



Soil-transmitted helminth infection, skin infection, anaemia, and growth retardation in schoolchildren of Taveuni Island, Fiji

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Abstract

Aim To estimate the prevalence of hookworm, ascaris, and trichuris infection; as well as anaemia, growth retardation, scabies, and impetigo; in schoolchildren of Taveuni Island, Fiji.

Methods Schoolchildren from five villages on Taveuni Island were examined and had their haemoglobin concentration measured on a finger-prick blood sample. In addition, they had a faecal sample examined for the presence of helminth ova.

Results 258 children aged 5–15 years were surveyed. The overall prevalence of infection was: hookworm 14%, ascaris 33%, trichuris 17%, scabies 32%, and impetigo 2%. Eight percent of children were anaemic, while 8% and 6% of children were on or below the third centile for weight and height respectively.

Conclusions The relatively low overall prevalence of hookworm infection and of anaemia suggests that regular anthelmintic treatment of schoolchildren would only provide modest health benefits. Further study is needed to identify the reasons why Taveuni Island schoolchildren weigh less than expected for their age.

Anaemia due to hookworm infection and impetigo secondary to scabies are reported to be common problems in Fijian children.^{1–3} Both hookworm infection and scabies are amenable to community-based control programs which can provide significant long-term benefits for childhood health.^{4–7}

The World Health Organization (WHO) has drawn attention to the morbidity and mortality caused by soil-transmitted helminths (i.e. the hookworms *Necator americanus* and *Ancylostoma duodenale*, and the nematodes *Ascaris lumbricoides* and *Trichuris trichiura*). It has been estimated that the burden of disease caused by soil-transmitted helminth (STH) infection in school-age children in developing countries is greater than that caused by any other communicable or non-communicable disease.

In response to this problem, the WHO has recommended that school-based programs to control STH infections should be instituted if the cumulative prevalence of STH infection in schoolchildren is greater than 50%.⁸

Prompted by local concern about the impact of hookworm and scabies on the health of the children of Taveuni Island, we sought to estimate the prevalence of STH infection, anaemia, scabies, impetigo, and growth retardation in a representative sample of schoolchildren aged 5 to 15 years on Taveuni Island, Fiji.

Methods

We based our survey on WHO guidelines for school-based surveys.⁸ Children were recruited at five geographically separated schools during the second week of June 2004. After obtaining informed

written consent from their parents, the children had their height and weight measured, their hands, arms, legs, and feet examined for scabies and impetigo, and the haemoglobin concentration estimated on a finger-prick sample of their blood, using a portable haemoglobinometer (HemoCue, Sheffield, England).

All children were provided with a specimen jar containing 7 ml of 40% formalinised saline, and were asked to return this jar to school, the following day, with a small sample of their faeces. These faeces samples were refrigerated until examined at Diagnostic Medlab, Auckland, for the presence of helminth ova using the formal ethyl acetate concentration method.

All children were treated with a single 400 mg oral dose of albendazole (Eskazole, SKB) and those with anaemia (haemoglobin [Hb] level <110g/L) were treated with ferrous sulphate (Ferrogradumet, Abbott) 325 mg daily for 3 months.

Children with scabies or impetigo were treated with permethrin cream (Lyderm, PSM Healthcare Ltd) or mupirocin ointment (Bactroban, GSK) respectively. Nurses with responsibility for the communities served by each of the schools assisted with the evaluation of each child, gave advice to the child and their parents on the medical treatments provided, and arranged follow-up care as necessary.

Children whose height or weight was less than or equal to the third centile for children of their age and sex (2000 CDC growth charts, National Center for Health Statistics)⁹ were defined as suffering from growth retardation.

Scabies infection was diagnosed in children with typical papules and a history of itch, and was graded as 1+ (<10 papules), 2+ (10–20 papules), or 3+ (>20 papules). Impetigo was diagnosed in children with superficial vesicular or crusted skin lesions and was graded as 1+ (1-2 lesions), 2+ (3-5 lesions), or 3+ (>5 lesions).

Differences in categorical variables across groups were compared using Fisher's Exact test, and an unpaired t-test was used to compare continuous variables. All analyses were performed using SAS statistical software.

The study was approved by the Fiji Department of Health Ethics Committee.

Results

A total of 258 children, aged between 5 and 15 years and from five schools, participated in the survey (Table 1).

