Evaluation of the Efficacy of Chemotherapy Based Control of Soil-transmitted Helminth Infections and Schistosomiasis among School-age Children in sub-Saharan Africa

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ABSTRACT

Introduction: School-age children apart from being high risk group for soil-transmitted helminth (STH) infections and schistosomiasis, also play an important epidemiological role in the transmission of these infections. The objective of this review was to assess the efficacy of chemotherapy based control of STH infections and schistosomiasis among school-age children in sub-Saharan Africa.

Method: A systematic review of studies on the use of chemotherapeutic interventions in the control of STH infections and schistosomiasis among school-age children in sub-Saharan Africa was conducted. Using the Medline Entrez-Pubmed Search, relevant publications were identified via combination of keys words such as soil-transmitted helminths, schistosomiasis, school-age children, chemotherapy, Africa.

Result: Praziquantel was the most common schistosomicidal drug evaluated, while mebendazole and albendazole were the common chemotherapeutic agents used in the treatment of STHs evaluated. Egg reduction rates (ERR) of >90 % and cure rates (CR) of >80 % were recorded in most cases of schistosomiasis in school-age children following praziquantel treatment. Majority of the studies recorded cure rates of >75 % for Ascaris lumbricoides and hookworm infections following albendazole treatment. However, the efficacy of albendazole was poor against Trichuris trichiura infection.

Conclusion: Regular anthelminthic treatment of school-age children will significantly reduce both morbidity and adverse consequences attributed to STH infections and schistosomiasis.

Key words: *School-age children, soil-transmitted helminth, schistosomiasis, chemotherapy, Africa*

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INTRODUCTION

Helminth infections particularly those caused by soil-transmitted helminths (hookworm, Ascaris lumbricoides, Trichuris trichiura) and schistosomes (Schistosoma haematobium, Schistosoma mansoni) constitute a major public health and developmental challenge in the tropical and sub-tropical regions of the world. These infections are associated with poverty and underdevelopment and are most prevalent in the poorest communities of the developing world including almost all countries of the sub-Saharan Africa.[1,2] Current estimates indicate that an

estimated 4.5 billion people are at risk of STH infections and the global estimate of number of cases of A. lumbricoides is 807 million, T. trichiura 604 million, Hookworm (N. americanus; A. duodenale) 576 million, Schistosomiasis (S. haematobium, S. mansoni and S. japonicum) 207 million.[3,4] School-age children apart from being high risk group for soil-transmitted helminth (STH) infections and schistosomiasis, also play an important epidemiological role in the transmission of these infections.[5] Soil-transmitted helminths and schistosomes are transmitted via eggs excreted in human faeces and urine in areas that lack adequate sanitation.[1] Due to the enormous number of eggs produced by one adult female worm, a single contaminated stool passed in the soil is sufficient to infect an entire village for years.[6] The burden of these helminth infections has been consistently underestimated in the past, but there is now a general consensus that STH infections and schistosomiasis represent an important public health problem especially for school children.[2,3,7,8] Helminthic infections therefore exert a negative effect on the health status, nutritional status and performance (cognitive task) of school-age children. On a global scale soil-transmitted helminth infections and schistosomiasis accounts for 40% of the global burden of disease of all tropical disease excluding malaria.[1,9] The global burden of disease caused by the three major soil-transmitted helminths is an estimated 22.1 million disability-adjusted life years (DALYs) lost for hookworm, 10.5 million for Ascaris lumbricoides, 6.4 million for Trichuris trichiura and 39.0 million for the three infections combined as compared with malaria at 35.7 million.[10-12] The DALYs lost for schistosomiasis is 4.5 million.[1,10] Although estimates of disability-adjusted life years (DALYs) lost due to these helminth infections portray a more accurate picture of the disease burden caused by the infections, the estimates of DALYs lost differ greatly from one source to another.[2,13-15] In the current Global Burden of Disease (GBD) assessments by the WHO for instance, it is not clear whether prevalence of infection per se was used to gauge the disease burden of helminths or the more appropriate duration of infection-associated pathology, which is often irreversible.[4] However, total DALYs lost annually may range from 4.7 million to 39 million.[15]

