Evidence from the most comprehensive studies into school-age children’s nutritional status indicates that this age group suffers from levels of stunting and underweight, and in some regions, wasting, that are comparable with pre-school children. While these studies cannot claim to be representative of all school-age children in the study country or region, they do consistently show very high prevalence rates for stunting and underweight among African, Asian and South American school-age children. The high levels of stunting may be attributed to delayed puberty and catch-up growth in older children although in the majority of studies, the pattern observed was one of sustained linear growth retardation throughout the primary school years. The full physiological implications of these findings although unclear may offer a window of opportunity to improve the growth of school age children. What is clear is that stunted children enroll late into school and are probably less likely to complete their schooling. Boys in school also appear to be more stunted than girls.

High levels of iron deficiency and anaemia are reported in most studies and in some countries the levels of anaemia among adolescent girls and boys are almost universal. This has direct implications for their growth, cognitive development and, in adolescent girls at risk of early pregnancy, an increased
risk of dying. Iodine deficiency continues to represent a significant problem alongside efforts to iodised salt, distribute supplements and to generate increased awareness of the problem. Studies continue to show the deleterious effect of this deficiency on intellectual ability. There is limited information on the extent or distribution of vitamin A deficiency although recent surveys indicate that this is a problem of public health significance in the school-age child. This results in reduced immunity, increases the risk of disease and may lead to increased absenteeism. Deficiency of vitamin A in this group is also likely to reduce the effectiveness of interventions to reduce anaemia.

Overweight and obesity is emerging as a new problem in school-age children in countries undergoing the ‘nutrition transition’. The increasing evidence of an association between stunting and obesity suggests that obesity could represent a major problem for developing countries in the future.

Studies undertaken of the health and nutrition status of children who do not enroll for school reveal that they more likely to be sick and have higher levels of malnutrition (stunting is particularly high) than those who attend school. It is noted that this group is subject to multiple disadvantage which needs to be addressed through their active inclusion in existing school health programmes or other targeted initiatives.

Approximately 11% of the global burden of disease is suffered by children of school age. ARIs are the most common cause of ill health in this age group although there is an
apparent shortage of literature on potential school based control or treatment measures. Malaria, diarrhoea and helminth infections, the focus for school health programmes, represent the other major causes of ill health. There is growing evidence of the risk that HIV/AIDS represents to the sexually active school-age population.

There are effective school-based programmes that directly address some of the main health and nutrition problems facing the school-age child. New evidence is emerging of the potential to increase the effectiveness of iron supplementation programmes though the provision of weekly or even intermittent dosing of schoolchildren. The positive effect of weekly dosing on the iron status and growth of adolescents has been strongly demonstrated in East Africa and there are examples of similar effects from South America. The challenge, however, is to ensure the levels of compliance needed for such an effect at the programme level. The use of multiple micronutrient supplementations has been shown to have a beneficial effect on iron, iodine and vitamin A deficiency in schoolchildren, at a cost of US$0.7 per child per year. There is also evidence from South Africa of a significant reduction in iodine deficiency among school-age children following the recent introduction of iodised salt.

The impact of school feeding, particularly the provision of breakfast has been shown to result in increased attendance and cognitive function among already undernourished schoolchildren thus conferring the most benefit to those most in need.
De-worming programmes have been shown to result in improved growth and reduced levels of anaemia, particularly in children suffering from moderate to severe forms, thus benefiting those at highest risk. The cost-effectiveness of these programmes has been amply demonstrated in East and West Africa and suggests that programmes can deliver treatments for intestinal worms for around US$0.03 per child per year. There has also been important new work into the treatment of schoolchildren who would not normally benefit from mass de-worming to identify mechanisms through which children infected with schistosomiasis can also benefit from treatment.

The value of sanitation, hygiene and water programmes in schools is justified because of the potential high risk of disease transmission if facilities are either non-existent, in a poor state of repair or incorrectly used. In addition, studies show that school aged children can provide effective links with their peers (child to child) and the wider community in communicating important hygiene messages as well as promoting improved sanitation. Encouraging safer behaviour through participatory hygiene promotion has been shown to be more effective than traditional didactic measures. The new UNICEF school sanitation and hygiene programme has attracted funding from bilateral donors and will be more firmly located within the education department, promoting a more integrated approach in the school curriculum while linking with parallel efforts in the community.