206 children (80% of the total sample) provided a faecal sample for subsequent examination for helminth ova. The overall prevalence of STH infection was 45% (95% CI: 38–52%). Hookworm (14%), ascaris (33%), and trichuris (17%) were commonly detected (Table 1).

The prevalence of hookworm infection did not differ greatly between villages. In contrast, however, the prevalence of ascaris and trichuris did differ between villages (Figure 1). Overall, 39/50 (78%) of children from Waimakilu village had a STH infection, compared with 8/41 (20%) of children from Niusawa village; $p < 0.001$. Three children, one each from Bouma, Wainikeli, and Niusawa villages, had *Strongyloides stercoralis* ova in their faecal samples.

250 children (97% of the total sample) provided a finger prick sample of blood. The haemoglobin concentration in these samples ranged from 71–149 g/L (mean=125, SD=11) (Figure 2).

Table 1. Demographic features and prevalence of soil-transmitted helminth (STH) infections, skin infections, anaemia, and growth retardation in children from five schools on Taveuni Island, Fiji

	Village					Total n=258
	Waimakilu n=50	Bouma n=52	Wainekeli n=50	Niusawa n=49	Vuna n=57	
Male/Female	24/26	26/26	28/22	30/19	27/30	135/123
Age: median;range (yrs)	11; 6-13	10; 6-12	10; 8-15	10; 7-11	8; 5-11	10; 5-15
Weight \leq 3 rd centile for age	3	4	5	0	7	19
Height \leq 3 rd centile for age	5	2	3	3	1	14
Height and weight \leq 3 rd centile for age	1	2	3	0	1	7
Scabies	35 (70%)	23 (44%)	2 (4%)	12 (24%)	12 (21%)	84 (32%)
Anaemia <110g/L	3 (7%)	8 (16%)	2 (4%)	1 (1%)	5 (9%)	19 (8%)
Faecal sample received	50	27	36	41	52	206
Hookworm infection	8 (16%)	5 (19%)	6 (17%)	5 (12%)	5 (10%)	29 (14%)
Ascaris infection	31 (62%)	11 (41%)	14 (39%)	3 (7%)	10 (19%)	69 (33%)
Trichuris infection	23 (46%)	4 (15%)	1 (2%)	3 (7%)	4 (8%)	35 (17%)
Any STH infection	39 (78%)	15 (56%)	18 (50%)	8 (20%)	13 (25%)	93 (45%)

Table 2. Association between hookworm infection and anaemia (Hb <110g/L) in children from five schools on Taveuni, Fiji

	Anaemia n=19	No anaemia n=243
Hookworm		
Yes	4 (21%)	25 (10%)
No	8 (42%)	169 (70%)
Number of hookworm ova seen		
None	8 (42%)	169 (70%)
Few	3 (16%)	21 (9%)
Many	1 (5%)	4 (2%)

Figure 1. Prevalence of hookworm, trichuris, ascariis, and any soil-transmitted helminth infection in children from five schools on Taveuni Island, Fiji

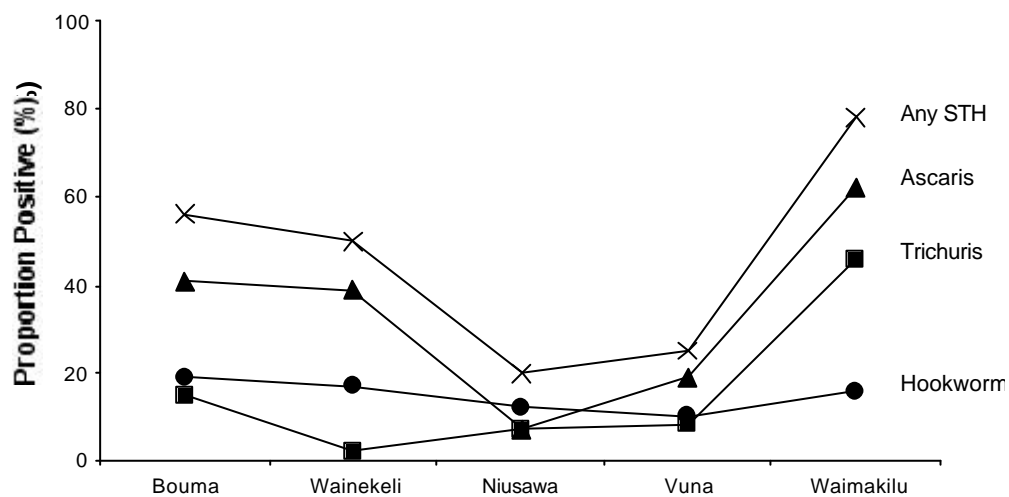


Figure 2. Fingerprick haemoglobin concentrations in children from five schools on Taveuni Island, Fiji