Among the principal reasons for the high estimates of DALYs lost to soil-transmitted helminth infections and schistosomiasis are the associations between hookworm and anaemia; ascaris and stunting of growth; trichuris and impaired school performance; and the causal relationship between schistosomiasis and anaemia, stunting, and cognitive impairment.[16-23] The burden of disease resulting from these infections has been calculated by classifying the spectrum of possible consequences of infection into defined disease states. The classification is based on two worm-burden thresholds; a lower threshold above which there are detrimental effects on physical fitness and school performance, which may be temporary or permanent; and a higher threshold above which there is a risk of clinically overt illness.[1,12] The morbidity caused by soil-transmitted helminth infections and schistosomiasis is most commonly associated with infections of heavy intensity. Because STHs are transmitted through poor sanitation and hygiene, and schistosomiasis by contact with infected freshwater streams and lakes, school-aged children are typically at increased risk resulting in high prevalence and intensity of infection due to high level of exposure.[1,2] Although light helminthic infections are often asymptomatic, the adverse health and nutritional impacts of severe worm infections on children are well documented: helminthic infections often lead to iron deficiency anaemia, protein energy malnutrition, stunting (a measure

of chronic undernutrition), wasting (a measure of acute undernutrition), listlessness and abdominal pain and may negatively affect class-attentiveness of schoolchildren.[3,13,14] Without chemotherapeutic treatment, the infections may also have more serious medical consequences in a minority of cases: roundworm infections sometimes lead to fatal intestinal obstruction, hookworm infection can cause severe anaemia, whipworm is associated with chronic dysentery, and urinary schistosomiasis can result to severe damage of the kidneys and/or bladder, while S. mansoni infection can cause lesions of the liver, portal vein, and spleen, leading to periportal fibrosis, portal hypertension, hepatosplenomegaly, splenomegaly, and ascites.[24]

The availability of safe and relatively inexpensive drugs for both schistosomiasis (praziquantel) and STHs (albendazole and mebendazole) has made control through chemotherapy a potentially affordable option even in resource-poor countries.[25] Consequently, the World Health Assembly (WHA) in May 2001 observed that where control measures including chemotherapeutic interventions have been implemented in a sustainable way, as demonstrated in several countries, mortality, morbidity and transmission of helminth infections have decreased dramatically. Therefore the WHA passed resolution 54.19 endorsing regular anthelminthic treatment of high-risk groups, particularly school-age children, as an effective public health measure to reduce the morbidity and mortality attributable to STH infections and schistosomiasis.[26] The WHA therefore recommended that Member States should sustain successful control activities in low-transmission areas in order to eliminate schistosomiasis and soil-transmitted helminth infections as a public health problem, and to give high priority to implementing or intensifying control of schistosomiasis and soil-transmitted helminth infections in areas of high transmission while monitoring drug quality and efficacy; with the goal of attaining a minimum target of regular administration of chemotherapy to at least 75% and up to 100% of all school-age children at risk of morbidity by 2010.[26] Implementation of this recommendation was facilitated by the establishment of the Partners for Parasite Control and the Schistosomiasis Control Initiative.[27-30]

The objective of this review was to evaluate the efficacy of chemotherapy based control of STH infections and schistosomiasis among school-age children in sub-Saharan Africa. This is with the view to highlighting the need for pragmatic public health policy on the control of soil transmitted helminth infections and schistosomiasis through regular school deworming programmes in the light of the epidemiological importance of and the effects of these infections on child well-being in sub-Saharan Africa.