School-based health programmes have previously been characterised as being heavily focussed on disease prevention,
uncoordinated, lacking integration and poorly evaluated and disseminated. This situation appears to be rapidly improving as new policies, programmes and partnerships are being formulated. Overall, there appears to be significant advancement in the effort to intensify joint international action for school health and nutrition. International agencies are promoting a package of school-based interventions that have evolved from examples of best practice and, if implemented will go a long way towards addressing the poor health and nutrition status of the school-age child.

**1.1 Nutrition and Health Status and the Development of School-Age Children**

An understanding and awareness of the heavy burden of malnutrition and disease among school-age children is growing although until recently there have been relatively few large-scale surveys that document levels of morbidity in any detail. While a better picture of the health and nutrition status of this age group is being built, the true extent of the burden of ill health and malnutrition is not known (Partnership for Child Development, 1998a).

Children of school age face health and nutrition problems that may affect their individual physical development, their capacity to attend school and their ability to learn. The aetiology of impaired cognitive development is now a central area for concern while improvements in cognitive performance produce opportunities for evaluating the impact of school health and nutrition programmes.
Evidence from many of the recent studies reviewed indicates that school-age children continue to experience multiple conditions concurrently. For example, they are commonly infected with more than one helminth infection while also suffering from anaemia and reduced linear growth, which indicates poor nutrition.

The situation of school-age children who do not attend school is reviewed separately. There is growing concern that non-school attenders may suffer disproportionately from ill health and malnutrition and that these insults may continue through their primary school years. In other words, non-attendance at school is both a symptom and a cause of multiple deprivation.

The main nutritional problems facing the school-age child include stunting, underweight, anaemia and iodine deficiency and, on the basis of information from recent surveys, vitamin A deficiency may also be an important problem in this age group. In countries experiencing the ‘nutrition transition’, overweight and obesity are growing problems in the school-age child.

The main health problems facing school-age children are helminth infections, malaria, diarrhoeal diseases, respiratory infections and tuberculosis. Much of the disease burden derives from the poor environmental conditions in which they live including exposure to biological, chemical and physical hazards in the environment and a lack of resources essential for human health.
1.2 Malnutrition

1.2.1 Stunting, Underweight and Wasting

Stunting (low height-for-age) and underweight (low weight-for-age) are widespread problems in developing countries and can reflect a broad range of insults such as prenatal under-nutrition, deficiencies of macronutrients and micronutrients, infection and, possibly, inadequate attention by caregivers. The cause of stunting is widely believed to occur mainly in early childhood (mostly by 3 years of age) through a cumulative process (Frongillo, 1999). An area of debate is whether stunted children can ‘catch-up’ growth in later years if their health and diet improve, and if so, whether school-based interventions can contribute to ‘catch-up’ growth in this age group.

Stunting is known to be important in young children because it can have long-term consequences for entry into school, learning, educational performance and productivity. It is also associated in females with negative outcomes for future pregnancies. In spite of this, there has been relatively little information gathered on the nutritional status of the school-age child and this is reflected in the lack of clear guidelines for assessing their growth and the functional significance of various threshold points for assessing their nutritional status. Variation in the rate of maturation and growth make the interpretation of adolescent growth patterns particularly difficult. The WHO Expert Committee on Anthropometry recommends that physical measurement of adolescents should
be accompanied by puberty status assessment to properly interpret growth in this age group. Identifying the timing of puberty in different populations, however, is often difficult (Shahabuddin et al., 2000). Overall, boys tend to experience the adolescent growth spurt later than girls and are likely to have a greater growth potential than girls (Lwambo et al., 2000).

The increased degree and prevalence of stunting with age could be explained by the delayed onset of puberty in both boys and girls. It also appears, however, that although children show evidence of growth into late adolescence, that full ‘catch-up’ growth is not occurring but that linear growth retardation persists throughout the primary school years. These findings are contrary to the formerly widely held view that stunting is a process that usually happens in early childhood.