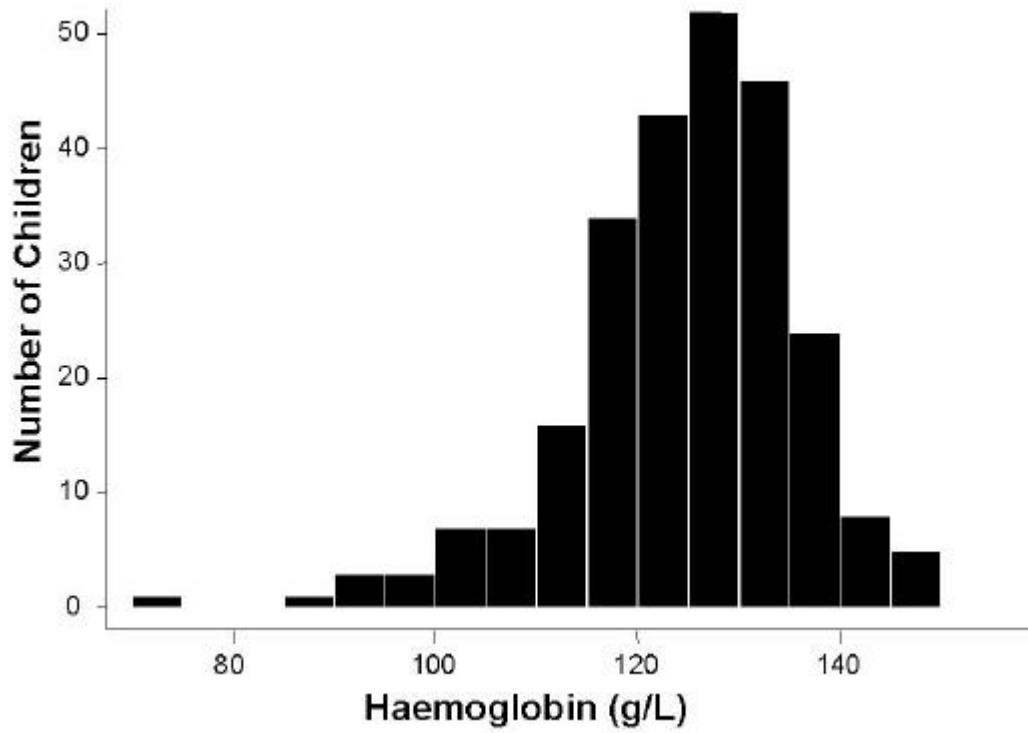


Figure 3A. Height and weight of boys from five schools on Taveuni Island, Fiji

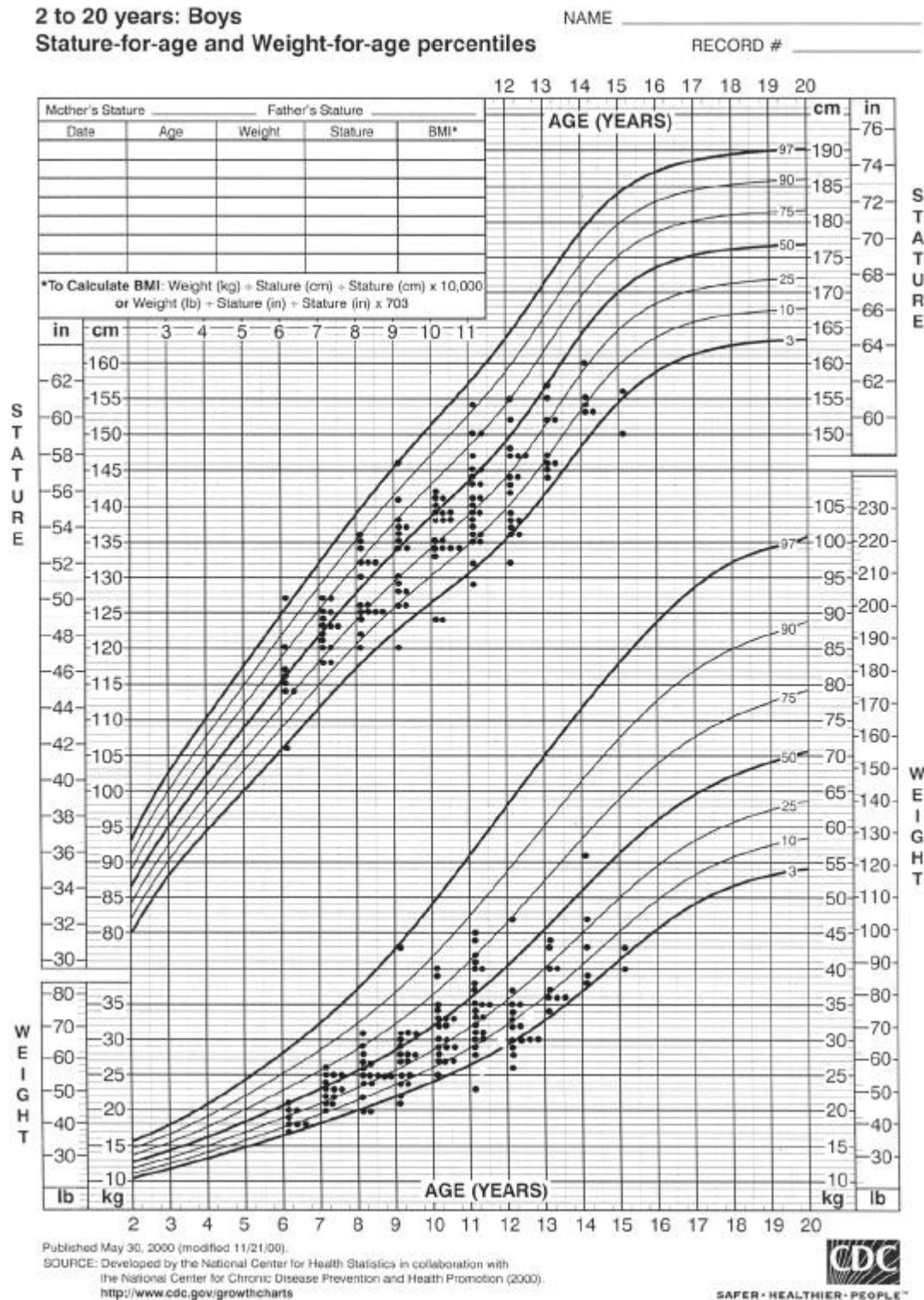


Figure 3B. Height and weight of girls from five schools on Taveuni Island, Fiji