Materials and Methods

A systematic review of published articles on the use of chemotherapeutic interventions in the control of STH infections and schistosomiasis in school-age children in sub-Saharan Africa was conducted within January and February 2011. Using the Medline Entrez-Pubmed Search, relevant publications were identified via combination of keys words such as soil-transmitted helminths, schistosomiasis, school-age children, chemotherapy, Africa. The search yielded 108 published articles which focused on the outcome of chemotherapeutic intervention against soil-transmitted helminth infections and/or schistosomiasis in school-age children most relevant to the objective of the review.

Particular attention was paid to published articles providing information on the pre-chemotherapeutic treatment and post-chemotherapeutic treatment prevalence of soil-transmitted helminth infections and schistosomiasis in school age children. The

various published articles were systematically reviewed with respect to the location, population, the period, type of study and outcome of study to enhance comparison between studies.

Results

A total of thirty-two (32) studies fulfilled the criteria for this review and were categorized into two groups. The first group was made up of studies which investigated the efficacy of mass chemotherapy using anthelminthic drugs against soil-transmitted helminth infections among school-age children in sub-Saharan African (Table 1). The second group was made up of studies which investigated the efficacy of schistosomicidal drugs for mass chemotherapy against schistosomiasis among school-age children in sub-Saharan Africa (Table 2).

Efficacy of mass chemotherapeutic control using anthelminthic drugs against soil-transmitted helminth infections in school-age children

There were thirteen (13) identified studies in this group which investigated the efficacy of mass chemotherapeutic control against soil-transmitted helminth infections using the following drugs: levamisole, mebendazole, albendazole and pyrantel-oxantel. There were significant reductions in the prevalence of soil-transmitted helminth infections among school children following the chemotherapeutic intervention (Table 1). Although cure rates were not always high, all the drugs however produced significant increase in egg reduction rates. Albendazole was very effective against *Ascaris lumbricoides* and hookworm infections with majority of the studies recording cure rates >75%, but the efficacy of the drug was poor against *Trichuris trichiura* with many of the studies recording cure rates <27% (Table 1). Other drugs used (mebendazole, levamisole, prantel-oxantel) also recorded poor efficacy against *Trichuris trichiura*. Higher cure rates and higher egg reduction rates were recorded when mebendazole and levamisole were combined than when each drug was used separately.[31]

Efficacy of mass chemotherapeutic control using schistosomicidal drugs *against schistosome infections in school-age children*

There were nineteen (19) identified studies in this group which investigated the efficacy of various schistosomicidal drugs used for mass chemotherapy among school children. The drugs assessed were praziquantel, artesunate, oxaminiquine, amodiaquine, metrifonate and sulphadoxinepyrimethamine (Table 2). Generally there were significant reductions in the prevalence of schistosomiasis among school children following the chemotherapeutic interventions as well as significant increase in cure rates and egg reduction rates. Most of the studies used praziquantel and cure rates >80% and egg reduction rates >90% were recorded in most cases, however low cure rates of 33 % [32] and 41 % [33] were also observed. Other schistosomicidal drugs such as artesunate and oxaminiquine produced cure rates >70% in Kenya [34] and Nigeria [35] respectively. Drug combinations such as praziquantel and artesunate, sulphadoxinepyrimethamine and artesunate, amodiaquine and artesunate produced higher cure rates than when one schistosomicidal drug was administered.[36,37] Cure rates for *S. haematobium* ranged from 33.0% in Cote d'Ivoire to 94.5% in Senegal,[32,37] while cure rates for *S. mansoni* ranged from 57.8% in Uganda to 100% in South Africa[38,39] (Table 2).

Table 1: Summary of studies on the efficacy of anthelminthic drugs against soil-transmitted helminth infections in school children in sub-Saharan Africa