The evidence also suggests that boys are more likely to be stunted and underweight than girls. In some countries, boys were also significantly more likely to be wasted or thin than girls. The reason for the apparent higher levels of stunting in boys is unclear and may be influenced by a bias in the school population. It is also suggested that it could reflect delayed onset of puberty, itself caused by under-nutrition and the failure to reach their growth potential through slow compensatory linear growth.

Important questions are raised from these studies that reflect a pressing need for more information on the patterns and determinants of growth in this age group. First it is important to identify whether the height deficits accrued
during the primary school years are made up through longer pubertal growth and at what stage boys and girls stop growing in height. Second, the functional implication of linear growth retardation in school-age children needs to be more clearly understood and third, to what extent is school age stunting preventable through school-based interventions? (Stoltzfus et al., 1997a).

The evidence from these studies is that linear growth continues beyond the ‘normal’ pubertal growth period which suggests that school-based programmes aimed at improving health and nutrition status may have the potential to bring about catch-up growth in stunted school-age children.

Boys in most countries tended to be significantly more stunted than girls and in all countries boys were more underweight than girls. A higher drop out rate of girls than boys may explain this although in two of the countries, the sex ratios in classes were equal. An alternative explanation is that the adolescent growth spurt is either delayed in boys or is not occurring at all. A distinct growth-spurt was not identified in either girls or boys although linear growth did persist into the late teens, beyond the years usually associated with growth in puberty (Partnership for Child Development, 1998b).

1.2.2 Micronutrient deficiencies

Deficiencies of iron, iodine and vitamin A are a major problem in developing countries. Micronutrient deficiencies can negatively effect the mental development and learning ability of schoolchildren and increase their susceptibility to infection.
1.2.2.1 Iron deficiency and anaemia

Iron deficiency (ID) is the most common nutritional disorder in the world and is estimated to affect more than 2 billion people of whom 1.2 billion suffer from iron deficiency anaemia (IDA) (Gillespie, 1998) It is estimated that 210 million school-age children suffer from IDA (Del Rosso and Marek, 1996). The main focus of IDA reduction programmes has been on young children and women of reproductive age because of the increased risk of postpartum and perinatal mortality, intrauterine growth retardation and low birth-weight. Insufficient intake of iron rich foods is the major cause of ID. It can also be caused by parasitic infections (particularly hookworm and malaria) and deficiencies of other nutrients (Draper, 1997). There is substantial evidence that IDA in children is associated with decreased physical and mental development and impaired immune function.

There are a number of new studies that emphasise the high prevalence of iron deficiency and anaemia in school-age children. These provide further justification for the current focus on providing iron supplements to schoolchildren in areas of high prevalence.

The general picture relating to anaemia is complicated mainly because different thresholds apply to the four different age and sex classes contained within the school-age population. Younger children appear to have lower haemoglobin concentrations than older children while older children have a higher prevalence of anaemia. Differences between the sexes do not appear to be significant.
Estimates from the WHO global database are that 53% of school-aged children in developing countries are suffering from IDA. The highest prevalence is reported to be in Asia (58.4%) followed by Africa (49.8%) (ACC/SCN, 1998).

1.2.2.2 Iodine deficiency

School-age children are often used to assess IDD because of their physiological vulnerability and their accessibility through schools. The measurement of goitre in school-age children is important because it can be used to reflect the current status of IDD in the general population.

Observational studies carried out over the past 30 years (reviewed by the Partnership for Child Development, 1996), have found that school-age children living in iodine-deficient areas have lower IQ and poorer cognitive and motor function than school-age children living in iodine-sufficient areas. In a recent study of school-age children suffering from mild and moderate iodine deficiency in Bangladesh, it was found that hypothyroid children performed worse than euthyroid children for reading and spelling (Huda et al., 1999).

Recent studies of IDD prevalence in school-age children have found very high levels of goitre and iodine deficiency highlighting the severity of IDD in this age group and the pressing need for more effective salt iodisation programmes.

The criteria used to define IDD as a public health problem are outlined below.

Total goitre rate of 5-19.9% Mild iodine deficiency
Iodine deficiency affects an estimated 1.6 billion people worldwide and an estimated 60 million school-age children. The consequences of iodine deficiency, collectively referred to as iodine deficiency disorders (IDD), include severe mental retardation, goitre, abortion, stillbirths and low birth weight and mild forms of motor and cognitive deficits. Adolescent girls are an important target group for IDD control because of the adverse consequences on foetal development of iodine deficiency during pregnancy and because they generally have a higher prevalence of goitre than boys.

