DOCUMENT RESUME

ED 448 860	PS 029 076

AUTHOR	Williams, James H.; Leherr, Kay
TITLE	Children's Health and Nutrition as Educational Issues: A Case Study of the Ghana Partnership for Child Development's Intervention Research in the Volta Region of Ghana. Technical Paper No. 91. SD Publication Series.
INSTITUTION	Agency for International Development (IDCA), Washington, DC. Bureau for Africa.
SPONS AGENCY	Academy for Educational Development, Washington, DC.; Edna McConnell Clark Foundation, New York, NY.
PUB DATE	1998-12-00
NOTE	39p.; Prepared in collaboration with the Ghana Partnership for Child Development for the Harvard Institute for International Development and the Office of Sustainable Development, Bureau of Africa, USAID, Washington, under contract to the Advancing Basic Education and Literacy Project (ABEL2), Academy for Educational Development.
AVAILABLE FROM	USAID Development Experience Clearinghouse, 1611 North Kent Street, No. 200, Arlington, VA 22209-2111; Web site: http://www.dec.org (Document No. PN-ACD-822, $3, plus shipping and handling).
PUB TYPE	Reports - Evaluative (142)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Academic Achievement; Case Studies; *Child Health; *Children; Developing Nations; Early Adolescents; Elementary Education; Foreign Countries; Health Programs; *Health Services; Intervention; *Nutrition; Partnerships in Education; *Program Effectiveness; Public Policy
IDENTIFIERS	Ghana; *Parasitic Infections; *School Based Services

ABSTRACT

As increasing numbers of children in developing nations survive to school age, practitioners, researchers, and policymakers are increasingly focusing on the health and well-being of school-age children and on the possibility of using the infrastructure of the school system to deliver health and nutrition interventions. This research, conducted in Ghana through the worldwide Partnership for Child Development, identified and targeted school-age children's prevalent health problems; used simple, low-cost mass interventions through the schools; and developed partnerships for implementation between health and education, government, and non-governmental agencies. The specific intervention for this study focused on de-worming. Samples of 8- to 9- and 12- to 13-year-olds were obtained in 1994 at 3 intervention and 2 comparison sites for baseline, with subsequent samples selected for follow-ups. The results indicated that the interventions were effective in reducing infection levels of schistosomiasis and hookworm, reducing malnutrition, and improving achievement, though not necessarily improving students' attendance. The intervention effect on achievement was especially strong for nutritionally disadvantaged children and for girls. The feasibility of mass school-based treatment was demonstrated, with treatment provided to 85,000 children at a cost of $3.21 per child. Further research needs related to education policy were identified. (A list of the persons interviewed for the report is appended.) (KB)

SD Publication Series
Office of Sustainable Development
Bureau for Africa

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USAID

Human Resources and Democracy Division
Office of Sustainable Development
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This paper was prepared in collaboration with the Ghana Partnership for Child Development (GPCD) for the Harvard Institute for International Development and the Office of Sustainable Development, Bureau for Africa, USAID/Washington, under contract to the ABEL2 Project, Academy for Educational Development. The data analyzed here were collected by the GPCD, which receives principal support from the Edna McConnell Clark Foundation. GPCD and USAID/Ghana also provided logistical and human resource support.

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Acknowledgments

It is impossible to repay with simple acknowledgments the time, effort, and care that numbers of people have taken to assist us in gathering information for this report and in assisting the international members of the team.

We would like to thank National School Health Education Programme (SHEP) coordinator and the health education consultant to the Ministry of Education for valuable insights and materials on the needs, strengths, and challenges facing schools and school children. We thank the director general of the Ghana Education Service (GES), his deputy, and the director of maternal and child health at the Ministry of Health. The regional directors of education and of health, Volta Region, and the regional SHEP coordinator gave us a warm welcome to the Volta Region, valuable insights into the implementation process, and access to their schools, staff, and operations. Similarly, the district directors of health and of education and the district SHEP coordinators in Kpandu and Hohoe Districts provided invaluable information to help us understand the Partnership's activities from the perspective of field implementers. The district education staff at Kpandu District was particularly helpful in providing access to their data. We thank the head teachers, teachers, and students at Hohoe District schools who permitted us to see their schools. We thank Dr. Wen and the Ghana Partnership for Child Development data collection team for taking time to show us the procedures for survey of schistosomiasis and helminths.

We thank the director of the School of Public Health, University of Ghana, Legon, for his time and insight into the constraints to school health as well as to Professor Nsowah Nuamrah of the Institute for Statistics, Economic and Social Research. Our appreciation goes to the coordinators of Childscope and of Action Research at the Institute for Educational Development and Extension at the University College of Education at Winneba for explaining their programs to us. Thanks also to the district director of health and the disease control officer, Winneba District, for their hospitality and insight. Health education activities are undertaken by a number of organizations in Ghana. We thank the staff of Plan International and Catholic Relief Services for taking time to talk with us. Appreciation must go the UNICEF/Ghana for their time and insight. At the Ministry of Education, we thank the statistics staff and Thomas LeBlanc for assistance in seeking ever-elusive data for our analysis. Richard Lansdown of the Partnership for Child Development (PCD) and Hugh Hawes of the University of London provided us background into health education issues from a larger, more theoretical, and comparative perspective.

We thank USAID/Ghana, in particular the health officer, education officers, and the secretarial staff for their support and interest. The ABEL2 Project and the Harvard Institute for International Development (HIID) provided essential support from the United States. We thank the Office of Sustainable Development, Africa Bureau, USAID/Washington for its long-standing support of this and similar lines of research and advocacy. Our gratitude goes to Professor Donald Bundy of the PCD, to Carolyn Winter of the World Bank, and Shirley Burchfield of HIID for their continued interest in looking across traditional sectoral boundaries and their support of this activity.

Most of all we thank the GPCD for their hospitality and willingness to open their doors to us and to share information as we work to understand and portray the interconnections among health, nutrition, and education. At the Partnership, we thank the professional staff for their time and contributions to this effort. We also thank Dr. Araba Sefa-Dedeh at the University Medical School for taking the time to meet and talk with us. We make a special note of appreciation to the computer and database specialist at GPCD for her hours of work with us on retrieving and understanding GPCD's data. We must thank the driver at GPCD for his assistance in getting us around.

Finally, the international members of the team express our deep appreciation for the extraordinary commitment of time and for the warm hospitality of Sam Adjei, Director of the Health Research Unit and GPCD, and to Emelia Allan, Program Coordinator of GPCD. Without their efforts this study, not to mention the health of children in the Volta Region of Ghana, would be much worse off.

Despite all this assistance and insight, any errors of omission or commission are the responsibility of the authors and not of any sponsoring organization.

Executive Summary

Background

After decades of focus on infant and child survival, increasing numbers of practitioners, researchers, and policymakers are focusing on the health and wellbeing of school-age children and on the possibility of using the infrastructure of the school system—buildings, teachers, supervisors, training capacity, and lines of communication—to deliver health and nutrition interventions.

The reasons for this shift are increasingly well publicized: more children are surviving to school age; at the same time, greater proportions of school-age children are entering school. Schools provide an established infrastructure for potential delivery of health and nutritional interventions and "messages" to children in school (as well as out of school) and their families. Children are more receptive to health and nutritional education than adults, and many health and nutritional conditions are amenable to safe, low-cost treatment.

A number of conditions amenable to treatment are known to affect the educability of children. Worms infect an estimated sixty million children in Africa, impairing their cognitive abilities, general wellbeing, and school attendance. Iron deficiency affects an estimated fifty million African children, reducing their attention span, motivation, and achievement. Iodine deficiency affects twelve million African children, interfering with their hearing, visual perception, and coordination. vitamin A deficiency affects nine million young Africans, leading to poor growth, increased morbidity and mortality, and higher risk of anemia and blindness. All these conditions are amenable to effective, low-cost treatment.

The big question—addressed by the larger studies on which this paper is based—is whether such treatment is feasible and effective on a large scale using the organizational infrastructure of *developing country* school systems. The larger studies focused on building knowledge about ways of implementing mass school-based treatment of certain health and nutritional conditions as well as the effectiveness of such large-scale interventions.

This research seeks to understand these issues from an *educational policy perspective*: Do health and nutrition interventions measurably improve the *quality* and the *efficiency* of schooling, a case could be made *on educational grounds* for investment in the health and nutrition of school children. Health and nutrition could then be seen (rightly, we believe) as the joint responsibility of education and health ministries and as a necessary input to the educational process. This research thus focused on measurement of educational outcomes and their interaction with health and nutritional conditions.

The Ghana Partnership for Child Development

Ghana is one of six countries participating in the worldwide Partnership for Child Development, a consortium of donors and researchers established to examine the feasibility and effects of school-based health and nutrition interventions on health. The Ghana Partnership for Child Development (GPCD) is supported by the Edna McConnell Clark Foundation, the Scientific Coordinating Centre for the Partnership for Child Development at Oxford University, the James

S. McDonnell Foundation, the Rockefeller Foundation, the United Nations Development Programme (UNDP), the Wellcome Trust, the World Bank, UNICEF, and the World Health Organization (WHO). GPCD is managed by the Health Research Unit of the Ministry of Health and is a collaborative project of the Ministry of Health and the Ghana Education Service of the Ministry of Education. Technical support is provided by the Scientific Coordinating Centre in Oxford.

The Partnership's overall strategy consists of three components: identifying and targeting prevalent conditions of school-age children; using simple, low-cost mass interventions, which can be delivered through schools; and developing partnerships for implementation between health and education, government, and NGOs. The specific interventions have focused on deworming, micronutrient supplementation, and health education. The GPCD was chosen because of its careful research design and documentation process. This report is based on GPCD's research.

Baseline and Sampling

GPCD collected baseline data in March 1994. A random sample of 8–9 and 12–13 year olds was chosen from five districts, three "intervention" and two "comparison"—or control—districts. Data collected included demographic information, parasite infection status, anthropometric status, hemoglobin status, iodine status, vitamin A status, attendance rate, and assessment score, (a measure of student performance based on continuous assessment scores and classroom tests). Students also provided knowledge, attitudes, behavior, and practices data (KABP) and responded to a morbidity questionnaire. A randomly-chosen subsample of students and their parents were interviewed for KABP data, household characteristics, and socioeconomic status indicators. Finally, an assessment, based on facilities and teacher performance, was made of each school.

Comparisons between the intervention and comparison areas are reported here. Although substantial efforts were made to identify an appropriate comparison area to account for confounding variables, during baseline data collection the intervention area and the comparison area were found to differ in many aspects. These included, but were not limited to, prevalence of parasitic infection and attendance rates. Therefore, treatment effects cannot be strictly identified on the basis of comparison but are understood as the best measures available.