Country	Type of Study	Drug used	Hookworm			A. lumbricoides			T. trichiura			Post-treatment assessment	Reference
			P/P (%)	CR (%)	ERR (%)	P/P (%)	CR (%)	ERR (%)	P/P (%)	CR (%)	ERR (%)		
Ethiopia	CI	ALB	NA	84.2	95.0	NA	83.9	96.3	NA	NA	NA	NA	Adugna et al., 2007
		MEB	NA	83.5	94.2	NA	90.6	96.7	NA	NA	NA	NA	
Ethiopia	RCT	MEB	NA	NA	NA	NA	NA	NA	NA	89.8	99.1	NA	Legesse et al., 2004
		ALB	NA	NA	NA	NA	NA	NA	NA	17.1	69.8	NA	
South Africa	CI	ALB	3.1/0.0	100	NA	29.5/4.7	84.1	NA	51.9/38.0	26.8	NA	16 weeks	Jinabhai et al., 2001
South Africa	CI	ALB	59.4/0.0	100	NA	58.9/17.4	68.9	NA	83.6/61.5	26.4	NA	12 months	Taylor et al., 2001
South Africa	CI	ALB	NA	NA	NA	NA	NA	NA	NA	23.0	96.8	NA	Adams et al., 2004
South Africa	CI	ALB	82.9/17.6	78.8	93.2	22.0/0.8	96.4	97.7	59.8/52.2	12.7	24.8	3 weeks	Saathoff et al.2004
Tanzania	RCT	MEB	NA	NA	68.0	NA	>96.0	>95.0	NA	23.3	>80.0	4 weeks	Albonico et al., 2002
		PY-OX	NA	NA	67.0	NA	>96.0	>95.0	NA	35.1	>80.0	4 weeks	
Tanzania	CI	ALB	61.0/11.0	82.0	97.6	NA	NA	NA	NA	NA	NA	6 weeks	Guyatt et al., 2001
Tanzania	CI	ALB	45.6/11.9	73.9	NA	0.9/0.7	22.2	NA	4.8/0.7	85.4	NA	8 months	Massa et al.,2009
Tanzania	RCT	MEB+LEV	94.0/71.8	26.1	88.7	62.0/1.4	98.5	99.1	93.1/74.5	22.9	85.0	3 weeks	Albonico et al., 2003
		LEV	96.2/87.6	11.9	61.3	59.5/5.7	91.2	98.5	93.8/90.0	9.6	41.5	3 weeks	
		MEB	94.9/91.5	7.6	52.1	59.7/3.0	96.5	99.0	90.7/75.0	22.9	81.0	3 weeks	
Uganda	CI	ALB	50.9/10.7	79.0	92.9	2.8/0.6	78.6	NA	2.2/1.6	27.3	NA	2 years	Kabateriene et al,2007
Kenya	CI	MEB	NA	50.0	66.3	NA	79.6	NA	60.6	NA	NA	6 months	Muchiri et al., 2001
		ALB	NA	92.4	96.7	NA	83.5	NA	67.8	NA	NA	6months	
Kenya	CI	ALB	16.7/ 0.2	98.8	NA	1.6/0.0	100	NA	0.8/0.6	25.0	NA	8 weeks	Kihara et al., 2007

CI=Chemotherapeutic intervention; RCT=Randomized controlled trial; MEB=Mebendazole; ALB=Albendazole; LEV=Levamisole; PY-OX=Pyrantel oxantel; P/P= Pre/post treatment prevalence; CR= Cure rate; ERR= Egg reduction rate; NA= not accessible/not determined

Table 2: Summary of studies on the efficacy of schistosomicidal drugs against schistosomiasis in school children in sub-Saharan Africa

