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THE IMPACT OF REPEATED MALARIA ATTACKS ON THE SCHOOL PERFORMANCE OF CHILDREN

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Abstract. The impact of repeated malarial infections on the school performance of children was investigated in 571 school children 6–14 years of age in a malaria-endemic area in southern Sri Lanka where both *Plasmodium falciparum* and *P. vivax* infections are prevalent. Malaria infections confirmed by microscopy were monitored over a six-year period. School performance was assessed by two specially designed, school grade–specific, test papers for Sinhala language and mathematics. The scores for Sinhala language and mathematics for each school term test for the year 1997 were obtained. Malarial infections were a major predictor of children's performance in language and mathematics after controlling for parent's education, monthly family income, and house type. The education of the father predicted language scores but not mathematics scores. A child who experienced more than five attacks of malaria scored approximately 15% less than a child who experienced less than three attacks of malaria. The data suggest that repeated attacks of malaria have an adverse impact on the school performance of children.

INTRODUCTION

The burden of malaria in the tropical world today is estimated to involve 300–500 million episodes of acute illness and more than one million deaths per year, mainly in African children.[1,2] This amounts to the loss of about approximately 44 million disability-adjusted life years annually, a conspicuous drain on human health by today's standards. However, by its adverse long-term effects on trade, foreign investment, and commerce, the impact of malaria extends beyond its direct effects on human health to the economic development of nations, costing African countries approximately 1–2% of their Gross Domestic Product.[3] Even these estimates, however, fail to account for effects that malaria has long been suspected to have on the mental and physical development of individuals exposed to it, which have contributed greatly to the impoverishment of regions and nations affected by this disease.[4]

Today, most people who live in malarious areas do so under a lower risk of exposure to the full effects of the disease due to the implementation of malaria control measures, and access to antimalarial treatment. Even so, malaria still inflicts a considerable burden, a major part of it on children, who being non-immune are the most vulnerable to the disease. Thus, most children born in endemic regions will, by the time they reach adulthood, have experienced several episodes of malarial disease.

In spite of this continued wide prevalence of malaria in children, the effects of malaria on mental and cognitive development of children have hardly been evaluated in controlled studies. Neurologic effects of malaria have been studied in subjects who have recovered from cerebral malaria. Such studies have revealed psychological as well as neurologic sequelae including learning disabilities among post-cerebral malaria subjects.[5–10] While cerebral malaria is a special case, a relatively rare manifestation of the disease occurring in less than 1% of childhood infections in Africa, and even fewer elsewhere, long-term neuropsychiatric effects of general, apparently uncomplicated, malarial infections in adults have also been documented.[11] The vast majority of malarial infections in children are acute, uncomplicated, febrile episodes from which they make an apparent complete recovery when treated. The impact of repeated malarial episodes on the development of the child, particularly as they relate to mental and cognitive function, could, nevertheless, be relevant to the later potential and prosperity of the individual and the community.

We report here a study of the impact of malarial infections on the school performance of children. The study was performed in southern Sri Lanka in an area where both *Plasmodium falciparum* and *P. vivax* malaria are endemic, and where many children experience multiple episodes of malarial disease.

MATERIALS AND METHODS

Study population and area. This was a historical cohort study in which 571 children 1–8 years old were followed over a period of six years beginning in January 1992. The study was conducted in the Kataragama and Buttala areas of the Moneragala district in southern Sri Lanka, where malaria infections in the population have been monitored as a part of long-term studies of the Malaria Research Unit of the University of Colombo. Both *P. vivax* and *P. falciparum* infections of unstable endemicity are prevalent in the area and malaria transmission is unstable. Severe malaria is rarely seen.

The study population comprises a farming community engaging in rice and cash crop cultivation and subsistence farming, with a few engaged in service occupations. The language of the residents in the area is Sinhala, which is usually spoken at home. A famous shrine is located in Kataragama that is visited by many pilgrims, especially during the annual festival held in July/August.

During this period, the malaria incidence in the children was monitored by passive case detection at malaria diagnosis and treatment centers in the area. The diagnosis of malaria was confirmed by microscopic examination of thick blood smears. Blood films were prepared for all children on presentation, and species identification was done using Giemsa-stained thin blood smears. At the end of November 1997, at the time of assessment of school performance, the children

were in Grades 1–7 in school. The dates of birth of the children were obtained from the birth certificates of the children kept in the school and the age of the child was calculated to the nearest month.