1.2.2.3 Vitamin A

Vitamin A deficiency is widely recognised as an important cause of blindness in children. Mild or sub-clinical vitamin A deficiency causes impaired immune function and, an increased risk of mortality from infectious diseases that can have an effect on school attendance and consequently academic performance. It is estimated that 85 million school-age children are at increased risk of acute respiratory and other infections because they are deficient in vitamin A (Del Rosso, 1999).

Vitamin A deficiency also affects iron metabolism so that with any iron supplements taken, subsequent improvement in iron status may be limited when vitamin A status is low. This is
being increasingly recognised as a potential constraint when considering the impact of school-based iron supplementation.

School-age children, have not been considered an “at-risk” group for vitamin A deficiency in the past and subsequently, little is known about the occurrence or effects of this deficiency in this age group. The small number of recent studies undertaken, do however, suggest that vitamin A deficiency is a public health problem in school-age children although the magnitude of this problem is unclear.

1.2.3 Short-term hunger

In addition to the problems associated with malnutrition in school-age children, there is also evidence of negative consequences for children suffering from short-term hunger, common in children who are not fed before going to school. Children who are hungry are more likely to have difficulty concentrating and performing complex tasks, even if otherwise well nourished (Del Rosso and Marek, 1996).

1.2.4 Overweight and Obesity

Overweight and obesity is becoming increasingly prevalent in developing countries where improvements in socio-economic conditions and rapid urbanisation are causing a ‘nutrition transition’. This is characterised by a rapid shift in the composition of diet (higher fat and lower carbohydrate), (reduced) activity patterns and a subsequent shift in body composition. In emerging economies, levels of childhood overweight and obesity are reported to be rising to levels
reported in the United States. Stunting is also believed to be a risk factor for obesity and it is suggested that this relationship may lead to considerable problems with obesity in children in developing countries over the coming decades (Popkin et al. 1996; Sawaya et al., 1998).

1.2.5 Health Problems

Health status is now accepted as a proxy indicator for poverty. The poor, particularly children in developing countries, carry the greatest burden of morbidity and mortality. Much of this burden results from hazards within their homes or their immediate environment (Cairncross et al., 1996). High levels of malnutrition, and its known synergistic relationship exacerbate their vulnerability to disease particularly diarrhoeal disease, ARIs and malaria. For the urban poor in developing countries, there is a double jeopardy as they find themselves exposed to both "traditional" diseases of poor sanitation and overcrowding and the "modern" diseases of chronic heart and lung disease. School-age children living in poor urban areas are also at a high risk of injury from road traffic accidents.

The estimated burden of disease disaggregated to focus on the age group 0 – 14 years is illustrated in table 6 below. The table presents the disability adjusted life year (DALYs) which allows for an assessment of the relative burden of disease between regions and also between age groups (an ageing population being an indicator of a successful public health policy). According to these estimates, school-age
children share 11% of the disease burden, the majority of which are preventable (WHO, 1996).

1.3 Helminth infections

Intestinal parasitic helminth infections are a major public health problem throughout the world. Prevalence is estimated at 1 billion for ascariasis, 900 million for trichuriasis, 500 million for hookworm and 200 million for schistosomiasis.

Global prevalence of infection (and number of cases) in school-age children are estimated at:

Roundworm 35% (320 million)
Whipworm 25% (233 million)
Hookworm 26% (239 million)

(Partnership for Child Development 1997)

School-age children are the most heavily infected group both in terms of prevalence and intensity of infection. Helminth infections are estimated to account for over 12% of the total disease burden in girls aged 5 to 14 years and over 11% of the burden in boys making this the single largest contributor to the disease burden of this group. Helminth infections have been shown to cause IDA (particularly hookworm), reduce growth and may negatively affect cognition (Stoltzfus et al., 1997b).