Country Reference	Type of Study	Species	Drug used	Pre/post Treatment prevalence (%)	Cure rate (%)	Egg reduction rate (%)	Post-treatment assessment time	
Nigeria	CI	S. haematobium	PZQ	NA	72.7	NA	8 weeks	Inyang-Etoh et al., 2009
		S. haematobium	ART	NA	70.5	NA	8 weeks	
		S. haematobium	PZQ+ART	NA	88.6	NA	8 weeks	
Nigeria	CI	S. haematobium	ART	NA	70.1	NA	4 weeks	Inyang-Etoh et al., 2004
Cote D'Ivoire	CI	S. haematobium (Taabo)	PZQ	94.0/63.0	33.0	87.7	6 months	N'Goran et al., 2001
		S. haematobium (Bodo)	PZQ	90.0/14.0	84.4	91.5	6 months	
		S. haematobium (Batera)	PZQ	88.0/49.0	43.3	62.4	6 months	
		S. haematobium (Assinze)	PZQ	67.0/10.0	85.1	77.8	6 months	
Senegal	RCT	S. haematobium	SP+ART	NA	92.6	NA	4 weeks	Boulanger et al., 2007
		S. haematobium	ADQ+ART	NA	68.7	NA	4 weeks	
Ethiopia	CI	S. mansoni	PZQ	NA	94.0	97.0	NA	Degu et al., 2002
Sudan	CI	S. haematobium	PZQ	NA	73.2	NA	3 months	Kardaman et al., 1985
		S. mansoni	PZQ	NA	64.7	NA	3 months	
Burkina Faso	CI	S. haematobium	PZQ	59.6/7.7	87.0	92.8	2 years	Touré et al., 2008
South Africa	CI	S. haematobium	PZQ	68.0/13.2	57.8	97.9	12 months	Saathoff et al., 2004
South Africa	CI	S. haematobium	PZQ	22.3/3.3	85.2	NA	16 weeks	Jinabhai et al., 2001
	CI	S. mansoni	PZQ	0.8/0.0	100	NA	16 weeks	
	RCT	S. haematobium	PZQ	43.4/8.3	80.9	NA	12 months	Taylor et al., 2001
South Africa	CI	S. haematobium	PZQ	NA	97.0	NA	NA	Schutte et al., 1983
		S. mansoni	PZQ	NA	97.0	NA	NA	
Zimbabwe	CI	S. haematobium	PZQ	NA	88.5	98.2	6 weeks	Midzi et al., 2008
Cameroon	CI	S. haematobium	PZQ	NA	41.0	90.4	3 weeks	Tchuente et al., 2004
Tanzania	CS	S. haematobium	PZQ	59.0/4.0	94.0	99.0	6 weeks	Guyatt et al., 2001
Uganda	CI	S. mansoni	PZQ	42.4/17.9	80.7	83.0	2 years	Kabateriene et al., 2004
Kenya	CI	S. mansoni	PZQ	47.4/8.6	81.9	NA	8 weeks	Kihara et al., 2007
Kenya	PC	S. haematobium	PZQ	67.0/21.0	94.5	NA	12 months	Satayathum et al., 2006
Kenya	CI/CS	S. mansoni (Kangudo)	PZQ	NA	77.6-87.2	NA	5 weeks	Thiong'o et al., 2002
		S. mansoni (Kibwezi)	PZQ	NA	67.1-81.1	NA	5 weeks	
		S. mansoni (Kibwezi)	OXA	NA	56.7-87.2	NA	5 weeks	
		S. mansoni (Kangundo)	OXA	NA	71.6-79.7	NA	5 weeks	
Kenya	CI	S. haematobium	PZQ	69.0/19.0	NA	NA	NA	King et al., 1988
		S. haematobium	MEF	69.0/19.0	NA	NA	NA	

CI=Chemotherapeutic intervention; PC=Prospective cohort; RCT=Randomized controlled trial; CS=Cross sectional; PZQ=Praziquantel; ART=Artesunate; OXA=Oxamniquine; SP=sulphadoxinepyremethamine; ADQ=Amodiaquine; MEF= metrifonate; NA= not accessible/not determined.