Assessment of school performance. Two survey instruments were used to assess school performance of these children. The first was a special examination designed specifically for the study in collaboration with the National Institute of Education, which develops culture specific school curricula in Sri Lanka. Two papers, each containing 25 questions, were developed to assess the child's knowledge on mathematics and language. The language of the residents of the area is Sinhala. The test papers, which were grade specific, were prepared after validation of 100 questions, each in the Sinhala language and mathematics for each of the grades 1–7, with the teachers rating of the student. The validation was done in two schools comprising more than 800 students in the Anuradhapura district, a malaria-endemic area in the North Central Province of Sri Lanka. Twenty-five questions that discriminated most between good and poor students were used to prepare the test papers for this study. The special examination was conducted during the last week of November 1997. Both of the papers, namely, the Sinhala language and mathematics test papers, were completed by the students in one day, one paper being answered during the morning hours and the other during the afternoon. The maximum duration of time given for each test paper was one hour and the examination was conducted under standard examination conditions.

The second survey instrument was composed of three routine end of school term examinations for the year 1997. The averages of the scores for language and mathematics for each of the three school examinations for the year 1997 were computed.

Determination of the socioeconomic status of the children. Houses of all children selected for the study were visited by one of the investigators and the socioeconomic status of the family was assessed by a direct structured questionnaire. The respondent was a parent or guardian. The monthly family income and the education status of the parents were recorded. House type was assessed based on the material used for the construction of walls, floor, and roof, and houses were classified into three groups as good, medium, or poor.

Incidence of malaria. The malaria incidence of the children was recorded at the Malaria Research Station and the District Hospital in Kataragama during the period of follow-up from January 1992 to November 1997. The Malaria Research Station and the District Hospital are the only health care institutions that provide malaria diagnosis and treatment services for the population of the area. The exact dates of diagnosis, the species involved, and the ages of the children were recorded.

Data analysis. Data analysis was done using one-way analysis of variance (ANOVA) to test for differences in means between groups. Pearson correlation coefficients were calculated to determine the linear dependence between continuous variables. Multivariate analysis using ANOVA models was done to adjust for potential confounding variables. Epi-Info (Centers for Disease Control and Prevention, Atlanta, GA) and SPSS (SPSS, Inc., Chicago, IL) statistical software packages were used for data analysis.

Permission to conduct the study. Ethical clearance was obtained from the Ethical Review Board of the Faculty of Medicine, University of Colombo, Colombo Sri Lanka. Permission to conduct the study was obtained from the Zonal Education Officers of the Department of Education of Sri Lanka, respective parents/guardians, and class teachers.

RESULTS

A total of 571 children were included in the study. The characteristics of the children are shown in Table 1. Eighty-six percent of the children were between the ages of 6 and 12 years. More than sixty percent of the mothers and 57% of the fathers had an education above grade 5, while 6.3% of the mothers and 3.1% of the fathers had not attended school. Fifty-one percent of the fathers were engaged in farming or slash and burn cultivation, while 61% of the mothers were housewives. More than 70% of the households had a monthly family income less than 3,000 Sri Lankan Rupees ($36 U.S. dollars), and almost 60% of the families were living in medium or poor houses, indicating the poor rural socioeconomic background of this population.

In this cohort of 571 children, 385 experienced 1,091 attacks of malaria between January 1992 and November 1997. The remaining 186 children did not experience a single attack of malaria. Of the 1091 recorded malarial attacks, 749 were due to *P. vivax* and 342 to *P. falciparum*.

In November 1997, the school performance of the children was evaluated in both language and mathematics by both of two types of tests (i.e., the standard school examinations and

TABLE 1
Characteristics of the population in Sri Lanka

Variable	Number	%
Sex		
Male	288	50.4
Female	283	49.6
Age (years)		
6–12	492	86.2
>12	79	13.8
Mother's education (grade)*		
10	97	17.0
6–10	252	44.1
1–5	186	32.6
None	36	6.3
Father's education (grade)*		
10	94	16.5
6–10	232	40.6
1–5	227	39.8
None	18	3.1
Monthly family income (SL Rs)†		
>5,000	51	8.9
3,000 to <5,000	120	21.0
1,000 to <3,000	244	42.8
<1,000	156	27.3
House type‡		
Good	236	41.3
Moderate	178	31.2
Poor	157	27.5
Malaria attacks during the past 6 years		
None	186	32.6
1–2	218	38.2
3–5	126	22.1
≥6	41	7.1