GPCD chose a new sample of 8–9 and 12–13 year olds for each subsequent data collection, creating a rolling sample throughout the study. Data collected during Resurvey I and Resurvey II consisted only of student level data, including demographics, parasite infections, anthropometric status, hemoglobin status, attendance rate, and assessment scores. However, at the end of the project, KABP will be reassessed at the student and the parent level, and newly developed achievement tests will be administered.

Treatment

Deworming, as summarized in Table I, was achieved through administration of two drugs—Praziquantel to treat urinary Schistosomiasis and Albendazole to treat intestinal helminth infections. During the first administration, both drugs were given to all students in every school in the intervention area. For the second and third administration, Albendazole was given to all of the students, but Praziquantel was given only to those students who self-reported blood in urine. The efficacy of these treatments was assessed at each stage with post-intervention surveys. Altogether, nearly 85,000 children were treated with one or both anthelmintics. Ninety-six percent coverage of the target population was achieved with Albendazole.

Table 1. Summary of GPCD Activities

March 1994	Baseline Data Collection
July–August 1994	Mass Albendazole and Praziquantel treatment
January 1995	Post-intervention survey
March–April 1996	Resurvey I
July 1996	Mass Albendazole and Praziquantel treatment
September 1996	Post-intervention survey
March 1997	Resurvey II
June 1997	Mass Albendazole and Praziquantel treatment
August 1997	Post-intervention survey
October 1997	Iron supplementation (pilot)
March 1998	Resurvey III
April 1998	Mass Albendazole and Praziquantel treatment
May–June 1998	Post-intervention survey
December 1998	End of project
February 1999	Resurvey IV

In terms of micronutrients, baseline data revealed that vitamin A deficiency was insufficiently prevalent to warrant mass provision. Iron supplementation has proven more problematic; weekly administration of tablets is required, whereas annual administrations of Albendazole and Praziquantel have been deemed sufficient. In addition, iron supplementation is associated with discomfort. A pilot iron supplementation program began in October 1997.

As for the health education component, teachers and other local education officials were trained in administration of the anthelmintics and in related matters. In addition, the GPCD has collaborated and sponsored a series of research activities related to the health education curriculum and instructional materials. However, as of late 1997, a comprehensive health education program had yet to be implemented in the GPCD study areas.

Health and Nutritional Outcomes

Parasitic Worms. Data were collected on the prevalence and intensity of the five most common species of parasitic worms: *Schistosoma haematobium*, *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, and *Strongyloides stercolrais*. The treatment appears to have resulted in sharp reductions in prevalence and intensity of schistosomiasis and hookworm, but with little or no consistent reductions in *Ascaris, Trichuris,* or *Strongyloides*. Baseline data in 1994 suggested a prevalence of 15 percent of *S. haematobium* in the intervention area. After the first treatment, this rate fell to 6 percent, then rose to 8 percent in 1997. While a certain amount of reinfection is to be expected, the 1997 rate is just over half the baseline rate. Prevalence of hookworm in the treatment area also decreased from 52 percent in 1994 to 29 percent in 1996 and 16 percent in 1997. The prevalence and intensity of *Ascaris* fell significantly from 1994 to 1996, but rose, through reinfection, from 1996 to 1997. The prevalence and intensity of *Trichuris* and

Strongyloides did not change significantly in the treatment area between 1994 and 1997. As a result, the intervention was deemed effective in reducing infection levels of schistosomiasis and hookworm.

Nutritional Measures. Reductions in parasite loads are likely to be related to increases in growth and iron status. Such an effect was investigated by collecting data on weight, height, mid-upper arm circumference, tricep skinfold thickness, and hemoglobin status. Using this information, percentages of students who were stunted, underweight, wasted, or anemic were calculated. Stunting, which is measured by height-for-age, is an indicator of chronic malnutrition. Underweight, which is measured by weight-for-age, reflects current malnutrition, but does not distinguish from past undernutrition. Both stunting and underweight measures can be somewhat suspect because they rely on the age of the child, which is not always accurately reported, so figures must be interpreted with care. Wasting, which is measured by weight-for-height, is an indicator of acute malnutrition. Anemia is measured by hemoglobin levels and is indicative of iron deficiency.

In 1994, 50 percent of the students in the intervention area were identified as stunted. This percentage was significantly reduced to 42 percent in 1996 and 41 percent in 1997. The percentage of students identified as underweight also significantly decreased from 41 percent in 1994 to 33 percent in 1996, with an insignificant increase to 34 percent in 1997. The percentage of students in the intervention area who were identified as wasted (5 percent) and anemic (48 percent) remained statistically constant throughout the three years. In the comparison area, the percentage of students identified as stunted (37 percent), underweight (31 percent), or wasted (2 percent) remained constant throughout the study, while the percentage of students identified as anemic rose significantly from 27 percent in 1994 to 50 percent in 1997. Thus, the evidence suggests that the intervention was effective in reducing malnutrition.

Educational Outcomes

One of the main purposes of the GPCD's research was to assess the effect of a school-based health intervention on the education of the school-going child. Educational outcomes were measured through attendance rates and academic assessment scores, an average of teachers' assessment scores for each subject from the continuous assessment registers. Because these scores are subjective, interpretation across districts and schools is difficult. However, because of the lack of any national standardized tests, the assessment scores are the best available measure of students' academic achievement. In addition to the assessment scores, the Partnership has developed and tested standard tests to be used to gauge achievement more reliably across schools, and introduced those tests in October 1997.

Attempts were also made to assess the effect of the intervention on the persistence of school-age children. It would have been very useful to understand the effect of the intervention on student persistence, particularly any changes in the likelihood and speed of completing basic education, and the rate of entering secondary school. Unfortunately, the necessary data on repetition and enrollment were not available at the district level for years past. However, it was possible to develop a rough estimate of the possible effects of the intervention on dropout in one district, disaggregated by gender.

Attendance rates were high and not apparently affected by the treatment. Attendance in the intervention area remained significantly higher (though relatively flat) as compared with the comparison area from 1994 to 1996 and 1997, while attendance grew more clearly in the comparison area. Because the initial rates exceeded 90 percent in the intervention area, we speculated that 90 percent may represent a kind of natural ceiling, above which attendance is very difficult to improve. In the event, the treatment was not associated with a statistically significant increase in attendance.

Assessment scores, by way of contrast, showed consistent improvements in the treatment group over the intervention period. Assessment scores in the intervention districts increased significantly from 1994 to 1996 and again from 1996 to 1997, while increases in the comparison districts were not statistically significant at the .05 level. The treatment was associated with similar changes in proportions of children in lower categories of performance. The percentage of children "failing," that is scoring less than 45 percent, for example, fell from 31.8 percent in 1994 to 22.8 percent in 1997, while the percentage of children in categories of good, very good, and excellent increased.

Gender Effects. Examining the effects of the intervention by gender, it was found that although both boys' and girls' assessment scores increased significantly, the effect was greater for girls than for boys—the effect size for girls (.31) was almost twice that of boys (.17). In 1994, girls' average assessment scores were significantly lower than boys. By 1997, girls had caught up in the intervention area to the point where there was no statistical difference between boys' and girls' scores.

Adding age to the statistical model permitted examination of interactions among age, sex, and treatment. Results suggest that although the treatment is effective in improving scores overall, the effects are particularly pronounced for girls and even more so for girls aged 12–13, an age where girls are especially vulnerable to dropout. The implication is that if a health intervention can reduce the dropout rates of adolescent girls in basic education, it may contribute to higher enrollment of girls in secondary education.

Interactions with Malnutrition. Statistical analysis suggests that while assessment scores increased significantly for both stunted (chronically malnourished) and non-stunted children in the treatment area, the effect was more then one and a half times greater among the malnourished children. Though the stunted children began the study with substantially lower average assessment scores, by 1996 there was no statistical difference in achievement between the two groups. This suggests that an effective health intervention program may mitigate some of the negative effects of malnutrition on achievement. Somewhat surprisingly, a similar comparison of anemic and non-anemic children found that the effects of treatment were greater among the non-anemic children, suggesting that anemia may reduce the positive effects of the treatment on school achievement. If, along with deworming, anemia is reduced as was planned by introduction of iron supplementation in October 1997, the effects of the intervention are likely to be even greater than with deworming alone.

Effects on Dropout. As noted, a rough measure of dropout was calculated before and after the intervention for boys and girls in one treatment district where data were available over a number of years. Tentative results suggest substantially lower dropout after the intervention, 42 percent lower for boys and 46 percent lower for girls. Both before and after the intervention, girls are more likely to drop out than boys, but the intervention appears to have narrowed this gap, albeit by a small margin.

These results suggest that there is a strong and positive effect of the deworming treatment and health education program on the achievement, though not necessarily on the attendance, of students in the intervention area. This achievement effect is especially strong for nutritionally disadvantaged children and for girls, especially adolescent girls. Although some questions remain about the reliability of teacher continuous assessment scores as an indicator of achievement, hopefully these questions can be laid to rest by testing samples of pupils in comparison and intervention areas using the standard instruments developed by the Partnership.

Feasibility and Next Steps

An important outcome of the research was demonstration of the feasibility of mass school-based treatment of helminth infections, on both technical and organizational grounds. Treatment was provided to 85,000 children, at a cost of US$3.21 per child treated in 1996 (which included the opportunity costs of volunteer labor in rapid appraisal and drug administration). Praziquantel accounts for $2.94 of this amount; Albendazole for the remaining $0.27. In implementing the intervention, GPCD developed and piloted a number of instruments, procedures, and protocols for carrying out mass, school-based treatment of helminths.

From an education policy research perspective, five "next steps" would seem to be indicated in the context of the GPCD's work: 1) examine the effects of iron supplementation on attendance and achievement as well as any interactions with anthelmintics and health education interventions; 2) measure the effects of the intervention using reliable indicators of persistence in and completion of primary school as well as entrance to and success in secondary school, especially for girls; 3) validate the findings reported here using achievement assessment instruments of better known validity and reliability, such as the standard achievement assessment instruments developed by the Partnership; 4) broaden the health education component in an effort to change the behavior of children, teachers, and community members in health and education-enhancing ways; and 5) continue the process of institutionalizing school health, both at national levels (by incorporating school health into the government's education budget and overall education reform strategy) and local levels (by increasing involvement of field implementers and "beneficiaries" at districts, communities, and schools in making decisions about, planning, and implementing health and nutrition interventions in schools and communities, with an eye to sustaining and extending these activities beyond the life of the GPCD research).

I. Introduction

Purpose and Perspective of the Paper

This paper describes the operations research intervention carried out by the Ghana Partnership for Child Development (GPCD) in the Volta Region of Ghana in collaboration with the Ministries of Education and Health and the Ghana Education Service. Ghana was chosen because it is one of the leading countries in Africa in promoting school health.[1] GPCD's Volta intervention is among the world's most extensively documented projects related to health, nutrition, and educational conditions, interventions and consequences. The GPCD research explicitly set out to measure outcomes of interest to educational policymakers.