1.4 Malaria

Globally the malaria situation is serious and worsening with mortality ranging between 1.5-2.7 million and morbidity 300-500 million annually. 90% of the burden is in Africa (south of the Sahara) where it is estimated that it will kill 1 in 20 children under five years of age. 90% of the global burden of
disease for malaria is attributable to environmental factors. Malaria affects 40% of the world’s population and is most common and severe in pre-school children and pregnant women in Africa. In school-age children, malaria is estimated to account for between 10-20% of mortality and is an important cause of morbidity. Schoolchildren who have not acquired exposure-driven immunity may be at particularly high risk of severe and fatal consequences when exposed to the disease in unstable transmission areas. Pregnant schoolgirls are also a particular high-risk group.

Malaria is also an important cause of absenteeism from school and accounts for between 13-50% of all school days missed because of preventable medical causes. There is also evidence that brain insult, as a consequence of cerebral malaria in early childhood, may have an effect on a child’s cognitive and learning ability. Like diarrhoea, the priority age group is younger than school age children (Brooker, et al, 2000).

1.5 HIV/AIDS

Although human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) and other sexually transmitted diseases (STDs) constitute a relatively modest portion of the burden of disease in school-age children, there is growing evidence that HIV/AIDS constitute a severe threat to the future health and well-being of sexually active school-age children. Population studies in Tanzania have shown that HIV prevalence among adolescents and young adults (15 –
24 years) range from 1% in rural areas to 21% in certain urban areas (Klepp et al., 1997).

1.6 Diarrhoeal diseases

WHO estimates that 3.3 million children die from intestinal infections such as cholera, typhoid or infectious hepatitis every year. The total number of diarrhoeal episodes may be as high as 4000 million (WHO 1996). Most of the diarrhoeal disease burden occurs in children in developing countries with under fives at greatest risk (Murray and Lopez 1996). Approximately 90% of the diarrhoeal disease burden is related to environmental factors of poor sanitation and lack of access to clean water and safe food. Where appropriate sanitation facilities and adequate supplies of water for hand-washing and safe water for drinking are either non-existent or inadequate, the school environment can become an added source of disease transmission (Hubley, 1998).

1.7 Health and nutrition of non-school attenders

There is a growing awareness and concern for the health and nutrition situation of non-attending school-age children which has prompted an increase in the level of research and programming to identify and address problems in this age group. The evidence from recent studies highlights the importance of early childhood development programmes that prevent stunting in the early years, and the importance of school-based programmes that extend health and nutrition services to out-of-school children (Brooker, 1999a).
A failure to extend health and nutrition services to non-attending school-age children is likely to exacerbate existing inequalities in society.

School enrolment rates vary enormously between regions, within regions and within countries although information on the numbers of non-enrolled children or on those who do not complete their basic education is incomplete. Delayed enrolment can lead to fewer years in school, poor educational achievement and ultimately poor employment prospects. It is estimated that out of a total 625 million children of primary school age, 79% are in school (Whiman et al. 2000).

Girls’ participation in school remains low in many countries, often lagging well behind that of boys. The gender gap for primary school education is particularly high in countries such as Nepal, Pakistan, Benin, Chad and the Yemen (World Bank, 2000). The factors that limit girls’ access to education are varied and include household socio-economic constraints, the demands placed on older girls to nurse sick family members, the onset of menses, teenage pregnancy, early marriage and child labour (Fentiman, 1998).

The approach developed to reach the non-enrolled children has shown encouraging results. Over 90% of target non-attending children presented for treatment at the local primary school and the highest proportion of these were female (Talaat et al. 1999).
1.8 Cognition and Educational Achievement

There have been numerous studies into the factors that may limit a school child’s cognitive development (memory, problem solving, numerical and language skills) and their ability to participate fully in school education. In developing countries, these studies have focussed on the effects of stunting, wasting, micronutrient deficiencies, short-term hunger and more recently, helminth infections.

The studies into the effect of under-nutrition on cognitive ability although not entirely conclusive do indicate that chronic under-nutrition is associated with lower achievement levels in school children. Stunting in the first two years of life has been found to be strongly associated with lower test scores in school age children (age 8-11). This is related to later enrolment, increased absenteeism and repetition of school years. Severe stunting at age 2 has also been found to be significantly associated with later deficits in cognitive ability (Mendez & Adair, 1999).