* Grade of formal education.
† Monthly family income in Sri Lankan Rupees (SLRs) (1 U.S. dollar = 83.00 SLRs).
‡ See Materials and Methods for classification of house type.

the special test). Overall the scores of both examinations were strongly correlated for each subject ($P < 0.001$) (Table 2). The total number of malarial attacks experienced by the children during the six years of follow-up showed a significant negative correlation with both the scores of the special tests and the average scores of the school tests for both Sinhala language and mathematics.

The association between the scores of the special test and the total number of malarial attacks was further investigated by categorizing the total number of malaria attacks experienced by the children during the follow-up period. Both language and mathematics scores were significantly associated with the number of malarial attacks experienced ($P < 0.001$), the educational status of the mother ($P < 0.001$), the monthly family income ($P < 0.001$), and the house type ($P < 0.001$) (Table 3). Language, but not mathematics scores, was also associated with the educational status of the father ($P < 0.001$). Language and mathematics scores were poorer in children who had experienced more attacks of malaria, whose parents were less educated, had a lower monthly income, or lived in poor houses.

The multiple regression model controlling for all these variables showed that the total number of malarial attacks experienced by the children was significantly associated with language and mathematics scores in both the special and school examinations (Table 4). In the multivariate model, none of the other variables (mother's education, monthly family income, and house type) were significantly associated with either language or mathematics of both the special and school examinations, except for father's education with language scores. The association between language scores and father's education was seen in both the special and school examinations (Table 4). Children who experienced less than three attacks of malaria scored at least 15% more in both the special and school examinations than children who experienced more than five attacks of malaria during the same period.

The associations between the number of malaria attacks and school performance were the same for both *P. vivax* and *P. falciparum*. The school performance of children by the number of malaria attacks due to the two species of malaria parasites is shown in Table 5. The performances of the students were significantly associated with the number of malaria attacks for both *Plasmodium spp.* For *P. falciparum*, the differences in the scores for language and mathematics for both the special tests and the school tests between children experiencing different number of attacks of malaria were significant. For *P. vivax*, the results were the same except for language scores of the school tests in which there was no difference between children experiencing 1–2 attacks of malaria and no attacks of malaria. Among children experiencing more than three attacks of malaria of a particular species, there were no differences in language and mathematics scores of both the special tests and the school tests between the two *Plasmodial* species.

There was no statistically significant association between the anthropometric indices (weight-for-age, height-for-age, and weight-for-height) and school performance. Children who had lower hemoglobin levels performed better, but the difference was not statistically significant.

DISCUSSION

The results of this study demonstrate that malaria infections have an adverse impact on the school performance of children. The school performance of 571 children followed-up over a period of six years was assessed in two subject areas, language and mathematics, through two series of independent examinations. When potential confounders were controlled for, malaria infections were found to be a major predictor of these children's school performance. Several other variables such as parents' education and indicators of the social and economic status of the family also correlated with examination scores. However, in the multivariate model, apart from father's education, which was a determinant of language scores, the other variables did not influence school performance independently. Family income and house type are known risk factors for malaria[12,13] and are likely to have influenced the scores through their association with the disease. When all other variables were controlled for, experiencing

TABLE 2
Correlations between scores of the special examinations and routine school examinations in Sri Lanka

	Pearson correlation coefficient (P)* (n = 571)				
	Special examinations		School examinations		
Variable	Mathematics‡	Language§	Mathematics¶	Language#	Malaria attacks**
Special examinations					
Mathematics‡	1.000				
Language§	0.6894 (<0.001)	1.000			
School examinations					
Mathematics¶	0.7601 (<0.001)	0.5999 (<0.001)	1.000		
Language#	0.6835 (<0.001)	0.7336 (<0.001)	0.8134 (<0.001)	1.000	
Malaria** attacks	−0.3448 (<0.001)	−0.3804 (<0.001)	−0.3136 (<0.001)	−0.3382 (<0.001)	1.000

* P value indicates significance level testing the null hypothesis that the correlation coefficient equals 0.
† Sample size.
‡ Score of mathematics paper specially designed for the study.
§ Score of Sinhala language paper specially designed for the study.
¶ Average score for mathematics for the three-term examinations during the 1997 school year.
# Average score for Sinhala language for the three-term examinations during the 1997 school year.
** Total number of malaria attacks during the period 1991–1997.