Begun in 1994, the GPCD effort built on previous school health initiatives in the Volta Region (see Figure 1). Ghana is one of six countries in the Partnership for Child Development, a consortium that has undertaken longitudinal operations research in order to: 1) assess the effect of targeted packages of simple, low cost school-based interventions on the health and education of school children; and 2) refine strategies for delivery of those packages and for development of the organizational partnerships necessary for successful implementation of cross-sectoral programs.[2,3] The GPCD has developed a package of deworming, health education, and micronutrient supplementation. To date, the package has concentrated much of its effort on deworming, though the education and health effects of iron supplementation and enhanced health education will be examined more closely in 1998. Consistent with its mandate, the GPCD has carefully documented the research process and findings.[4] This paper draws heavily on GPCD's documentation, though the team carried out substantial additional analysis of factors predicting educational outcomes. The interpretations and conclusions, however, are those of the research team.

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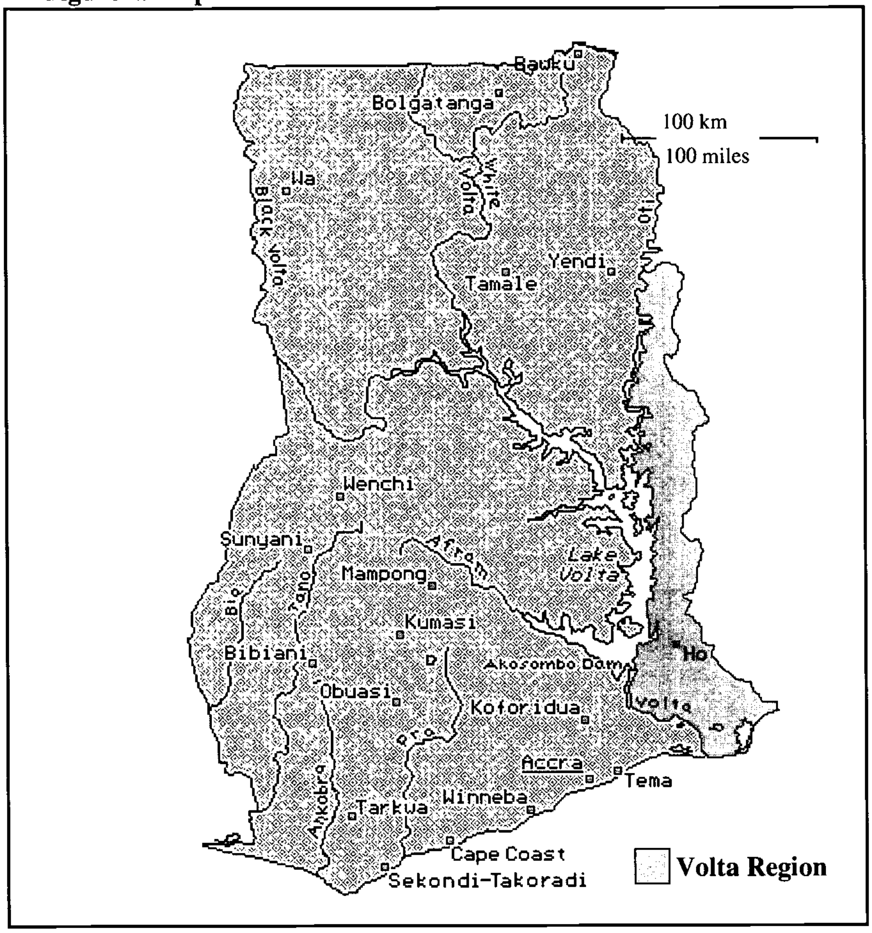
[1] "School health" is a term used broadly here to refer to health education as well as the variety of health and nutrition interventions, policies, practices, and measures that use schools to improve the health, nutrition, and education of school-age children in and out of school.

[2] Countries participating in the Partnership for Child Development are Colombia, India, Ghana, Indonesia, Tanzania, and Vietnam. The Partnership headquarters are at the Scientific Coordinating Centre, Partnership for Child Development, University of Oxford, South Parks Road Oxford OX1 3PS, United Kingdom; Tel: +44 1865 281246; Fax: +44 1865 281245; Internet: www.ceid.ox.ac.uk/child/Home.htm

[3] The Ghana Partnership for Child Development (GPCD) is supported by the Edna McConnell Clark Foundation, the Scientific Coordinating Centre for the Partnership for Child Development at Oxford University, the James S. McDonnell Foundation, the Rockefeller Foundation, the United Nations Development Programme (UNDP), the Wellcome Trust, the World Bank, UNICEF, and the World Health Organization (WHO). GPCD is managed by the Health Research Unit of the Ministry of Health and is a collaborative project of the Ministry of Health and the Ghana Education Service of the Ministry of Education. Technical support is provided by the Scientific Coordinating Centre in Oxford.

[4] See Ghana Partnership for Child Development, *Documentation Series, Nos. 1-11* and other documents prepared by GPCD.

Figure 1. Map of Ghana



This paper is intended to serve as a discussion tool, by:

1) focusing awareness on the *educational importance* of children's health and nutritional status;

2) describing in some detail the process and the effects—educational as well as health—of one type of *school-based intervention strategy*, a strategy that has actually been implemented and its effects monitored; and

3) discussing the *implications* of this intervention—from the perspectives of educational and health effects, organization, and implementation—for educational policymakers and for the larger process of educational development within Africa and beyond.

In particular, the report is aimed at those who know little about the educational effects of children's health and nutrition. The report also targets those who believe that health and nutrition are of moderate or low priority in the improvement of education systems in Africa. Part of the reason for the relatively low priority of school health on educational reform agendas is the lack of data supporting improvements in educational outcomes as a consequence of school-based health and nutritional interventions. When budgetary priorities are made, evidence to support school health (referring, again, both to the health and nutrition of school age children and to the use of schools to deliver health interventions) is generally not available.

Real world data rarely meet the expectations of researchers and advocates for completeness, rigor, and adequate control. However, the GPCD intervention provides clear and consistent evidence of the positive effects of the GPCD intervention package on children's achievement, especially that of malnourished children, and of girls, especially adolescent girls. These results provide hard evidence of the positive effects on quality and equity of targeted school-based health and nutrition interventions.

The results support this paper's primary contention that, whether acknowledged, treated, or not, children's health and nutritional status play an important, often hidden, role in the classroom. When children's health and nutrition are poor, efforts to improve quality are rendered inefficient, for children are unable to take full advantage of the educational stimuli that schools offer. Unfortunately, no research to date, including this effort, has systematically examined the tradeoffs and complementarities among educational, health, and nutritional inputs. It is not yet known the extent to which investments in educational inputs are more and less effective when used to educate children of greater and less health and nutritional wellbeing. We are not yet able to quantify or compare with costs of intervention any efficiency gains to the education system achieved through improved health of its children. We cannot yet project the benefits of these interventions on the future productivity and human resource capital of a nation.

Nonetheless, this research has contributed to our growing understanding in a number of areas critical to school health.

Policy Issues

Research in recent years has revealed an especially close relationship between education and health/nutrition. Education, especially of girls, is associated with decreases in mortality, morbidity, and fertility. More educated populations are better able to make use of health facilities and health information, earn higher incomes, eat more nutritious food, and take other steps leading to better health. More educated women have fewer and healthier children, later.

Similarly, healthier and better nourished children are better able to take fuller advantage of educational stimuli. Children who are sick or malnourished suffer from poor attendance, attention, and cognitive function. They are less likely to enter school, stay in school, and learn while there. What is the use of improving the quality of the school if the child is too sick or hungry to attend or to learn? The quality of the child is as important as the quality of the school.[5]

Even so, health and nutrition are rarely brought to discussions of education sector development strategy. Education sector analyses generally discuss the status of the education system, but rarely the status of the children in it. Similarly, schools are often absent from discussions of health strategy. Even if schools are considered as mechanisms for delivery of health services, the

[5] Levinger, Beryl (1994). *Health, Nutrition, and Education for All.* New York, United Nations Development Programme.

interface with school systems and overall educational development strategy is often ignored. One set of reasons relates to the organizational difficulties of working across sectors. Another set of reasons is lack of knowledge. For a great deal is *not* known about the effects on education and on health as well as the feasibility of school-based health and nutrition interventions.

Thus, while some of the linkages between education and health/nutrition are well-documented—for example, the strong associations between female education and increased infant survival and reduced fertility—relatively little is known about the effects of school-based health and nutrition interventions on the health and education of school-age children, or the feasibility and cost of such interventions. Evidence is particularly weak in the realms of intervention and implementation strategy, cost, and policy outcomes of interest to educational decisionmakers.

Increasing Emphasis on School Health

Two dimensions of school health—school-based health interventions and the health of school-age children—are attracting increasing attention for several reasons. First, the numbers. As increasing numbers of children survive beyond the first five years, more children enter school. At the same time, greater proportions of school-age children are entering and staying in school, at least into the primary cycle. Thus, one reason for paying more attention to school health is the increasing size of the school-age population.

Another reason for increased attention to school health is that school systems represent an established infrastructure for potential delivery of health and nutrition interventions and messages. The primary school is the single public institution that reaches the largest number of people in Africa. The infrastructure is largely in place, with coverage exceeding that of public health institutions. Schools are staffed with trained personnel, potentially able to deliver (some) health and nutrition services. Primary schools are especially important in the African context because primary schooling is the only formal education that many children will get.[6] In Ghana, as in sub-Saharan Africa as a whole, many fewer children enter secondary school as compared to the number that finish—or enter—primary school.

Primary schools are increasingly recognized as important centers for adolescent health. One-third of Ghana's primary school population is estimated as being age 10 and older (conversation with Adofo). In some African countries, more adolescents are enrolled in primary school than in secondary school. And again for the foreseeable future, the only formal education many children will get will be in primary school.

The provision of good health and nutrition to school-age children provides a way to enhance the quality of life into older childhood and beyond. Worldwide, more than 90 percent of children survive beyond the age of five, yet there are few programs to improve the health of these survivors. As child survival rates increase, attention expands from ensuring survival alone to enhancing the quality of life for those who survive and the consequent contributions they can make to their communities and nations. The relative discrepancy between the disease burden in

[6] In addition to reaching children *enrolled* in school, researchers are increasingly looking to the school as a means of reaching both the families and communities of school children as well as *school-age children not enrolled* in school (See the work of Alicia Fentiman and of Richard Lansdown, of the Partnership for Child Development).

developing and in developed countries is now much larger among school-age children than among children under five (British Council Conference on School Health, July 28, 1997), thanks in large part to the success of child survival efforts over the past several decades.

Moreover, children are more receptive to health messages than adults. Thus, school-based delivery of health education fits in with a strategy of preventive health, consistent with the public health approaches taken by many nations. The widely-utilized child-to-child strategy, for example, seeks to make children "agents of change" by teaching them critical health messages to take from school to their homes and communities.

