamani

tions by a multistage, stratified random sampling technique, based on age and gender. The appropriate number of samples to be studied was calculated to be 2,880.

Laboratory techniques

To find eggs or larvae of the soil-transmitted helminths in the stool samples we used Kato-Katz thick smear method. To identify the species of hookworm larvae we used the modified Harada Mori fecal cultivation technique as described by Kosin *et al* (1972).

Statistics

Most of the collected data were analyzed descriptively and some were statistically analyzed using χ^2 test, to assess the significance levels of any differences found.

RESULTS

Of the tabulated 2,880 samples, 2,394 could be analyzed completely. Among the 2,394 stool samples examined, the numbers of samples found positive with ova were 1,764 for *A. lumbricoides*, 1,944 for *T. trichiura*, 586 for hookworm, and 39 for *S. stercoralis*, thus giving a prevalence rate of 73.7%, 62.6%, 24.5% and 1.6%, respectively (Table 1). Of the total 2,082 infected samples, 33.1% had single infection and 66.9% had mixed infections. Among the mixed infections, infection with two species (dual infection) was the highest (47.8%), followed by single infection (33.1%), triple infection (18.3%), and quadruple infection (0.8%). A combined infection with *A. lumbricoides* and *T. trichiura* was predominant in the dual infection, while in the triple infections a combination of *A. lumbricoides*, *T. trichiura* and hookworms was most frequent.

Table 1
The prevalence of STH infection in rural population of Bali.

Species	No. of stool samples	Positive samples	Prevalence (%)
A. lumbricoides	2,394	1,764	73.7
T. trichiura	2,394	1,499	62.6
Hookworm	2,394	586	24.5
S. stercoralis	2,394	39	1.6

The prevalence-gender relationship revealed the following: The prevalence of hookworm infection in male was 28.7% and in female was 20.3%; this difference was statistically significant. The prevalence rates of *A. lumbricoides*, *T. trichiura*, and *S. stercoralis* in males were 72.7%, 62.5%, and 1.2% respectively, while in females the prevalence rates were 74.6%, 61.8%, and 2.1% respectively, but the differences were not statistically significant (Table 2).

The differences of prevalence according to age groups for the three species namely *A. lumbricoides*, *T. trichiura*, and hookworm were highly significant, but not for *Strongyloides stercoralis*. The prevalence of hookworm infection increased steadily with age to reach a maximum level (37.7%) in adulthood (above 18 years), while *Ascaris lumbricoides* and *Trichuris trichiura* reached the highest prevalence level in elementary school age (77.3% and 70.7% respectively). The highest prevalence of *S. stercoralis* infection was found also in elementary school age, however, it was not statistically significant (Table 3).

The prevalence rates in the four geoclimatic types of area are presented in Table 4. The infection prevalence in wet highland of *A. lumbricoides* was 87.6%, *T. trichiura* 82.4%, hookworms 44.5%, and *S. stercoralis* 3.3%; all significantly higher if

Table 2
The prevalence of STH infection in rural population of Bali, by gender.

	Male	Female	Total	p-value
Total number examined	1,199	1,195		
% infected with *Ascaris*	72.7	74.6	73.7	0.286
% infected with *Trichuris*	63.5	61.8	62.6	0.386
% infected with hookworm	28.7	20.3	24.5	0.000
% infected with *Strongyloides*	1.2	2.1	1.6	0.074

Table 3
The prevalence of STH infection in rural population of Bali, by age groups.

	≤ 7 yrs	8-12 yrs	13-18 yrs	> 18 yrs	Total	p-value
Total number examined	504	699	496	695	2,394	
% infected with *Ascaris*	74.0	77.3	68.5	73.5	73.7	0.000
% infected with *Trichuris*	50.8	70.7	65.5	61.0	62.6	0.000
% infected with hookworm	16.3	19.2	21.8	37.7	24.5	0.000
% infected with *Strongyloides*	1.6	2.4	0.6	1.6	1.6	0.108

Table 4
The prevalence of STH infection in rural population of Bali, by geoclimatic types of area.

	Geoclimatic type of area					
	WLL	WHL	DHL	DLL	Total	p-value
Total examined	614	539	692	549	2,394	
% infected with *Ascaris*	57.0	87.6	74.9	77.2	73.7	0.000
% infected with *Trichuris*	51.0	82.4	44.9	78.5	62.6	0.000
% infected with hookworm	28.5	44.5	14.6	12.8	24.5	0.000
% infected with *Strongyloides*	1.5	3.3	1.0	0.9	1.6	0.003

WLL= wet lowland; WHL= wet highland; DHL= dry highland; DLL= dry lowland

compared with the prevalence in other areas (wet lowland, dry highland, dry lowland).