Discussion

The high prevalence and high infection intensity prior to chemotherapeutic intervention recorded in the studies reviewed clearly indicates that in the absence of mass chemotherapy, the prevalence of STH infections and schistosomiasis among school-age children in sub-Saharan Africa remains high. This observation necessitates regular treatment of school-age children in sub-Saharan Africa. Although STH infections and schistosomiasis rarely cause fatality, chronic infection with high worm burden can lead to serious health consequences including malnutrition, physical and intellectual growth retardation, and cognitive and educational deficits in school-age children.[13,14] The need for sub-Saharan African countries to embark on a pragmatic approach to mass chemotherapy against STH infections and schistosomiasis cannot be overemphasized. The World Health Assembly (WHA) resolution 54.19 in 2001, endorsed regular anthelminthic treatment of high risk groups particularly school children as an effective public health strategy to reduce the morbidity and adverse consequences attributable to STH infections and schistosomiasis.[26] This resolution resulted in the establishment of several major control efforts. Great progress had been made in a number of sub-Saharan African countries in the control of STH infections and schistosomiasis via mass chemotherapy among school children.[39-45] In many parts of sub-Saharan Africa there is currently a growing awareness of the public health significance of these helminth infections which previously were grossly neglected, and concerted advocacy for their control has resulted in increased political will and financial means to combat them .[46] It is however unclear whether existing financial resources and global political commitments are sufficient to reach the World Health Assembly's ambitious goals in the sub-region and other developing parts of the world.[47] The obstacles to achieving this are substantial and depend in large part on whether countries have reliable and sustainable systems for delivering deworming drugs and addressing other challenges associated with the large scale use of anthelminthic drugs. Four anthelminthics (albendazole, mebendazole, levamisole, and pyrantel pamoate) are currently on the WHO model list of essential medicines for the treatment and control of STHs,[2,48] while chemotherapy with praziquantel is the mainstay for the treatment and control of schistosomiasis. [48,49] Each of these drugs has an excellent safety record; adverse reactions are minimal and transient, and serious adverse experiences are extremely infrequent.[48] The interventional studies reviewed indicated that a single oral dose of 40 mg of praziquantel per kg of body weight was safe, showed no or only a few but transient side effects, but resulted in high parasitological cure and egg reduction rates against both S. mansoni and S. haematobium.[50,51,54-57] Interestingly, a randomized comparison of low-dose (20mg/kg) with standard dose (40 mg/kg) praziquantel therapy suggests an equivalent effect of these two regimens in reducing structural urinary tract morbidity over a nine-month period and concluded that in certain settings, a 20 mg/kg dose of praziquantel may be sufficient in providing practical control of renal and bladder morbidity due to S. haematobium infection.[58] Further studies are however required to validate this finding in other areas of sub-Saharan Africa. In view of the operational and therapeutic properties as well as the gradually decreasing costs of praziquantel, millions of people have been treated with praziquantel over the past 20 years and it is predicted that many more millions of individuals suffering from schistosomiasis especially school children will be treated with this drug several years to come.[49,59,60]