TABLE 3
Scores of examinations of children in Sri Lanka in relation to selected variables

Variable language	Mean scores % (±SD)			
	Special examination		School examination	
		Mathematics	Language	Mathematics
Malaria attacks				
0	62.52 (24.28)	69.44 (22.48)	58.49 (20.84)	64.14 (18.77)
1–2	50.72 (22.52)	64.08 (18.56)	54.90 (17.67)	62.39 (15.15)
3–5	43.00 (19.60)	55.40 (19.84)	44.96 (17.00)	52.01 (17.74)
≥6	31.52 (21.76)	37.56 (21.28)	36.54 (18.66)	42.81 (20.18)
F-value*	31.83	33.09	23.21	25.89
P	<0.001	<0.001	<0.001	<0.001
Father's education (grade)†				
>10	57.40 (24.60)	69.80 (21.56)	56.46 (20.51)	66.27 (18.49)
6–10	50.48 (23.16)	61.40 (21.40)	52.65 (19.80)	59.56 (17.26)
1–5	50.32 (24.56)	61.08 (21.12)	51.42 (19.40)	57.45 (18.41)
None	48.44 (28.28)	41.12 (28.00)	48.52 (20.35)	43.74 (25.16)
F-value*	2.29	9.89	1.65	9.54
P	0.077	<0.001	0.178	<0.001
Mother's education (grade)†				
>10	59.16 (23.80)	70.12 (18.12)	59.71 (19.86)	65.66 (18.44)
6–10	49.48 (24.32)	60.92 (22.44)	51.53 (19.64)	59.61 (17.09)
1–5	49.92 (23.52)	60.64 (22.24)	50.32 (19.29)	56.33 (18.96)
None	53.00 (24.84)	54.68 (22.80)	53.59 (20.01)	55.23 (21.16)
F-value*	4.21	6.36	5.26	6.08
P	0.006	<0.001	0.014	<0.001
Monthly family income (SL Rs)‡				
>5,000	56.88 (24.32)	70.12 (19.92)	58.76 (16.39)	68.14 (15.25)
3,000 to <5,000	55.96 (24.68)	64.12 (23.72)	55.31 (21.90)	61.21 (19.10)
1,000 to <3,000	52.80 (23.44)	62.24 (21.96)	53.97 (18.65)	59.87 (18.54)
<1,000	44.24 (23.52)	57.32 (20.60)	46.47 (19.67)	54.01 (17.36)
F-value*	7.35	5.10	7.77	8.89
P	<0.001	<0.001	<0.001	<0.001
House Type§				
Good	58.44 (24.72)	68.68 (20.20)	57.80 (20.07)	65.55 (17.23)
Moderate	51.84 (22.76)	62.44 (21.80)	52.38 (18.81)	58.55 (17.08)
Poor	40.64 (21.04)	51.48 (21.00)	44.88 (17.94)	50.59 (18.15)
F-value*	27.94	32.03	20.79	34.12
P	<0.001	<0.001	<0.001	<0.001

* F-value comparing the mean scores of the different categories.
† Grade of formal education.
‡ Monthly family income in Sri Lankan Rupees (SL Rs) (1 U.S. dollar = 83 SL Rs).
§ Type of house construction assessed based on the materials used for the roof, floor, and wall.

more than six malarial infections during the six-year period decreased language and mathematics scores by 15% relative to those who had experienced fewer than three malarial infections in the same period.

School performance is a reflection of the cognitive ability of a child. Tests of academic performance can be assessed using school progress reports and the teachers' judgement.[14] School performance is dependent on a number of factors, including facilities available in the schools, the quality of the teaching, and other social factors such as parental supervision, etc. With regard to facilities available in schools and the quality of teaching, all students were exposed to a similar environment because only non-fee levying government schools exist in this community, and it is unlikely that these factors would have confounded the results of the study. It is also unlikely that other social factors would have influenced the results because the community is relatively homogenous with respect to social status being a typical poor rural agricultural community.