Finally, a series of important health and nutritional conditions widely prevalent among school-age children appear to be amenable to cost-effective, school-based treatment. These conditions include helminths and micronutrient deficiencies (especially vitamin A, iodine, and iron) as well as sensory impairment.[7] Deworming, micronutrient supplementation, and sensory screening rank among the top ten priorities for school-age children listed by the *1993 World Development Report: Investing in Health.*

Approximately fifty million school-age children in Africa suffer from iron deficiency anemia.[8] Iron deficiency impairs learning capacity in several ways. Children with iron deficiency are less attentive and motivated in school, and they perform less well on tests of cognitive development and school achievement. Approximately twelve million African school-age children are estimated to suffer from iodine deficiency, which impairs hearing, visual perception, and visual-motor coordination.[8] More severe deficiencies result in goiter, reduced learning aptitude, and lower school attendance. Iodine deficiency during pregnancy can cause severe mental retardation. Approximately nine million African school-age children are estimated to suffer from vitamin A deficiency, which is associated with poor growth, increased morbidity and mortality, and higher risk of iron deficient anemia among young children. Severe untreated vitamin A deficiency causes blindness. Approximately sixty million African children of school age suffer from helminths that affect their cognitive abilities, attendance at school, and overall wellbeing. Such parasites include hookworm, ascaris, trichuris, and schistosomiasis (bilharzia).[6,8] Helminth infection often interacts with and contributes to other nutritional deficiencies, such as iron deficiency. The cost of medication to treat these conditions is quite low, ranging from several cents to US$2. Several of these conditions require infrequent administration of medication; in many cases, one treatment per year is sufficient to maintain low rates of infection. Mass, school-based treatment of children is considered safe and efficacious (Bundy, et al. 1990). These conditions are listed among the most cost-effective health interventions for school-aged children, according to the World Bank's 1993 *World Development Report, Investing in Health.*

[7] Some researchers emphasize protein-energy malnutrition (PEM) and temporary hunger as critical to school performance (see, for example, Levinger 1994). Other researchers see these conditions as important but not amenable to cost-effective intervention.

[8] Ellen Piwoz, "Nutrition and Educational Outcomes in Sub-Saharan Africa," Prepared for the USAID Conference on Health, Nutrition, and Education, May 1995, SARA Project.

Research Questions

Much of the rationale for establishing the multi-country, multi-year Partnership for Child Development studies lay in testing in a series of real national contexts the efficacy and cost-effectiveness for school-based treatment of helminth infection and micronutrient deficiencies among school children. The research involved not only the clinical aspects of treatment but the logistical and organizational issues involved in treating large numbers of children in rural areas, as well as a careful documentation of initial and subsequent health, education, and nutritional conditions and changes. Several sets of questions led to the Partnership's research:

- *Feasibility:* Are large-scale school-based health and nutrition interventions feasible? Can teachers, for example, be trained to provide medication? What implementation issues will arise with large-scale intervention?

- *Effectiveness:* Is it possible to have a significant effect on health and nutritional conditions through large-scale school-based interventions?

- *Cost:* What are the costs of a large-scale, school-based treatment program of a package of interventions? What are the recurrent costs of an ongoing program likely to be?

Several areas are of more direct interest to educational policymakers:

- *Effects on School Quality and Performance:* Do school-based health and nutrition interventions improve the attendance and performance of school children? It is known that nutritional deficits and poor health status as well as their improvement affect cognitive performance, but despite the common-sense assumption that healthier and better-nourished school children learn better, the extent to which these effects translate into school performance measures is largely undocumented. It may be that the effects of malnutrition and poor health are too subtle to be measured with conventional education performance measures such as attendance and achievement test scores (interview with Nokes). Viewed somewhat differently, conventional educational performance measures may be too unreliable to capture the cognitive effects of improvements in health and nutrition. It may also be the case, for example, that so many factors influence school achievement that the effects of a single set of factors such as health and nutrition may be impossible to identify. Regardless, little is known about the effects of school-based health and nutrition interventions on measures of interest to educational policymakers—attendance and achievement, enrollment and persistence.

- *Equity Effects:* Do school-based health and nutrition interventions have an equity-enhancing effect on girls, the poor, rural children, unhealthier and more malnourished children, and adolescents, or do the effects of these interventions accrue to the already advantaged?

- *Behavioral Changes:* The extent to which school health programs result in sustained changes in behavior among school children is unknown. Are existing health education curricula organized in a such way that school children can readily understand and translate the messages into behavioral change? Do the curricula reinforce and extend the treatments received at school? How might health education curricula better meet the needs of children in rural schools, which often employ teachers having little training in health education content or pedagogy?

Organizational Context

Until the late 1970s, school health—in the form of hygiene—was a traditionally important component of schooling in Ghana. Hygiene was taught as a subject and was included on examinations. In addition, students, as well as villages, were inspected to maintain high standards of cleanliness. In the late 1970s, hygiene fell off the school timetable as a separate subject. Parallel to this decreasing interest among schools in health, hygienic conditions in schools, villages, and towns alike are widely seen has having deteriorated significantly.

With the ratification of the UN Convention on the Rights of the Child in 1991, the Ghanaian Ministries of Education and of Health were directed to establish an integrated comprehensive School Health Education Programme (SHEP) for school-age children.[9] A national coordinator sitting in the headquarters of the Ghana Education Service (GES) was named in 1992. At the same time, the two ministries established a steering committee to facilitate collaboration across the two sectors. Though inactive for several years, this steering committee has met to begin its work, a number of concrete steps for which have been proposed (deHeer 1997). In a further effort to promote school health, the Ministry of Education uses a consultant to advise the minister and other senior officials on policy issues.

GES has assigned significant personnel to school health; each region and district has a full-time SHEP coordinator, who works with regional and district health and education officials to promote the health of school children under their authority. In addition, each school has a school health coordinator, who works to promote health in the school. Despite this commitment of personnel, however, SHEP has not yet received a line item in the budget. As a consequence, its funding has come primarily from external donors. As a result, many SHEP coordinators are said to lack sufficient training, materials, and transport to carry out their work. It is said that the effectiveness of SHEP coordinators at all levels depends on the individuals' energy and resourcefulness in mobilizing support and necessary resources. In addition to SHEP, the Ministry of Health continues to manage school health services as well as nutritional issues and communicable diseases (deHeer 1997). The role, responsibilities, and mandate of SHEP vis-à-vis others responsible for the health of school-age children appear not to have been communicated clearly throughout the education and health systems. As a consequence, there are substantial gaps and overlaps in services.

Health education issues are currently taught in basic education (primary and junior secondary schools) as part of the life skills curriculum as well as in science class. In the curriculum reform, health education will be taught as part of Environmental Studies. As an unexamined part of the larger curriculum, the extent of actual health education taught in a particular class or school appears to depend largely on the motivation of individual teachers. A small portion of the teacher training curriculum is apparently devoted to health education, but most of the officials interviewed felt that few teachers had adequate mastery of content or pedagogy to be effective

[9] SHEP's responsibility includes all school-age children, whether enrolled in school or not (deHeer 1997).

conveyers of health education. Indeed, lack of teacher knowledge of health issues was noted a number of times by people interviewed for this paper.

In the early 1990s, a task force for child development was constituted to promote greater health among children. This led over time to the Partnership's research, as it was realized that there were insufficient data to monitor the effects of chemotherapeutic interventions.

Throughout the period, of course, non-governmental organizations and donors have run a number of projects with implications for school health in the Volta Region and in Ghana as a whole. These projects differ in emphasis and activities, but beyond the schools in which they operate, few projects attempt, as does the Partnership, to relate to the school system as a whole. As a consequence, the country's school health efforts remain a patchwork of more or less local efforts, with little systemic effect.

Working across sectors involves significantly greater coordination than working within a particular sectoral ministry. GPCD's distribution of anthelmintics, for example, must be coordinated by a complex of organizations. Within the central Ministry of Health, for example, three bodies, in addition to the Health Research Unit, are involved. In addition, coordination must take place between the Ministry of Health, the Ministry of Education, and the GES, as well as between health, education, and general government officials at each level of the system. Thus, efforts must be coordinated with the Ministry of Local Government at the national level, with regional governments in the regions, and with district assemblies at the district level. At the sub-district level, efforts are coordinated among the community health nurses (from the Ministry of Health), district SHEP coordinators, circuit officers, head teachers, school SHEP coordinators, and life skills and science teachers (from the Ministry of Education).

Despite this complexity, the Partnership's intervention was facilitated by the existence of an organizational structure as well as particular individuals responsible for promoting school health. Once SHEP coordinators in the Volta Region were assisted with training, concrete tasks, and transportation, they assumed much of the responsibility for coordination. Coordination is said to be easier at local levels, where the tasks at hand are more concrete.

II. The Strategy and Intervention

The Partnership's overall strategy consists of three components:

- identifying and targeting prevalent conditions of school-age children;
- using simple, low-cost interventions, which can be delivered through schools (thus far on an annual basis); and
- developing partnerships for implementation between health and education, government and NGOs.

In Ghana, the prevalent conditions were identified as intestinal worms; schistosomiasis; and iron, iodine, and vitamin A deficiency.[10] The package of interventions included chemotherapy for parasites, health education and nutritional supplementation.

GPCD research activities have taken place in the Volta Region of Ghana, which is the area between Lake Volta and the Togo border. Volta was chosen as the study area based on a number of considerations including the existence of relative groundwork, high basic education enrollment rates, relatively good medical facilities and experienced technicians, and accessibility to Accra. Three districts in the Volta Region were chosen as implementation or intervention sites (Hohoe, Jasikan, and Kpandu Districts) and two districts were chosen as comparison sites (Nkwanta and Kadjebi Districts). All schools in the intervention districts received the intervention. For research purposes, a sample of schools was randomly chosen within these districts to be included in the study. The target population of the study was identified as students ages eight, nine, twelve, and thirteen.

A summary of GPCD activities is given in Table 1. For baseline data collection in March 1994, a random sample of 8–9 and 12–13 year old students was chosen. Student data collection included demographic information, parasite infection status, anthropometric status, hemoglobin status, iodine status, vitamin A status, attendance rate, and assessment scores. Students also provided knowledge, attitudes, behaviors, and practices (KABP) data and responded to a morbidity questionnaire. A subsample of students was randomly chosen and the parents of these children were interviewed for KABP data, household characteristics, and socioeconomic status indicators. Finally, an assessment was made of each school based on facilities and teacher performance.

A new random sample of 8–9 and 12–13 year olds was chosen for each subsequent data collection, creating a rolling sample throughout the study. Data collected during Resurvey I and Resurvey II consisted of only student level data, including demographics, parasite infections, anthropometric status, hemoglobin status, attendance rate, and assessment scores. However, during the final and comprehensive Resurvey IV in February 1999, KABP will be reassessed at the student and the parent level and newly developed assessment tests will be administered.

[10] Baseline data subsequently revealed that vitamin A deficiency was insufficiently common to warrant mass provision. In the meanwhile, a national salt iodization campaign was in the process of being launched, and so mass provision of iodine was not pursued.