The relationship between short stature and late enrolment has been demonstrated for primary school children in Ghana and Tanzania, with short stature (height for age z score) being strongly associated with late enrolment (Partnership for Child Development, 1999b). IDA has been more conclusively shown to effect cognitive function particularly in children with moderate to severe anaemia (Drake et al. 2000).
Establishing the linkages between helminth infection and cognitive development in school-age children is complex. Several studies have shown that moderate to heavy parasitic helminth infections of children are associated with lower scores on tests of cognitive function and of educational achievement than children who are uninfected or lightly infected. The specific effects on mental function are not clear and may not only depend on the duration and intensity of infection but on the type of helminth infection (Nokes et al. 1999).

1.9 School-based nutrition and health programmes and evidence of impact

School health and nutrition programmes are the essential sequel and compliment to early child development programs. Good health and nutrition at school age is essential for good education. Freedom from disease promotes intellectual as well as physical development. It enhances school attendance and the ability to learn while at school.

The mass delivery of anthelmintics (deworming medication) and the delivery of micronutrients, particularly iron and iodine are among the most cost-effective, simple and safe school-based programmes that can be delivered by trained teachers. These interventions are only a short-term measure, however, if un-accompanied with appropriate health and nutrition information, education and communication (IEC) (Meresmen, 1999).

1.9.1 Micronutrient supplementation
1.9.1.1 Iron

There have been increased efforts to develop improved interventions for the control of iron deficiency and anaemia involving food fortification, oral supplementation and dietary education as a combined strategy.

Adolescent girls are an important target group in iron supplementation programmes in developing countries. This is because their iron requirements are relatively high, they tend to have early pregnancies and supplementation can protect them from iron deficiency during pregnancy that could also benefit foetal development.

Where iron deficiency is a public health problem in school-age children, iron supplementation is recommended even where the costs of purchasing the tablets have to be met by individual family’s (UNICEF/UNU/WHO/MI Technical Workshop, 1998).

Supplementation programmes targeted at pregnant women, however, have been fraught with problems in many developing countries because of weaknesses within health service delivery and because of low compliance with daily tablet intake.

In recent years, a number of studies have suggested that weekly iron supplementation is as effective as daily supplementation in raising haemoglobin levels (Beasley et al., 2000a). Many of these studies have found significant benefits in subjects receiving weekly supplements and there is now a growing momentum for a change in policy from daily to weekly
dosing (Beasley et al., 2000a). However, there is a still a need to further assess the effectiveness of weekly supplements under programme conditions to ensure that compliance is achieved.

There is conflicting evidence concerning the beneficial effect of iron supplementation on growth in children. Some studies have shown that daily supplementation improves growth and appetite, while others have not found any beneficial growth response.

1.9.1.2 Iodine

Universal iodisation of salt is seen as the permanent and sustainable solution to the global IDD problem. Iodisation of salt is the preferred approach for supplementation in iodine deficient populations as its source can be controlled and the technology required is relatively simple. In many countries, it is now mandatory for manufactured salt to be iodised although this does not guarantee the elimination or reduction of IDD. In many countries a persistence of goitre in schoolchildren is being observed despite and apparent successful implementation of near universal iodised salt consumption.

In areas where iodised salt is not available and where the prompt correction of IDD is urgent, iodised oil can be administered to schoolchildren relatively cheaply and simply and can maintain iodine levels for a period of twelve months.
1.10 School feeding programmes

School feeding programmes (SFPs) can address some of the nutrition and health problems of school age children. Many positive outcomes have been reported including, alleviating short-term hunger, and motivating parents to enrol their children in school and have them attend regularly, addressing specific micronutrient deficiencies, improving cognition and increasing community involvement in schools (Del Rosso. J.M., 1999)

In India, school children participating in a SFP were also provided with treatment for geohelminths. This resulted in a reduction in helminth infection from 71% to 40% with minimal additional costs since the SFP infrastructure was used for implementation (Del Rosso. J.M., 1999)

1.10.1 Cost of SFPs

SFPs have been widely criticised for being too expensive although there have been very few studies into there cost-effectiveness. The comparison of costs of SFPs is problematic because the number of feeding days varies as does the quantity and quality of the ration provided.