Language scores of both assessments were significantly associated with the number of malarial attacks the child had experienced, parent's educational status, family income, and house type, which is considered a proxy for socioeconomic status. Mathematics scores of both assessments were also significantly associated with all of the above factors except father's education. The direction of the associations, in general, were as expected with children performing better if they had experienced fewer malarial attacks, their parents' had attained a higher educational standard, the family income was higher, and they were resident in good houses. The scores of the two assessments i.e., special tests and school term tests, for each of the mathematics and language components, were significantly and positively correlated, ensuring that the special tests prepared for the assessment actually tested subject areas taught in school.

Educational level, family income, and house type are closely interrelated, and it is possible that the significant association of school performance with all three variables could be due to the correlation among the three variables. The impact of repeated malarial attacks on school performance of children observed in this study could also be due to the confounding effects of these three variables because malaria is a disease of the rural poor. It has been previously reported that in poor houses the density of indoor resting mosquitoes is higher than in good houses, and as a result, inhabitants of such houses are at greater risk of acquiring malaria.[12] Except for fathers' education, which was a significant predictor of

TABLE 4
Analysis of variance using mathematics and language scores of the special examination and school examination as the dependent variable*

	Mathematics				Language			
	Special examination		School examination		Special examination		School examination	
Independent variable	β	*P*	β	*P*	β	*P*	β	*P*
Intercept	36.399		44.446		45.778		52.956	
Number of malaria attacks†		<0.001		<0.001		<0.001		<0.001
0	25.126	<0.001	18.270	<0.001	27.923	<0.001	15.708	<0.001
1–2	14.837	0.001	16.089	<0.001	23.196	<0.001	15.272	<0.001
3–5	10.273	0.012	7.688	0.029	16.726	<0.001	7.628	0.016
Monthly family income (SL Rs)‡		0.694		0.392		0.625		0.738
<1,000	0.417	0.919	–3.172	0.358	1.574	0.666	–3.106	0.320
1,000 to <3,000	2.904	0.433	0.430	0.890	0.002	0.993	–1.880	0.503
>3,000 to <5,000	2.321	0.552	–0.130	0.968	–2.050	0.554	–2.709	0.360
Father's education§		0.197		0.611		<0.001		0.001
None	–9.571	0.112	–6.937	0.188	–26.003	<0.001	–19.203	<0.001
Grades 1–5	–4.279	0.141	–1.504	0.541	–5.509	0.033	–5.037	0.024
Grades 6–10	–5.425	0.054	–1.679	0.482	–6.405	0.010	4.388	0.043
Mother's education¶		0.231		0.079		0.143		0.548
None	2.077	0.651	–0.203	0.959	–5.846	0.151	–1.723	0.634
Grades 1–5	–1.872	0.540	–4.850	0.060	–2.204	0.415	–3.229	0.165
Grades 6–10	–4.443	0.117	–5.463	0.023	–5.074	0.044	–2.670	0.217
House type#		0.171		0.479		0.133		0.066
Good	6.325	0.061	1.794	0.5290	5.966	0.046	5.236	0.044
Moderate	3.732	0.215	–0.726	0.777	3.348	0.209	1.390	0.549

* β = regression coefficient.
† Number of malaria attacks during a life time. Reference group is >5 malaria attacks.
‡ Monthly family income in Sri Lankan Rupees (SL Rs). Reference group is ≥Rs.5,000.
§ Reference group is education > Grade 10.
¶ Reference group is education > Grade 10.
# Reference group is poor house type.

only language performance, mother's education, family income, and house type were not significant predictors of school performance in the multivariate model, probably due to the correlation among them and between them, and the number of malaria attacks. The finding that repeated attacks of malaria was the major predictor of school performance of children makes finding an explanation for such a phenomenon even more important.

There is a paucity of data regarding the specific cognitive domains that are associated with parasitic infection and the causal link between parasitic illness and school performance. The exact mechanism(s) by which repeated malarial attacks affect(s) school performance is difficult to elucidate from this study. Sequestered cytokine production is important in the mediation of malarial disease.[15] Cytokines released during acute infection may activate brain endothelial cells, leading to increased binding of infected erythrocytes in the brain and reduced cerebral blood flow. It is possible that cytokines affect brain tissue via secondary mediators, among which nitric oxide and free oxygen radicals have been postulated.[16,17] Gross clinical effects due to repeated episodes of malaria may present at a later stage. Impairment of school performance could also be due to adherence of parasitized erythrocytes to host cells, either endothelial or circulating blood cells, in the