Table 1. Summary of GPCD Activities	
March 1994	Baseline Data Collection
July–August 1994	Mass Albendazole and Praziquantel treatment
January 1995	Post-intervention survey
March–April 1996	Resurvey I
July 1996	Mass Albendazole and Praziquantel treatment
September 1996	Post-intervention survey
March 1997	Resurvey II
June 1997	Mass Albendazole and Praziquantel treatment
August 1997	Post-intervention survey
October 1997	Iron supplementation (pilot)
March 1998	Resurvey III
April 1998	Mass Albendazole and Praziquantel treatment
May–June 1998	Post-intervention survey
December 1998	End of project
February 1999	Resurvey IV

Drug administration included Praziquantel to treat urinary schistosomiasis and Albendazole to treat intestinal parasitic helminth infections. Drug administration was preceded by a thorough program of training teachers and other school staff in the purposes and procedures for administering the drugs. Training consisted of 1) training of trainers and community sensitization, 2) provision of basic skills to non-health education staff on calculating the appropriate dosage of Praziquantel, and 3) monitoring of children for side effects. The training was aimed at SHEP coordinators, circuit officers, head teachers, and class teachers. The training of trainers took place in Hohoe town for one day. The second training took place in each of the three intervention districts.[11]

During the first administration, both drugs were given to all students in every school in the intervention area. For the second and third administration, Albendazole was given to all of the students but Praziquantel was given only to those students who self reported blood in urine.[12] The efficacy of these treatments was assessed at each stage with post-intervention surveys. Altogether, nearly 85,000 children were treated with one or both anthelmintics, resulting in 96 percent coverage of the target population with Albendazole.

The drugs were delivered mostly through the school system's infrastructure. Praziquantel and Albendazole were delivered to the Volta Region by the GPCD administrative office using the GPCD project vehicle. Three SHEP coordinators moved the drugs from the region to the three intervention districts, where they were repackaged; they were then collected by twenty-seven district circuit officers who delivered them to each school. Class teachers administered the drugs under the supervision of head teachers.[11]

The implementation of iron supplementation has proven to be problematic, mainly because it requires weekly administration of tablets, whereas the chemotherapy requires treatment only once a year. Logistics of this portion of the intervention have only recently been worked out and the iron supplementation program was scheduled to begin in a pilot of selected schools around October 1997.

[11] "A Comparative Cost Analysis of a Large-Scale Drug Delivery Programme Integrated Into the School Health Programme in Ghana and Tanzania," draft 9/97, Partnership for Child Development.

[12] Self reported blood in urine has been shown to be a sufficiently accurate indication of urinary schistosomiasis.

III. Outcomes

Because the GPCD project was established as action research, specific data relating to both health and education outcomes was identified and collected. In addition, a comparison area was used to serve as a representation of what may have been occurring in the Ghana education system in addition to the GPCD project and to account for any confounding variables. This systematic planning and operation allowed for the following intervention outcomes to be identified.

Health and Nutrition Outcomes

The health and nutrition status of the students was assessed at each stage of data collection. It was expected that the Albendazole and Praziquantel treatments would significantly reduce the level of parasite infections in the students in the intervention area. In addition, it was expected that by reducing parasite infections, nutritional improvements would also be observed in the treated children. Following is a brief summary of the GPCD health and nutrition findings from 1994 through 1997. More extensive analysis and findings are available from the GPCD *Series on the Health and Education of School Children in Volta Region, Ghana.*

Parasite infections. Data was collected on the prevalence and intensity of the five most common species of parasitic worms: *Schistosoma haematobium, Ascaris lumbricoides, Trichuris trichiura,* hookworm, and *Strongyloides stercolrais*. Prevalence refers to the percentage of students who are infected with the parasite, while intensity refers to mean concentration of eggs in the urine or feces of the children.

Table 2

Prevalence of infection in intervention area (%)	1994	1996	1997
S. haematobium	15.2	5.9	8.0
A. lumbricoides	5.7	3.9	6.5
T. trichiura	0.7	0.9	1.0
Hookworm	52.1	28.9	16.4
S. stercolrais	1.8	1.1	4.0
Prevalence of infection in comparison area (%)			
S. haematobium	8.5	7.6	11.7
A. lumbricoides	12.0	7.8	7.4
T. trichiura	1.4	0.7	2.0
Hookworm	37.3	44.5	50.1
S. stercolrais	1.8	0.7	0.4

In 1994, the prevalence of *S. haematobium* in the intervention area was 15.2 percent. After the first round of treatment, the prevalence fell significantly to 5.9 percent. Despite an increase to 8.0 percent in 1997, the overall prevalence of *S. haematobium* was still significantly reduced (see Table 2). Intensity levels of *S. haematobium*, as measured by concentration of eggs in urine, also significantly decreased from 32.2 eggs per 10 ml urine (epm) in 1994 to 14.3 epm in 1997 (see Table 3).

Similar results were seen in the prevalence of hookworm in the intervention area. Initial hookworm prevalence was 52.1 percent in 1994. The prevalence level was significantly reduced to 28.9 percent in 1996 and 16.4 percent in 1997 (see Table 2). Intensity levels, as measured by concentration of eggs in feces, significantly decreased from 141.1 eggs per gram (epg) in 1994 to 57.4 epg in 1996 and 38.4 epg in 1997 (see Table 3).

A. lumbricoides prevalence in the intervention area was reduced from 5.7 percent in 1994 to 3.9 percent in 1996, but a high reinfection level caused the prevalence level to increase to 6.5 percent in 1997 (see Table 2). A similar trend was observed in the intensity of *A. lumbricoides* as measured by concentration of eggs in feces. The initial intensity level of 85.9 epg in 1994 was reduced to 34.5 epg in 1996, but subsequently increased to 42.7 epg in 1997 (see Table 3).

Table 3

Intensity of infection in the intervention area	1994	1996	1997
S. haematobium (epm)	32.2	11.6	14.3
A. lumbricoides (epg)	85.9	34.5	42.7
T. trichuria (epg)	0.3	0.9	2.0
Hookworm (epg)	141.1	57.4	38.4
Intensity of infection in the comparison area			
S. haematobium (epm)	9.8	15.4	16.4
A. lumbricoides (epg)	94.6	70.7	83.2
T. trichuria (epg)	0.6	0.4	12.7
Hookworm (epg)	62.3	141.8	162.8

The prevalence and intensity levels of *T. trichiura* and *S. stercolrais* did not change during the intervention period, but this was most likely because the initial infection levels for these parasites were relatively low (see Tables 2 and 3). Therefore, a lack of treatment effect on these species was not a major concern.

In the comparison area, there was no overall change from 1994 to 1997 in the prevalence levels of *S. haematobium*, *T. trichiura*, or *S. stercolrais*. Hookworm prevalence significantly increased from 37.3 percent in 1994 to 50.1 percent in 1997. *A. lumbricoides* prevalence, on the other hand, significantly decreased from 12.0 percent in 1994 to 7.4 percent in 1997, but this decrease was not as great as that seen in the intervention area from 1994 to 1996 (see Table 2). Again, intensity levels followed the same pattern as prevalence levels, with hookworm increasing from 62.3 epg in 1994 to 162.8 epg in 1997 and *A. lumbricoides* decreasing from 94.6 epg in 1994 to 83.2 epg in 1997 (See Table 3).

Because the prevalence and intensity levels of these parasitic infections remained constant or increased in the comparison area, reductions in infection observed in the intervention area can be attributed to the drug administration and health education. These results indicate that the treatment was effective in reducing the prevalence and intensity levels of hookworm in the intervention area in both 1996 and 1997. The prevalence and intensity levels of schistosomiasis were also reduced in 1996 in the intervention area, but a further reduction in 1997 was not observed. This possibly resulted from the use of diagnostic rather than mass treatment of Praziquantel and high reinfection rates. Although the treatment seemed to have no effect on *A. lumbrocoides* or *T. trichuria*, this was most likely due to the relatively low initial prevalence and intensity levels of these infections in the intervention area.

Nutritional anthropometry and hemoglobin. Reductions in parasite loads are likely to be related to increases in growth and iron status. Such an effect was investigated by collecting data on weight, height, mid-upper arm circumference, tricep skinfold thickness, and hemoglobin status. Using this information, percentages of students who were stunted, underweight, wasted, or anemic were calculated.

Table 4			
Nutritional indicators in the intervention area (%)			
	1994	1996	1997
Stunted	50.0	42.0	41.2
Underweight	41.2	32.5	33.5
Wasted	4.7	4.5	4.7
Anemic	47.6	49.1	48.4
Nutritional indicators in the comparison area (%)			
Stunted	37.2	31.1	34.2
Underweight	31.0	25.2	26.2
Wasted	1.8	4.4	4.8
Anemic	26.7	54.8	49.8

Stunting, which is measured by height-for-age, is an indicator of chronic malnutrition. Underweight, which is measured by weight-for-age, reflects current malnutrition, but does not distinguish from past undernutrition. Both stunting and underweight measures can be somewhat suspect because they rely on the age of the child, which is not always accurately reported, so figures must be interpreted with care. Wasting, which is measured by weight-for-height, is an indicator of acute malnutrition. Anemia is measured by hemoglobin levels and is indicative of iron deficiency.

In 1994, 50 percent of the students in the intervention area were identified as stunted. This percentage was significantly reduced to 42 percent in 1996 and 41 percent in 1997. The percentage of students identified as underweight also significantly decreased from 41 percent in 1994 to 33 percent in 1996, with an insignificant increase to 34 percent in 1997. The percentage of students in the intervention area who were identified as wasted (5 percent) and anemic (48 percent) remained statistically constant throughout the three years (see Table 4).

In the comparison area, the percentage of students identified as stunted (37 percent), underweight (31 percent), or wasted (2 percent) remained constant throughout the study, while the percentage of students identified as anemic rose significantly from 27 percent in 1994 to 50 percent in 1997 (see Table 4).

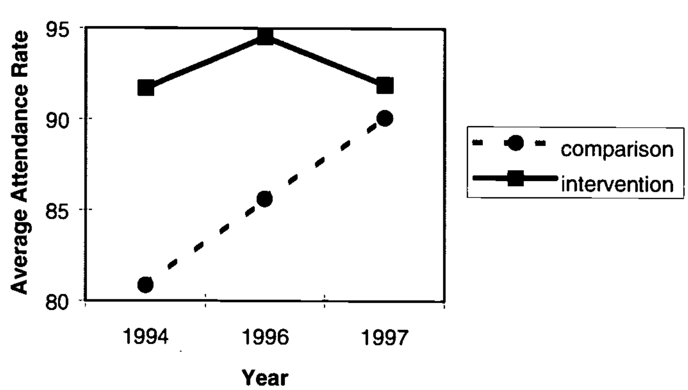
Educational Outcomes

One of the objectives of the GPCD was to assess the effect of a school-based health intervention on the education of the school going child. Educational outcomes were measured through attendance rates and academic assessment scores. The attendance rate for each child was calculated by dividing the number of days that the child attended school that year by the number of days in the school year and multiplying by 100. Attendance rates varied from 0 to 100 percent. The assessment score for each child was calculated by averaging the teachers' assessments scores for each subject from the continuous assessment registers. Assessment scores varied from 0 to 100. It should be noted that because these scores are somewhat subjective, interpretation across districts, and even schools, is difficult, but for lack of any national level standardized testing, the assessment scores are the best available measure of a student's academic achievement.