1.11 Control of helminth infections (deworming)

Although improved sanitation and hygiene provide the long term solution to controlling helminth infection, the growing evidence of the negative impact of helminth infections
combined with the recent development of inexpensive drugs has led to an increase in mass control programmes through schools.

The expected beneficial effects of deworming include improved growth, appetite, fitness, cognitive performance and iron stores. Recent information also suggests that deworming can contribute to the reduction of vitamin A deficiency. The precise mechanisms, by which these improvements occur, however, are unclear (Stettler et al. 1998).

1.11.1 Impact on child growth

Recent studies into the effect of deworming on growth have, as with previous studies, reported varied impact. The intensity of infection, the regularity and duration of treatment and nutritional status have all been identified as important factors that influence programme impact. Overall the growth and nutritional deficits caused by these infections have been shown to be reversible through appropriate treatment.

1.11.2 Impact on anaemia

Helminth infections are prevalent in areas where iron deficiency is widespread. The relationship between hookworm infection and anaemia has been well established in the past and more recent studies show that even light hookworm infections can lead to anaemia in school children when nutritional status is poor. Helminth infection influences iron status through loss of blood, loss of appetite resulting in a reduction in food intake and by interfering with metabolism.
In areas where hookworm infections are endemic (prevalence >20-30%) and where anaemia is prevalent, WHO recommend hookworm control strategies to improve the health and nutritional status of girls and women.

There has been uncertainty about the effect of *Schistosoma haematobium* on anaemia. Studies have shown that infection with *S. haematobium* can cause blood loss although it has not been clear whether, at a population level, this causes reduced haemoglobin concentrations. Multiple infections (polyparasitism) in school-age children make the study into this relationship particularly difficult.

### 1.11.3 Cost effectiveness

Targeting anthelmintic drugs at children of school age has been advocated as one of the most effective approaches to controlling helminth infection. The cost-effectiveness of programmes are said to be maximised when drugs for treating geohelminths and schistosomiasis are combined and co-administration is now recommended by WHO (Partnership for Child Development, 1996).

Helminth infections are not necessarily evenly distributed, however, and a recent analysis of prevalence surveys in Africa has found that the distribution of schistosome infection is largely independent of the distribution of geohelminths. This highlights the need for a cautious approach to combined control in areas where one infection is much lower in prevalence than another (Brooker, 1999b).
There is growing concern as to how schoolchildren who harbour schistosomiasis in low prevalence schools and therefore do not warrant treatment through a mass campaign can be reached. Studies into the use of questionnaires administered by teachers have shown that they can usefully predict high prevalence schools that warrant mass treatment but have not been shown to be sensitive when administered in low prevalence schools. Questionnaires that ask the child to recall the presence of blood in urine are less sensitive in girls and have been found to under-report the presence of blood in urine to the extent that only one quarter of infected girls would be treated using this approach (Guyatt et al., 1999). The use of reagent strips as an alternative has been shown to be more costly and is also less sensitive in diagnosing infection in older girls (Hall & Fentiman, 1999). This is an area identified as needing further work and evaluation of different methods.

While there is a vast amount of information on helminth infection levels in school-aged children (collecting school-based information is less costly and compliance is high), there is relatively little community-based data on prevalence. Recent analysis has been undertaken to establish if the prevalence rates in school-aged children can be used as a cost-effective method to estimate prevalence in the community. This analysis suggests that prevalence of infection in school-age children could provide a cost-effective predictive tool to identify target areas for control although the prevalence ratio will vary with the level of infection (Guyatt et al. 1999).
1.12 School Sanitation and Hygiene

In many schools facilities are either poor or absent and the aim of any school sanitation, hygiene and water programme combine hardware and software.

The former revolves around the construction of facilities and their subsequent maintenance and use while the latter focuses on necessary and appropriate learning experiences to encourage safe practice at school, home and throughout later life.

The latter is now referred to as hygiene promotion to distinguish between the former use of didactic teaching of health education and the new approach of participatory growth centred learning. Hygiene promotion is now seen as an intrinsic element of any water and sanitation initiative and, in the context of school health, is now a central focus for the UNICEF school sanitation and hygiene programme (UNICEF/IRC, 1998).

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