DISCUSSION

The prevalences of STH infections, except that of *S. stercoralis*, in Bali are still very high. This agrees with the results of a study by Bakta *et al* (1981) done in the village of Kedisan, east-northern part of Bali Island, where the prevalence of *A. lumbricoides* was 82.2%, *T. trichiura* 86.0%, and hookworms 37.9%. However, opposite results were found by Preuksaraj *et al*. (1983) in Thailand, where the prevalence of *Ascaris* was 4.04% and *Trichuris* 6.46%. This may be due to the intervention program that has been undertaken in the past few years in that country. Geoclimatic factors such as temperature, humidity, rainfall, farming ecosystem may be important in making such a high prevalence of STH infection in Bali. Some additional factors include people's low status of education, personal and environmental hygiene, socioeconomic factors and lifestyle. In Bali the range of temperature throughout the year is 18.7 to 28ºC. This temperature range is optimal for maturation of the helminth ova to become infective in soil (Belding, 1965). Farming ecosystem in the form of irrigated rice fields, with six months of rainy season and only three months of dry season in a year on the island, keeps the soil always sufficiently moist (Suweta, 1987), so it is favorable for helminth ova to develop optimally in soil (Belding, 1965).

For *Ascaris* and *Trichuris*, the infections were distributed somewhat equally among female and male populations, however, with hookworms, the prevalence of infection in males was significantly higher than the prevalence in females (see Table 2). The result of the present study agrees with that of the study done by Bradly *et al* (1992) in Zimbabwe. But our results contradicted those of Haswell-Elkins *et al* (1987) in South India. This may be due to the different sociobehaviors of the Balinese as compared to the people of South India. It is known that 54.6% of Bali's population are farmers, mostly males, of whom 94.03% never used slippers when working on their farms (Widjana *et al*, 1993). Being farmers, these males Balinese are exposed more openly than their female counterparts to soil contaminated with viable hookworm larvae. Gender-prevalence relationship of *S. stercoralis* infection showed similar inclination as with hookworm infection, although the relationship was not statistically significant.

The age-prevalence relationship showed the highest prevalence of *A. lumbricoides* and *T. trichiura* in elementary school aged children, and this is in agreement with Haswell-Elkins *et al* (1988). Children of this age group are most active and inquisitive but, at the same time, least careful about personal hygiene and cleanliness (Khan, 1983). Besides elementary school aged children, the prevalence of *A. lumbricoides* was also found high in adulthood (above 18 years old). Elderly people, who are included in this age group, being less strong and less active, tend to spend more time within or around their homes where transmission occurs continuously all the time (Khan, 1983). The prevalence of hookworm infection increased steadily with age to reach its maximum in adulthood (above 18 years). There is a consistent pattern of age-prevalence relationship in hookworm infection (Pritchard *et al*, 1989), very likely due to the fact that the chance of contact with polluted soil increases with increase of age (Anderson, 1986; Chandiwana *et al*, 1990).

Although the differences in prevalence by different geoclimatic areas were highly significant ($p < 0.01$), further analysis using logistic regression technique by taking altitude and soil condition as independent variables, revealed that altitude is not an important determinant factor for hookworm and *Strongyloides* infections. But the condition of the soil was found to be more important. The differences between ecosystem of wet land /rice fields, and the ecosystem of dry land with field crops, greatly determine the soil condition. As Chandiwana *et al* (1990) stated, geoclimatic conditions, primarily rainfall, markedly affected the population density of hookworm larvae in the soil, and so prevalence of infection as dependent variable showed variability. The analysis also conformed that the altitude and soil's condition equally determined the prevalence of *Ascaris* and *Trichuris* infections. In other words, *Ascaris* and *Trichuris* infections were distributed somewhat homogenously, compared with hookworm and *Strongyloides* infections. Bali, with a temperature range between 18.7-28ºC, with only a short (0-5 months) dry season (Suweta, 1987), favors the development of *Ascaris* and *Trichuris* ova into infective stage in the soil. *Ascaris* eggs are highly resistant to dryness and temperature fluctuation (Hunter, 1976), thus therefore they remain infective for a considerable period of time.

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