The following results are based on analysis performed by the GPCD team and additional analysis performed by the visiting consultants. Comparisons between the interventions and the comparison area are reported here, but should be interpreted with some caution. Although substantial efforts were made to identify an appropriate comparison area to account for confounding variables, during baseline data collection the intervention and comparison areas were found to differ significantly in many aspects. These included, but were not limited to, prevalence of parasite infection and attendance rates. Therefore, treatment effects can not be strictly identified on the basis of comparison but are accepted as the best measures available.

Attendance. Figure 2 illustrates the attendance rates for the comparison and intervention groups over the three years of the study. An analysis of variance (ANOVA) test with ATTEND as the dependent variable and TREATMENT and YEAR as the grouping variables indicated a significant interaction effect between TREATMENT and YEAR on SCORE (F=54.915, *p*=.000). This suggests that there is a different pattern across years for the treatment and comparison groups, which is evident in Figure 2. Post hoc tests of Tukey's Honestly Significant Difference (HSD) indicate that attendance rates in the intervention group increased significantly from 1994 to 1996 (91.70 vs. 94.51, *p*=.000), but decrease significantly from 1996 to 1997 (94.51 vs. 91.89, *p*=.000). Overall, there was no statistical change in attendance rates in the intervention group from 1994 to 1997 (91.70 vs. 91.89, *p*=.998). The comparison group, on the other hand, exhibited a steady increase with attendance rates at 80.85 percent, 85.61 percent, and 90.08 percent in 1994, 1996, and 1997 respectively (all increases significant at *p*=.000).

Figure 2. Attendance Rates by Year

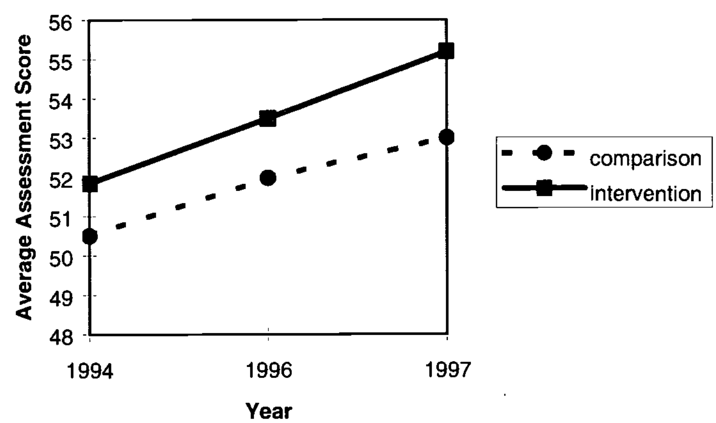


These results suggest that while the treatment initially had a positive effect on attendance, this effect was not maintained in the third year. However, because the initial attendance rates in the intervention area were relatively high and because attendance is affected by many different factors, it may not have been realistic to expect a significant increase in attendance rates. After all, many children miss school days because they are required to assist with important family tasks such as farming and fishing. These conditions are not likely to be improved by a health treatment intervention.

The increase in attendance in the comparison group may be explained by the initial low level, possibly a result of political conflict in the area during baseline data collection. Post hoc tests indicate that attendance in the intervention area was statistically higher than attendance in the comparison area in 1994 (91.70 vs. 80.85, *p*=.000). However, in 1997, there was no statistical difference in attendance between the two groups (91.89 vs. 90.08, *p*=.052). This may suggest that rates around 90 percent may be more representative of typical attendance figures, meaning that in the intervention area the rate was relatively standard across the research period but that in the comparison area initial low attendance rates returned to normal levels following the resolution of the political conflict. As was mentioned above, it may not be realistic to expect attendance to improve much beyond the 90 percent level.

Achievement. Figure 3 illustrates the assessment scores for the comparison and intervention groups over the three years of the study. An analysis of variance (ANOVA) test with SCORE as the dependent variable and TREATMENT and YEAR as the grouping variables indicated a significant effect on SCORE of YEAR (F=16.448, *p*=.000) and of TREATMENT (F=14.735, *p*=.000), but no interaction effect between TREATMENT and YEAR (F=.421, *p*=.656). This indicates that there is a modest difference in achievement between the intervention and comparison groups and that there is a difference in assessment scores across years, but that the patterns for the two groups are not different.

Figure 3. Assessment Scores by Year



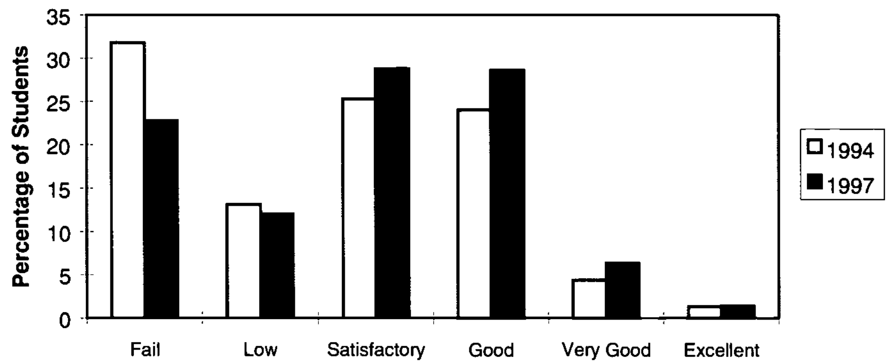
It can be seen that both the comparison and the intervention group increased in assessment scores from 1994 to 1997. However, post hoc tests of Tukey's HSD indicated that only the increases in the intervention area were statistically significant. In the intervention group, the increase from 1994 to 1996 was statistically significant (51.84 vs. 53.49, *p*=.014) as was the increase from 1996 to 1997 (53.49 vs. 55.19, *p*=.010). It follows that the increase from 1994 to 1997 was also statistically significant (51.84 vs. 55.19, *p*=.000). On the other hand, the assessment scores in the comparison group also increased, but the change from 1994 to 1996 was not statistically significant (50.51 vs. 51.98, *p*=.669), nor was the change from 1996 to 1997 (51.98 vs. 53.00, *p*=.894). The overall change from 1994 to 1997 in the comparison group also failed to reach statistical significance at the alpha=.05 level (50.51 vs. 53.00, *p*=.058).

These results indicate that the treatment was effective in increasing assessment scores in the intervention group compared to no statistical change in the comparison group. In addition, while the assessment scores of the comparison and intervention groups in 1994 were not statistically different (50.51 vs. 51.84, *p*=.468), in 1997 the assessment scores of the intervention group were statistically higher than those of the comparison group (55.19 vs. 53.00, *p*=.026). In other words, the treatment significantly increased the assessment scores of the intervention group, while there was no statistically significant change in the comparison group.

In addition to improving raw scores, the distribution of student classifications in the intervention group, according to GES classification, also improved. Figure 4 illustrates the distribution of student classifications for 1994 and 1997. Categories are as follows: Fail (<45 percent), Low (45-49 percent), Satisfactory (50-59 percent), Good (60-75 percent), Very Good (76-85 percent), and Excellent (>85 percent). The graph shows that the percentage of students in the lower categories decreased from 1994 to 1997 while the percentage of students in the higher categories increased.

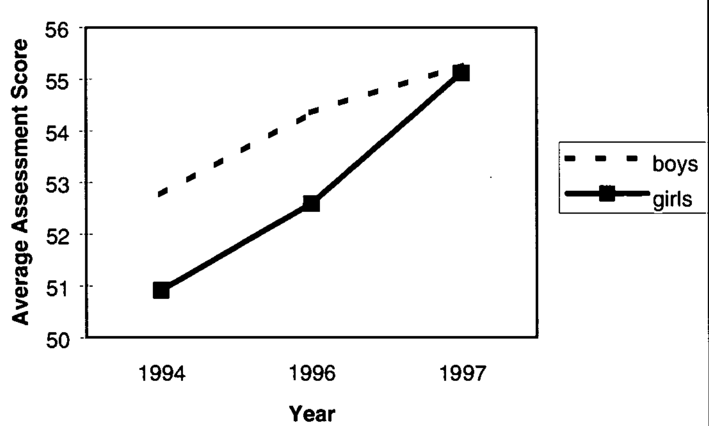
Those in the lowest category (Fail) decreased from 31.8 percent in 1994 to 22.8 percent in 1997, which indicates that the intervention may be effective in reducing dropout and repetition rates.

Figure 4. Percentage of Students by GES Classification



Gender Effects. It was shown in the previous section that the health treatment had a positive effect on assessment scores of the treated children. A further question may be if the effect of the treatment is the same for boys and girls. Figure 5 illustrates the mean values for boys and girls assessment throughout the study. Using only the data from the intervention area, ANOVA with SCORE as the dependent variable and YEAR and SEX as the grouping variables indicates that there is a significant effect of YEAR (F=22.69, *p*=.000) and of SEX (F=9.511, *p*=.002), but no interaction of YEAR and SEX (F=1.857, *p*=.156). This suggests that there are differences in assessment among boys and girls and that there are differences across years, but that the pattern of treatment effect is the same for boys and girls.

Figure 5. Assessment Scores by Gender

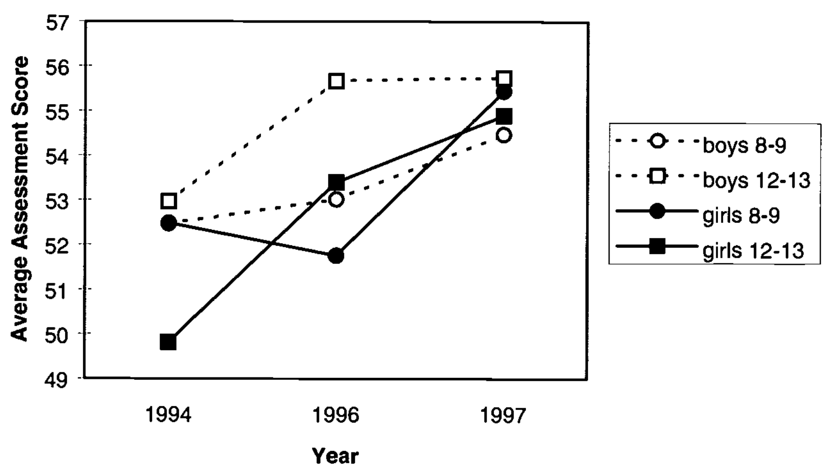


Post hoc tests of Tukey's HSD indicate that there are statistically significant increases from 1994 to 1997 for both boys (52.76 vs. 55.26, *p*=.005) and girls (50.91 vs. 55.12, *p*=.000), but the effect size for girls (.31) is almost twice the effect size for boys (.17). Therefore, although both boys and girls are improving significantly, it can be concluded that the treatment had a greater effect on the assessment scores of the girls. Figure 5 also illustrates that the treatment contributes to narrowing the gender gap in assessment.