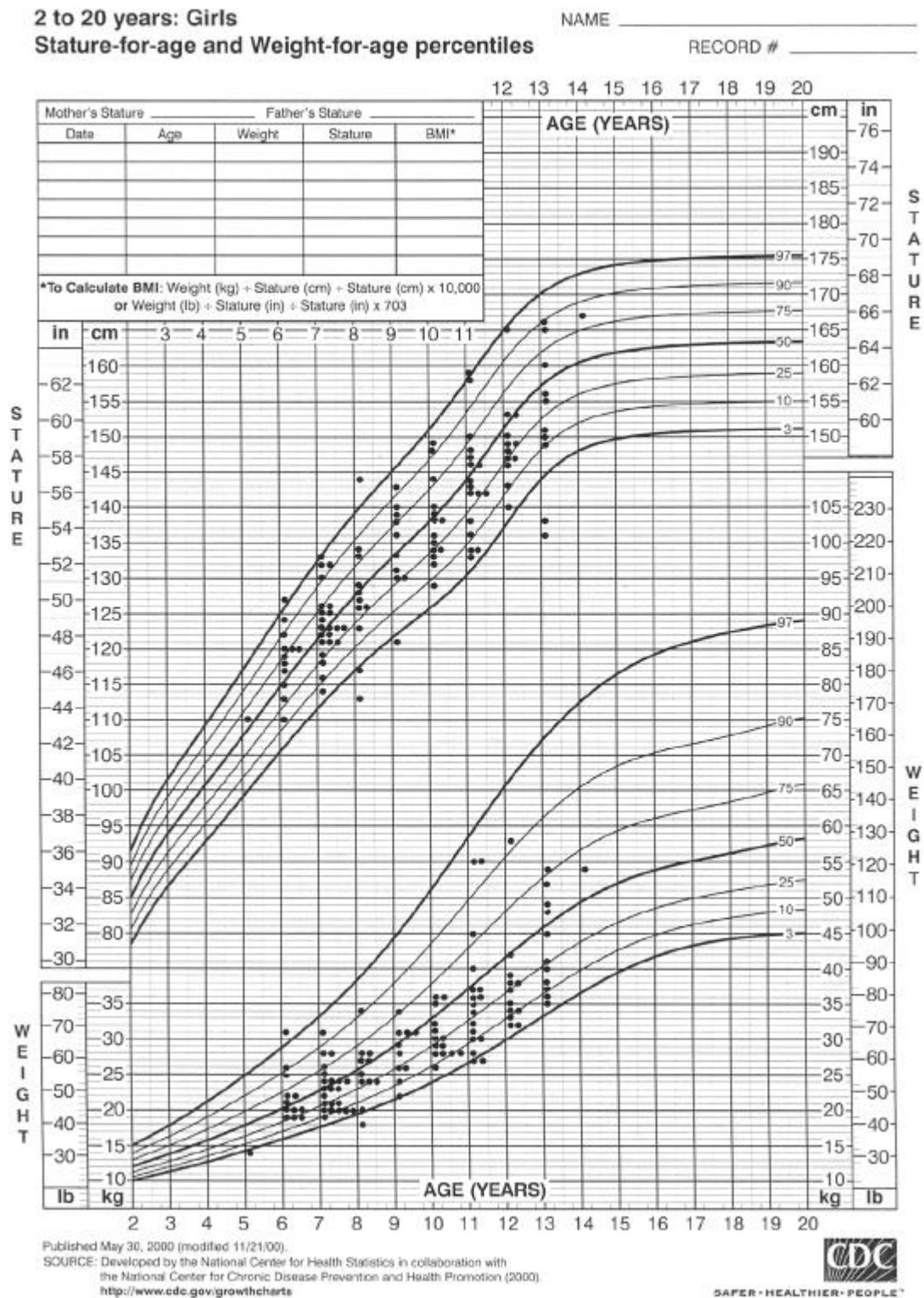
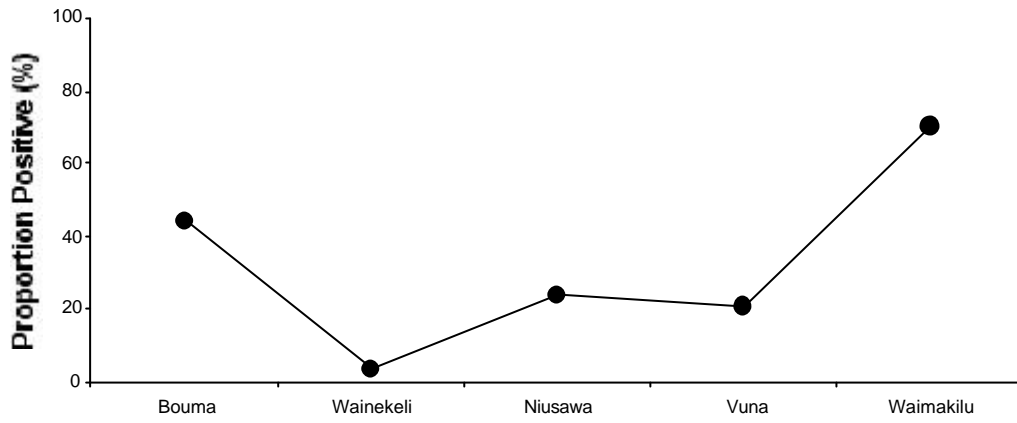


Figure 4. Prevalence of scabies in children from five schools on Taveuni Island, Fiji



Nineteen children (8%) had a haemoglobin concentration less than 110 g/L. Four out of 29 (14%) children with hookworm infection were anaemic, compared with 8/177 children who did not have hookworm infection (RR: 3.4, 95% CI: 0.95–11.4, $p=0.07$) (Table 2).