TABLE 5
School performance of children in Sri Lanka in relation to the number of attacks with different *Plasmodium spp.*

	Mean scores (± SD) in relation to number of malaria attacks				
	None	1–2	≥3	F-value*	*P*
Plasmodium vivax					
Special examinations†					
Mathematics	14.81 (6.02)	12.33 (5.60)	9.55 (5.28)	33.934	0.001
Sinhala	17.00 (5.34)	15.76 (4.61)	11.65 (5.67)	41.851	0.001
School examinations‡					
Mathematics	57.13 (20.51)	53.56 (17.64)	40.38 (17.21)	28.807	0.001
Sinhala	63.29 (18.21)	60.87 (15.66)	47.23 (19.13)	32.362	0.001
Plasmodium falciparum					
Special examinations†					
Mathematics	13.81 (6.21)	11.76 (5.30)	7.67 (4.41)	19.087	0.001
Sinhala	16.12 (5.62)	14.94 (4.99)	10.82 (4.45)	13.908	0.001
School examinations‡					
Mathematics	55.27 (19.87)	49.15 (18.53)	39.59 (18.79)	10.333	0.001
Sinhala	61.55 (18.16)	57.28 (17.46)	42.61 (19.07)	15.488	0.001

* The F statistic compares the means of the three categories.
† The average scores in mathematics and Sinhala language of the special examination papers.
‡ The average scores in mathematics and Sinhala language of the school examination papers.

post capillary venules of the brain, as described by Grau and de Kossodo.[18] It is unlikely that increased intracranial pressure could have played a significant role considering the fact that all infections were attacks of uncomplicated malaria with no cerebral signs. All these mechanisms lead to an alteration of consciousness that affects host behavior and mental processes. Even though cerebral malaria is the most studied form of severe malaria, little is known of its effect on the long-term cognitive development of survivors.[9] However, the impact of cumulative mild effects, if any, of repeated attacks of malaria on cognitive performance needs to be evaluated and documented.

It is also possible that malaria *per se*, as in other parasitic diseases, could have a direct effect on school performance via effects on the working memory of the brain.[19] Malaria could also affect school performance by its ability to cause chronic anemia. The impact of malaria-induced anemia on school performance has not been studied, but iron-deficiency anemia, commonly seen in hookworm disease, schistosomiasis, and intense trichuriasis, has a particularly strong link with impaired functioning.[20–23] Parasitic disease leading to anorexia, if sufficiently severe, can affect central nervous system function, which is reflected in changed behavior or impaired cognitive performance.[24]

Although the baseline characteristics of the children, such as prevalence of anemia, worm infections, etc. were not ascertained, the low prevalence of worm infections in the area previously reported[25] and the finding that school performance was not related to anthropometric indices indicate that repeated attacks of malaria is the most important determinant of school performance.

The effects of repeated attacks of malaria on school performance were seen for both species of *Plasmodia*. There were no differences in school performance between *P. vivax* and *P. falciparum* when only children who had experienced more than three attacks of malaria of a particular species were considered. Thus, the important factor appears to be the number of malarial attacks that is responsible for the adverse impact on school performance, and that factors, other than the immunopathologic ones of the different *Plasmodium sp. per se*, such as school absenteeism, may play an important role.

The malarial attacks experienced by these children were all uncomplicated. The dose-response relationship between the number of malaria attacks and school performance suggests a definite cumulative effect. This effect was evident even in uncomplicated attacks of malaria, which occur repeatedly with complete clinical recovery. These findings suggest that the impact of repeated attacks of uncomplicated malaria may have a profound influence beyond the school years of these children, possibly even on their educational and economic achievement during later years.

In this study, malaria infections were monitored over a six-year period. It is unlikely that a large proportion of malarial infections would not have been recorded because most patients seek treatment of malaria at either the local District Hospital or Malaria Research Station. Very few seek treatment of fever in the private sector.

Malaria appears periodically in epidemic proportions in most of Asia and has had devastating effects on the economies of countries as well as general human development. The impact of malaria on the school performance of children that has been demonstrated in this study may be a significant contributor to poverty in malaria-endemic countries, in general, and has significant implications for health care providers, in particular, and human development planners, in general. Unequivocal evidence has been provided for the urgent need to control malaria as a priority in a developing, malaria-endemic country such as Sri Lanka.

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