By adding age (AGEGP) to the ANOVA model as an additional grouping variable, interaction between SEX and AGEPG (F=5.874, *p*=.015) and between YEAR and AGEGP (F=5.208, *p*=.006) are identified, but no interaction is found between SEX, YEAR, and AGEGP (F=.576, p=.562). This indicates that scores within an age group vary by gender and also vary by year, but there is no three-way interaction.

Figure 6 illustrates the mean values for each age group within each gender. Post hoc tests of Tukey's HSD indicate that of these four groups, only girls aged 12–13 improved significantly from 1994 to 1997 (49.82 vs. 54.90, p=.000, effect size=.37). While each of the other groups also exhibit improvement, the effect sizes of .13, .19, and .21 for boys aged 8–9, boys aged 12–13, and girls aged 8–9 respectively are too small to be of statistical significance.

Figure 6. Assessment Scores by Gender and Age



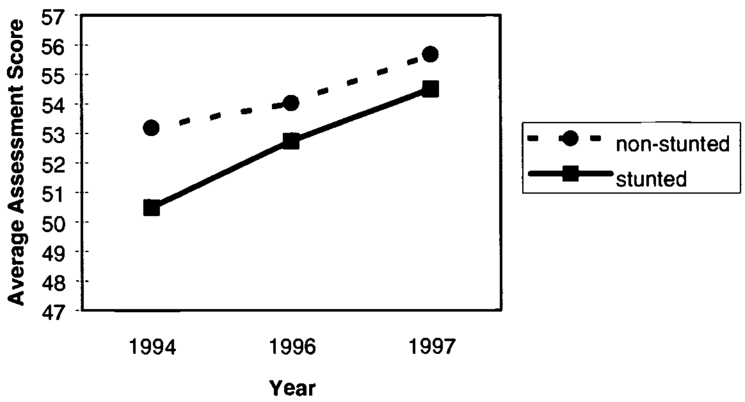
These results indicate that although the treatment was effective in improving assessment scores overall, the effects were especially pronounced for girls and even more so for girls aged 12–13. This finding is particularly meaningful because girls, especially older girls, are known to be vulnerable to dropout. If a health intervention program can reduce the dropout rates of adolescent girls then it may contribute to higher enrollment of girls in secondary school.

Interaction with Nutritional Status. It seems likely that a health intervention will have different effects for people of different nutritional status. At baseline, 50 percent of the students in the intervention area were classified as stunted, or suffering from chronic malnutrition. Although this percentage was reduced to 41.2 percent by 1997, this is still a large enough number of students to warrant a closer look at the educational effects of the intervention to this sub-population.

Using data from only the intervention area, an ANOVA with SCORE as the dependent variable and STUNTED and YEAR as the grouping variables indicated a main effect for both STUNTED (F=17.508, p=.000) and YEAR (F=21.056, p=.000), but no interaction effect between STUNTED and YEAR (F=1.477, p=.228). This suggests that while assessment scores did differ for stunted and non-stunted students, the pattern of effect of the intervention was not different for the two groups.

Figure 7 illustrates the mean assessment scores for stunted and non-stunted students throughout the intervention. Post hoc tests of Tukey's HSD indicate that assessment scores increased significantly from 1994 to 1997 for both the stunted (50.49 vs. 54.51, p=.000) and the non-stunted students (53.20 vs. 55.68, p=.003). However, the effect size for the stunted students (.28)

Figure 7. Assessment Scores by Stunted Status



is larger than the effect size for the non-stunted students (.18), indicating that the treatment program produced greater assessment gains for the stunted over the non-stunted students. In addition, although the assessment scores of the stunted students were significantly lower than those of the non-stunted students at baseline (50.49 vs. 53.2, *p*=.002), there was no statistical difference between the two groups in 1996 (52.75 vs. 54.02, *p*=.475) or 1997 (54.51 vs. 55.68, *p*=.577). This suggests that an effective health intervention program can to some degree mitigate the negative effects of some nutritional deficiencies.

Another nutritional indicator of interest is anemia. At baseline, 47.6 percent of the students in the intervention area were classified as anemic. This percentage was not significantly changed by the health intervention treatment. An ANOVA test with SCORE as the dependent variable and ANEMIC and YEAR as the grouping variables identified a significant interaction between ANEMIC and YEAR (F=3.356, *p*=.035). This indicates that the treatment had a differing effect, dependent on anemia status.

Figure 8. Assessment Scores by Anemia Status

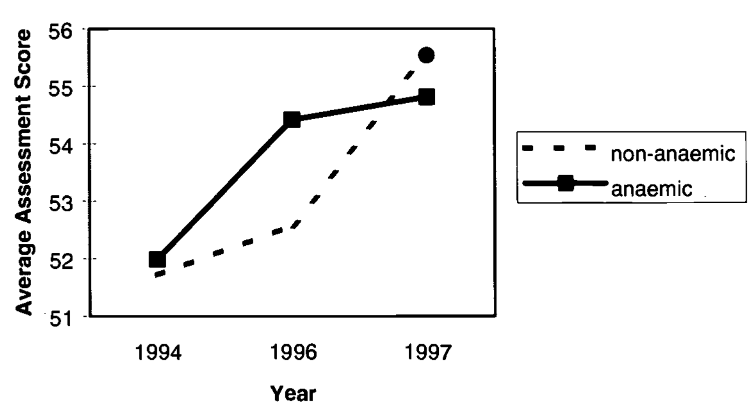


Figure 8 illustrates the mean assessment scores for anemic and non-anemic children throughout the study. Post hoc tests of Tukey's HSD indicate that assessment scores increased significantly from 1994 to 1997 for both the non-anemic (51.71 vs. 55.54, *p*=.000) and the anemic children (51.99 vs. 54.81, *p*=.001), but the effect size for the non-anemic (.27) was larger than that for the anemic children (.20). This suggests that the prevalence of anemia may mitigate the positive effects of the treatment in some cases. Likewise, if anemia is reduced in conjunction with anthelmintics, the observed effects are likely to be greater. Hopefully this will be seen with the introduction of the iron supplementation program.

These results indicate that there is a strong and positive effect of the deworming treatment and health education program on the achievement of the students in the intervention area. This effect is seen to be especially strong for nutritionally disadvantaged students and girls, especially adolescent girls. Although some questions remain about the reliability of teacher continuous assessment scores as an indicator of academic achievement, hopefully these questions can be laid to rest by testing samples of pupils in the comparison and intervention areas before and after the next drug administration, using the standard instruments developed and tested by the GPCD.

Persistence

One of the most powerful potential arguments for school health could be made if interventions were shown to improve the flow of pupils through the school system, by reducing repetition and increasing the retention of pupils so that a greater proportion of pupils entering the system completed basic education in a shorter time. In addition to the positive effects on individual pupils, their families, and society at large, it would be possible, with such information, to calculate the increased efficiency of the system "resulting" from the intervention. A calculation could then be made of the reduction in the cost per primary school graduate resulting from the health/nutrition intervention.

Unfortunately, the team was unable to obtain sufficient data to make such calculations. Analyses were further limited by lack of any district or circuit-level data for 1995/96 or 1996/97, except for Kpandu District. As a result, it was impossible to estimate a post-treatment effect for any district except Kpandu. Even there, it was possible only to estimate average dropout. Thus, these results are tentative. Hopefully, future versions of this report will have more data to make more credible conclusions.

In order to develop this rough estimate of dropout in an intervention area, enrollment for boys and girls in a particular year at a certain grade level in Kpandu District was divided by enrollment the following year for the next higher grade level, and 1 was subtracted from this figure to yield a percentage estimate of dropout. These figures were averaged across grades to develop an overall estimate of dropout before and after the intervention. Table 5 shows the results of these calculations.[13]

Table 8. Estimates of Dropout Before and After Intervention, by Sex, Kpandu District

	Before Treatment	After Treatment
Boys	4.0	2.3
Girls	7.4	4.0

These tentative results suggest substantially lower dropout after the intervention, 42 percent lower for boys and 46 percent lower for girls. In both cases, girls dropout is substantially higher than boys (1.8 times more before treatment, 1.7 times after). If these figures are to be believed, not only is dropout lower after the treatment, but the discrepancy between boys and girls' dropout is reduced, albeit not by very much.

[13] To estimate this figure more correctly would require subtraction of repeaters from each year's enrollment. Unfortunately, those figures were unavailable, thus further weakening the case.

Health Education

As with much of health education, the health education component of the intervention is more difficult to specify, and the effects are much more difficult to measure. As part of the chemotherapy, circuit supervisors and community health nurses received training in the administration of the drugs.

As part of its work in health education, GPCD conducted an analysis of existing school health materials. The researchers found that the existing materials were difficult for children to understand and relate to their experience. The concepts and presentation were too abstract for children to understand in any but the most "academic" way. As a result, pupils were able to "learn" the health material by rote, but were unable to apply it to their everyday lives. As a continuation of this research, GPCD is participating in a multicountry study of visual perceptions of school-age children in relation to the presentation of health messages. This research is expected to produce several concrete results, including guidelines for curriculum developers producing health education materials.

Health education, as envisioned by many of its proponents, suggests a very different than is common way of understanding the relationship among teachers, children, their peers, and "knowledge."[14] Based on a constructivist philosophy of learning, this approach to learning requires very great changes to teachers' "core practices" and beliefs. These are precisely the kinds of changes that are difficult to bring about on a large scale.[15] One of the truisms in health education is that it is easy to change knowledge, more difficult to change attitudes, and extremely difficult to change practices and behavior. The lesson might apply equally well to changes of the kind envisioned by the most creative health educators. While it is relatively easy to change teachers' knowledge and attitudes, changing their core behavior may be much more difficult. It is a much more difficult proposition indeed than asking them to administer a pill to each child once a year.

In part to address the issue of how to change teachers' teaching practice in health education, the GPCD is conducting a related study to examine the effects of more intensive health education activities on reinfection rates (as well as on attendance and achievement) as compared with a control group of children taught health education by conventional means. Teachers are being provided with teaching materials and comprehensive training in health education content and pedagogy. Children in both groups are being tested for helminths prior to introduction of the new health education approach, then treated for helminths, then tested again. While the enhanced curriculum is being implemented in the treatment group, a researcher is visiting schools to observe teaching of the curriculum. Based on the researcher's observations, teachers are being trained in areas of weakness. At the end of the year, children in both groups will be tested again for helminths. This study should result in a better understanding of the needs of effective health

[14] See, for example, *Health Promotion in Our Schools: Schools as Examples of Good Health, Children as Partners in Health Promotion.* The Child-to-Child Trust in association with UNICEF, TALC, United Kingdom (1997).