234 children (91% of the total sample) had their height and weight measured. The distribution of heights and weights of these children are shown in Figure 3. Overall, the distribution of the children's heights corresponded with the range found in children in the United States, although the distribution of heights for the older boys was less than expected. The distribution of weights of both the boys and the girls was lower than predicted at all age ranges. A total of 19 children (13 boys and 6 girls) were on or below the third centile of their expected weight for age, and a total of 14 children (9 boys and 5 girls) were on or below the third centile of their expected height for age.

There were no significant differences in the prevalence of growth retardation either between children with or without hookworm infection, or between children with or without any STH infection.

All 258 children were examined for the presence of scabies and impetigo; 84 (32%) children had scabies (which was graded as 1+ in 48 children, 2+ in 26 children, and 3+ in 10 children) but no child had crusted scabies.

The prevalence of scabies in children from each of the five schools is shown in Figure 4. Six children (2%) had impetigo, which was graded as 1+ in all six children. Two children in Waimakilu village school, and one child in each of the other schools, had impetigo.

Discussion

This study is the largest survey to date of the relationships between STH infection and anaemia and growth retardation in Fijian children. We are not aware of any recent comparable data from other regions of Fiji and therefore cannot exclude the possibility that our results are not broadly representative of all Fijian schoolchildren.

We did, however, make a concerted effort to recruit students across a broad age range, from widely separated schools, and within communities with differing levels of infrastructure development. As a result, we are confident that our results are representative of the approximately 3,500 children who attend the 21 schools on Taveuni, the third-largest island of the Fiji Islands group in terms of land area.

We found a striking disparity in the prevalence of STH infection between schoolchildren from different villages on Taveuni. In one village, Waimakilu, the cumulative prevalence of STH infection in schoolchildren was almost 80%, while in two other villages, Niusawa and Vuna, the prevalence was only 20% and 25% respectively.

These differences in the cumulative prevalence of STH infection between villages have important implications for the design of helminth control programs. In communities where the cumulative prevalence of STH infection in school-age children exceeds 70%, the WHO recommends that all school-age children should be treated for STH infection 2–3 times per year.

In contrast, in communities where the cumulative prevalence of STH infection in school-age children is 50–70%, the WHO recommends that all school-age children should be treated for STH infection at least once a year. The WHO does not recommend regular treatment of STH infection if the cumulative prevalence of STH infection in school-age children is <50%. Health education and improvements in sanitation and water supply are recommended for all communities, but especially those communities with a very high prevalence of STH infection.⁸

We found that the prevalence of hookworm infection was less than that reported by others. Hawley surveyed two communities on Viti Levu Island in 1968 and 1969, and found that the prevalence of hookworm infection was 11% in children aged less than 1 year, 38% in children aged 1–5 years, 87% in children aged 6–10 years and 90% in children aged 11–15 years.² Mathai et al surveyed two communities on Viti Levu Island during the 1990s and found hookworm infection in 19% of schoolchildren in one community and 50% of subjects of all ages in another community.¹

Similar high rates of infection were found in an isolated Aboriginal community in northern Australia where 93% of children aged 5–14 years were infected;⁴ in children in the Muheza, Tanga, and Korogwe districts of Tanzania where 61% of children were infected;⁵ and in primary schoolchildren in KwaZulu-Natal, South Africa, where 59% of children were infected.⁶ The prevalence of hookworm infection in the schoolchildren of Taveuni is much less than the prevalence in other countries where school-based anthelmintic programs have been instituted.^{3–5}

We found that 8% of children were anaemic (Hb <110 g/L). Buchanan et al surveyed a large number of children for anaemia in four regions of Viti Levu Island in 1975.¹⁰ Buchanan et al found that 33/890 (3.7%) of children aged 5–9 years were anaemic (packed cell volume [PCV] <0.33), and that 162/690 (23.5%) of children aged 10–14 years were anaemic (PCV <0.37).

Our results cannot be directly compared with those of Buchanan et al, however, because we used different criteria for the diagnosis of anaemia. Our results are broadly similar, however, and suggest that anaemia is not a common health problem for schoolchildren on Taveuni.

The association of anaemia with hookworm infection in our survey suggests that either testing for hookworm infection and treatment of those found to be infected, or empiric treatment of hookworm, should be routine for children with anaemia. However the relatively low prevalence of hookworm infection in our study suggests that community-wide treatment of hookworm would provide only modest benefits in terms of prevention of anaemia.