Most of the interventional studies on STHs reviewed in this report used only the

benzimidazoles (albendazole and mebendazole) because of the added advantage that they are given as a single-dose tablet and children do not need to be weighed.[31] Furthermore, the findings of this review indicated that the benzimidazoles exhibits considerable cure rates and egg reduction rates particularly against A. lumbricoides and hookworms [39,43,44,50,51] and aside from reducing the load of worms, benzimidazole treatment has been shown to improve the nutritional status and cognitive development of children infected with A. lumbricoides, T. trichiura, and hookworms and reduces hookworm associated anaemia in children.[52,53] It is important to state that these anthelminthic drugs have witnessed large scale administration in sub-Saharan Africa and other parts of the world where STH infections and schistosomiasis constitute a public health concern, which is in line with the resolution of the WHA.[26] However, the fact that STH infections and schistosomiasis do not confer protective immunity even after repeated infections and that people treated with the drugs especially children soon become re-infected implies a continual need for drug treatment in control programs. Therefore there is a considerable concern that repeated use of these few drugs over a long period of time might result in the development and spread of drug resistant helminths, which is already a significant problem in veterinary medicine.[46] In fact, some of the studies reviewed in this report which investigated the efficacy of albendazole, mebendazole and levamisole showed a parasitological cure rates lower that 30% particularly with T. trichiura infection.[31,38,39,43,51,54,61,62] Although there is limited evidence from the studies reviewed of a possible emergence of drug resistance, this may not be completely overruled. A number of previous studies have indicated that there are no drugs available that are highly effective against T. trichiura infection as single dose treatments, but other studies show that two or three repeated doses of albendazole on consecutive days are more effective than a single dose.[39,54,63] To repeat the dose on 2 or 3 days would however increase cost, and might reduce compliance and complicate management.[40] As a result of this, the need for alternative STH anthelminthics cannot be overemphasized. Pyrantel-oxantel (10 mg/kg) have been reported to offer a valuable alternative to mebendazole as a single-dose treatment for the control of intestinal nematode infections in children in endemic areas of sub-Saharan Africa, due to its comparable efficacy, its low cost and its suitability for use in young children.[64] Although praziquantel was efficacious against both S. mansoni and S. haematobium infections with little or no evidence of possible resistance as indicated in this report;[45,50,51,57] other antischistosomal drugs investigated such as oxamniquine and antimalarial drugs eg. artesunate, amodiaquine and sulphadoxine-pyremethamine were also reasonably effective.[34-36,65] Oxamniquine is the only main alternative antischistosomal drug, but its use is declining [59] and moreover in contrast to praziquantel, which displays activity against all human schistosome species, the activity of oxamniquine is confined to S. mansoni.[66] The antimalarial drugs particularly the derivatives of artemisinin (e.g., artemether and artesunate), have been shown to be schistosomicidal and have exhibited high parasitological cure rates. Consequently discussions are on-going on how this evidence base can be translated into sound public health actions and the possible implications especially in sub-Saharan Africa where the malaria scourge is most severe.[36,65,67,68] Because of the possible emergence of drug resistance to the anthelminthic compounds, STH infections and schistosomiasis remains a matter of serious public health concern. Against his background, the efficacy of combined anthelminthic

treatments with differing modes of action was assessed in some of the studies reviewed in this report.[31,36,65] The goal of this combination therapy is to identify a combination that would be efficacious and at the same time could delay the occurrence of anthelminthic drug resistance to each class of drug.[69] The evaluation of the efficacy of the combined administration of mebendazole 500 mg and levamisole 40 or 80 mg revealed higher efficacy than either drug alone against hookworm infections.[31] Similarly, in an evaluation of the efficacy of combined praziquantel and artesunate in the treatment of urinary schistosomiasis in Nigeria, it was confirmed that the treatment of urinary schistosomiasis with the combination of praziquantel and artesunate is safe and more effective than treatment with either drug alone.[36] In conclusion, it is important to state that there is an urgent need to rapidly develop safe and effective new drugs to complement the existing treatment options for STH infections and schistosomiasis. In recent times efforts have been made to evaluate new anthelminthic drugs,[3] these include nitazoxanide, a nitromidazole compound and tribendimidine both of which were explored as a broad-spectrum antiparasitic agents with anthelminthic properties against many soil- transmitted helminths.[70,71] Although these efforts are steps in the right direction, there is however a need for the development of new generation of tools for helminth infections control, appropriate environmental control measures and health education.[72-75] One of such new generation tools which holds the best prospect for the sustainable control of STH infections and schistosomiasis is the development of vaccines.[4,76,77] It is proposed that the availability of appropriate anthelminthic vaccines to be used alongside drugs in an integrated interventional programme linking vaccination with chemotherapy might result in a greater success in the control of these helminth infections.[73,77,78] However there is little evidence that anthelminthic vaccines would be available in the nearest future. Finally, existing evidence indicates that mass school-based deworming is extraordinarily cheap and cost-effective.[79] There is need for a pragmatic public health policy on the control of soil transmitted helminth infections and schistosomiasis through regular school deworming programmes in the light of the epidemiological importance of and the effects of these infections on child well-being in sub-Saharan Africa. Therefore, the well being of school-age children must be made a matter of utmost priority by the governments of countries in the sub-Saharan region and pragmatic efforts must be geared towards the strengthening of school health services as an important component of disease control programmes.

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