[15] See Richard Elmore, 1996. "Getting to Scale with Good Educational Practice," *Harvard Educational Review* (66:1), pp 1-26.

curriculum, grounded in actual teacher practice in typical rural schools in Ghana. In addition, the study should provide some indication of the health effects of health education curriculum. Hopefully, measures of achievement and attendance will illustrate the positive effects on educational outcomes as well. It would seem that the effects of health education, deworming, and iron supplementation (which began in October 1997) will be mutually reinforcing and synergistic, greater than the effects of the deworming alone.

Feasibility and Costs

In large part, the feasibility of mass school-based treatment of intestinal helminths and urinary schistosomiasis has been demonstrated by the treatment of nearly 85,000 children in 577 schools, and the dramatic decrease in hookworm and schistosomiasis prevalence. The intervention was explicitly designed to rely on the existing school system infrastructure for implementation, thus underscoring the effectiveness of the treatment.

Iron supplementation is more difficult because multiple dosages must be administered consistently and because of the side effect of constipation. However, given the high levels of anemia, the payoffs might well substantial, positively interactive perhaps with health education and deworming efforts, especially perhaps for adolescent and anemic girls.[16]

The GPCD conducted a cost analysis of the deworming portion of its program. Table 5 provides a breakdown of costs on 1996 as well as costs per child treated, divided into economic and financial costs. The financial cost refers to the actual costs of distributing the drugs, i.e., no labor costs. The economic cost includes the opportunity cost of unpaid labor days. Total economic costs came to $65,650 for both drugs—Praziquantel and Albendazole. On a per treated child basis, the costs came to $3.21 (full economic costs). The largest portion of expenditures went to rapid appraisal, drug administration, and Albendazole.

[16] We hope that attendance and assessment measures as well as PCD-developed achievement tests will be administered to treatment and control groups before and after treatment, so as to complete the picture the Partnership is developing of the educational effects of mass, school-based health and nutrition interventions.

Table 5. Breakdown of costs for drug intervention component of GPCD program, by financial and economic costs

	Financial Costs	Economic Costs
Albendazole	43 percent ($15,806)	24 percent ($15,806)
Praziquantel	23 percent (8,410)	13 percent (8,410)
Training	11 percent (4,075)	6 percent (4,075)
Drug administration	11 percent (4,056)	24 percent (15,997)
Rapid appraisal	8 percent (2,993)	30 percent (19,826)
Handling charges	4 percent (1,535)	2 percent (1,535)
Cost per child treated (US$)	$1.46 ($1.22 for Praziquantel +0.24 for Albendazole)	$3.21 ($2.94 for Praziquantel +0.27 for Albendazole)

Source: Ghana Partnership for Child Development Cost Analysis, 1996

IV. Next Steps toward School-Based Health and Nutrition

GPCD's treatment of 85,000 children in the Volta Region of Ghana demonstrates the feasibility and the process of mass, school-based treatment of helminths. As discussed above, these treatments appear to effectively reduce the rates and intensity of helminth infection. In addition, these treatments appear to improve the academic achievement of primary school children, especially girls, adolescent girls, and the chronically malnourished.

This section attempts to extend the discussion of the effects of school-based health and nutrition interventions, in two ways. First, it attempts to abstract "lessons" from this experience as well as factors in the GPCD intervention and context that seem to account for successful implementation. Second, it looks ahead to next steps, in terms of both research and intervention: What are the next steps in promoting school-based health and nutrition as educational interventions?

Lessons from the Partnership Intervention

- Most importantly, the research demonstrates the feasibility of using the existing school system as a means of delivering health interventions for improved health as well as education of children.

- Political commitment to school health facilitated the implementation of the research as well as receptivity to its findings. Indeed, Ghana's awareness of school health issues may have been an essential precondition for the Partnership research. Ghana's commitment to school health has resulted in the nation taking a number of steps to improve the education of its children by addressing their health and nutritional needs. The health needs of school children were rarely questioned by the various officials interviewed for this paper. The primary question was how.

- This commitment led to establishment of the SHEP network, which—when provided with technical and financial support—seems to provide an excellent organizational infrastructure for facilitating research interventions as well as promoting a variety of school-health initiatives. Though SHEP faces challenges, the existence of a mechanism and a network of officials, practitioners, and academics devoted to school health is likely a critical condition for success beyond the context of an isolated project.

- The primary effort in working across sectors is coordination; much more coordination is required than when working in a single sector. Coordination must be within organizations such as the Ministry of Health or the GES, between non-governmental organizations and government, at all levels of the system, horizontal and vertical, and among providers, field implementers, and recipients or clients. Coordination requires concrete mechanisms to ensure that it happens, and it needs funding. It seems safe to assert that if there are insufficient means to coordinate activities, collaboration will not succeed. As pointed out during the first set of interviews, education and health sector people do not even understand each other's vocabulary. If field implementers are committed to their work, coordination does seem easier in the field, where needed actions are visible and concrete, than at the center where the stakes are more abstract and political. If the intervention involves research, and the research is to serve both health and education sectors, it is important to involve both educators and health professionals at all important decision points.

- When training, technical support, materials, and transport are lacking, the effectiveness of SHEP coordination depends, it appears, on the personality, resourcefulness, and charisma of individuals. The system needs to find a reliable way to enable its SHEP coordinators to work.

- Even so, collaboration at local as well as central levels depends greatly—and unavoidably it seems—on personalities and individual commitment.

- Unexpectedly, perhaps, lack of coordination among donors may have played an important role in fostering innovative local solutions to school health problems. Organized, articulate non-governmental organizations, for example, are often able to develop proposals and secure funding from one of the many donors. The larger policy challenge is that there is no organizational mechanism to learn from these local innovations and to integrate them, gently and without quashing their enthusiasm, into a coherent and larger program. Unfortunately, the articulation and consensus required by coordinated programs does little to foster local innovations of the type observed.

- Unlike most school health initiatives, the GPCD research intervention has set out explicitly to learn, to measure its outcomes and inputs, and to document and share what is has learned. The intervention has sparked several subsidiary studies, generating a variety of research on topics discovered in the process of researching original questions.

- GPCD's effort was also unusual in its attempt to forge working relationships and engage officials across the entire basic education and health system affecting primary school children in the Volta Region. Early on the GPCD realized that a greater decentralization of its research activities was needed, an effort that continues.

- Broad ownership is critical, for school health is always under threat of inadvertent exile to a sectoral no-man's land, of marginalization to the exclusive province of true believers.

- At the same time, someone must bear the responsibility of funding, managing, and coordinating school health activities. School health needs a nurturing and supportive home, a home with political clout.

- During the initial phases of a project such as this, field implementers can often be mobilized through good will. In the long run, however, school health activities need to be incorporated into the work of field implementers, or incentives need to be provided.

- To become institutionalized within the larger education system, school health must be integrated into all parts of the school system—the teacher training, curriculum, supervision, reform, budgetary processes, and other program areas—early childhood development programs, community efforts, and so forth. Achieving this requires explicit strategies, a different level and kind of effort than that involved in a research and pilot project.

- GPCD's strategy may have been inadvertently wise: Start with a highly visible, vertical, concrete, and relatively easy intervention; develop coordinating mechanisms and acceptance by communities and government; then move on to more complex tasks such as multiple dose vitamins and health education.

- Once technical issues are addressed, organizational constraints become paramount. In the long run, organizational issues may prove more difficult than technical matters.

Next Steps

GPCD has shown the feasibility and relative low cost of mass treatment of school children. It has established organizational linkages that will pave the way for future interventions. It has developed a great deal of knowledge about how to implement large-scale, school-based health and nutrition interventions. The Partnership has attracted research ideas and has demonstrated the health and educational effects of its intervention. In the process, it has treated 85,000 children.

In order to move the agenda forward, we suggest five next steps:

- The effects of iron supplementation on attendance and achievement need to be assessed, particularly in interaction with anthelmintic and health education efforts, especially for girls.

- Reliable indicators of persistence and completion of primary school need to be developed and examined in relation to the health/nutrition interventions. In addition, it is important to understand the effects of the interventions on entrance to and success in secondary school, especially for girls. The current indicators measure attendance, but the effects of interventions on longer-term persistence and completion rates as well as the internal efficiency of school systems are important policy considerations.

- The findings reported here need to be validated using achievement assessment instruments of better known validity and reliability, such as the standard achievement assessment instruments developed by the Partnership.

- The health education component needs to be continued and broadened if the health-enhancing behaviors of children, teachers, and community members are to be changed and if the beneficiaries of interventions are to be empowered to improve their own health.

- The process of institutionalizing school health needs to be continued, both at national levels, i.e., incorporation of school health into the government's education budget and overall education reform strategy; and at local levels, i.e., through increasingly greater involvement of field implementers and "clients" at districts, communities, and schools in deciding about, planning, and implementing health and nutrition interventions in their schools and communities.

Appendix. List of People Interviewed

25 July 1997	Emelia Allan, Ghana Partnership for Child Development Edith Wellington, Ghana Partnership for Child Development Amerley Ollennu, Researcher, Ghana Partnership for Child Development
	Rev. Osei-Owusu, Director, Administration & Finance, GES
29 July 1997	Dr. Odoi-Agyarko, Director, MCH/FP
30 July 1997	Robert Haladay, Health Officer, USAID
	Joe Veree, Head of Education Division, UNICEF
	Dr. Hugh Hawes, Child to Child Dr. Richard Lansdown, Partnership for Child Development
31 July 1997	Dr. Frank K. Nyonator, Ho Regional Director, MOH Mr. Yempew, Regional Director of Education Services, Ho Kpikpi Irene, Regional School Health Coordinator, Ho
	Hope Fafaava Djentuh, District Director of Education, Kpandu Ms. Theresa Doboley, SHEP Coordinator, Kpando
1 August 1997	Dr. Wen, Parasitologist, MOH (GPCD) Mr. Tsywo, Headmaster, Kute L/A Primary School, Jasikan
	Dr. Kwaku, District Health Officer, Hohoe Mr. Dzitrie, District Education Officer, Hohoe Mr. N.G. Obro, SHEP Coordinator, Hohoe Mr. Ahadzi, Deputy Director, Education, Hohoe Mr. Doh, Training Officer, Health, Hohoe Ms. Dorothy Owusu, Headmistress, Holy Rosary RC Primary/JSS
	Dr. Amexo, District Director of Health, Kpando Ms. Comfort Agbadja, School Health Coordinator, MOH, Volta Region
5 August 1997	Paul Ackom, Coordinator Childscope, University at Winneba Mary Afua Ackummey, Coordinator, Action Research, University at Winneba
7 August 1997	Mrs. Adofo, National Coordinator, SHEP

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