There are few data available on the height and weight of schoolchildren in Fiji.^{11,12} Our results provide a useful overview of the height and weight of schoolchildren on Taveuni. We found that significant growth retardation was not common in schoolchildren on Taveuni. The overall distribution of heights for boys and girls corresponded well with the distribution predicted by the 2000 CDC growth charts, which are based on surveys of US children.⁹ However the overall distribution of weights for both boys and girls was lower than the distribution predicted by the 2000 CDC growth charts; 19/234 (8%) children weighed less than the third centile for their age and 14/234 (6%) children were shorter than the third centile for their age.

There was no association between village of residence, the presence of hookworm infection or the presence of any STH infection and growth retardation. This suggests that school-based anthelmintic programs would not have a significant effect on either the height or weight of Taveuni schoolchildren.

We found that scabies was common but was not associated with a high prevalence of impetigo. The two villages with the highest prevalence of scabies, Waimakilu and Bouma, were the villages which also had the highest cumulative prevalence of STH infection. This suggests that the same environmental factors may contribute to the persistence of these infections. We noted that the water supply was less well-developed in Waimakilu and Bouma than in the other three villages and expect that improvements in water supply to these and similar villages would confer diverse health benefits.

In conclusion we found a relatively low prevalence of hookworm infection, anaemia, and growth retardation in Taveuni Island schoolchildren. These results suggest that repeated, school-based, anthelmintic programs directed primarily against hookworm would confer marginal health benefits. We did, however, find moderately high cumulative prevalence of other STH infections which might benefit from repeated, school-based, anthelmintic programs directed primarily against ascaris and trichuris.

Alternatively, efforts to improve water supply and sanitation might achieve similar reductions in hookworm and other STH prevalence, with the additional benefit of reductions in the prevalence of other infectious diseases such as skin and gastrointestinal infections. We found a moderately high prevalence of scabies and a surprisingly low prevalence of impetigo. Improvements in water supply and improved case finding and treatment may be expected to reduce the prevalence of scabies.

Our measurements of height and weight and haemoglobin concentration provide data which should be compared with those from other Fiji or Pacific communities. They should stimulate research to determine the reasons for the children of Taveuni Island to generally weigh less than expected for their age.

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References:

1. Mathai E, Goneyali S, Volavola I. Prevalence of intestinal helminth infection in Fiji. *Pacific Health Dialog*. 1998;5:74–5.
2. Hawley TG. Necator infestation and haemoglobin levels in Fiji. *N Z Med J*. 1973;77:95–7.
3. Ram J, Ram P. Causes and features of severe iron deficiency anaemia. *Fiji Med J*. 1980;8:426–30.
4. Thompson RCA, Reynoldson JA, Garrow SC, et al. Towards the eradication of hookworm in an isolated Australian community. *Lancet*. 2001;357:770–1.
5. Guyatt HL, Brooker S, Kihamia CM, et al. Evaluation of efficacy of school-based anthelmintic treatments against anaemia in children in the United Republic of Tanzania. *Bull WHO*. 2001;79:695–703.
6. Taylor M, Jinbhai CC, Couper I, et al. The effect of different anthelmintic treatment regimens combined with iron supplementation on the nutritional status of schoolchildren in KwaZulu-Natal, South Africa: a randomized controlled trial. *Trans R Soc Trop Med Hyg*. 2001;95:211–6.
7. Wong L-CF, Amega B, Connors C, et al. Outcome of an interventional program for scabies in an Indigenous community. *Med J Aust*. 2001;175:367–70.
8. Montresor A, Crompton DWT, Gyorkos TW, Savioli L. Helminth control in school-age children. Geneva: World Health Organization; 2002. Available online. URL: <http://www.who.int/wormcontrol/documents/en/itoviii.pdf> Accessed May 2005.
9. 2000 CDC growth charts: United States. Available online: <http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/background.htm> Accessed May 2005.
10. Buchanan JG, Jha BK, Matthews JRD, Nixon AD. The prevalence and nature of anaemia among apparently normal subjects in Fiji. *Pathology*. 1979;11:369–76.
11. Hawley TG, Jansen AAJ. Height and weight of Fijians in coastal areas from one year till adulthood. *N Z Med J*. 1971;73:346–9.
12. Hawley TG, Jansen AAJ. Weights and heights of Fijians from coastal and inland villages. *N Z Med J*. 1978;87:86–90.