Impact of a video-based health education intervention on soil-transmitted helminth infections in Chinese schoolchildren

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School of Population Health
Abstract

Worldwide, more than 2 billion people are infected with soil-transmitted helminths (STH), commonly known as intestinal worms. The STH are a group of parasitic nematodes which include roundworms (Ascaris lumbricoides), whipworms (Trichuris trichiura) and hookworms (Necator americanus and Ancylostoma duodenale). Diseases caused by the STH belong to the group of Neglected Tropical Diseases, comprising 17 infections currently targeted for prevention and research by the World Health Organization, the United Nations Development Program and the World Bank. STH are intimately connected with rural poverty, inadequate sanitation and waste disposal, lack of clean water and poor hygiene, as well as limited access to health care and preventive measures such as health education. Even though STH rarely cause death, they impact significantly on public health and cause severe disability in the world’s poorest countries. The worldwide burden of STH has been estimated to be as high as 39 million disability-adjusted life years (DALYs), with almost half of the global disease burden due to these worm infections afflicting children aged 5-14 years. Nevertheless, STH remain largely neglected by the medical and international community. In China, STH still impact substantially on public health with an estimated 129 million infected people and children aged 5-14 years having the highest rates of infection. Major endemic foci are observed in the central, western and southern provinces.

To date, mass drug administration (MDA), aimed at treating morbidity, has been the cornerstone of STH control and is promoted by the World Health Organization. However, long-term health benefits of mass drug administration are limited due to rapid reinfection and there is growing concern about the development of parasite resistance to albendazole and other anti-STH drugs as a result of continued treatment pressure. Therefore, interventions that prevent STH reinfection, such as improvements in hygiene achieved through health education, are required to augment chemotherapy as part of an integrated approach, whereby chemotherapy reduces morbidity and prevalence, and preventive interventions (e.g. health education) prevent reinfection, thus reducing incidence. This will limit the number of treatment cycles required for effective control and subsequently reduce the treatment pressure, as well as creating a more sustainable long-term approach to control.

The major objective of the thesis was to determine whether a video-based education package, targeting STH prevention at school widens the students' knowledge and changes their behaviour,
resulting in fewer STH infections. Further, we systematically reviewed school-based video interventions targeting infectious diseases and formulated informed guidelines for the evaluation of future video-based studies within the school setting.

In a cluster randomized trial (N=1718 schoolchildren) in rural Hunan Province, China, we tested the efficacy of the educational control tool, based on an educational video, which was professionally developed during the course of the thesis. The results showed that an educational package based on the cartoon video ‘The Magic Glasses’ was highly effective in increasing knowledge, improving hand washing behaviour and preventing STH incidence. There was a 50% efficacy in preventing STH infections (P<0.0001) and a 90% increase in knowledge scores between the intervention and control groups (P<0.0001). The proportion of students washing hands after using the toilet increased by a factor of two in the intervention group (P<0.02). The 50% efficacy in preventing STH infection is unprecedented for health education targeting STH. This was due to an increase in knowledge and improved hygiene practice and establishes proof of principle that the video-based health educational intervention widens student awareness and changes behaviour, resulting in fewer STH infections. A clear correlation between knowledge, attitude and practice (KAP) and STH incidence was evident as, across the entire study population, uninfected students scored, on average, 9.88 points higher in the KAP questionnaire than infected students. A correlation was also observed between KAP and hand washing in both intervention and control groups. Notably, therefore, this study provides valid and highly significant quantitative evidence in the form of a rigorously planned, implemented and reported RCT and contributes substantially to the evidence base assessing the impact of video-based public health interventions.

The effective video-based health educational tool we have developed suitably complements the approach advocated by WHO and other agencies. Furthermore, it can readily be incorporated into current ongoing STH de-worming programs, such as the Schistosomiasis Control Initiative (SCI) activities in sub-Saharan Africa and the Chinese national STH control program, launched in 2006 by the Chinese Ministry of Health.

Further studies are now needed to assess the cost-effectiveness and the adaptability of the educational package to different cultural settings and as part of a multi-component integrated package for STH control. If such an approach proves effective, then its use can be up-scaled to national Chinese and international levels. Ideally, the educational package would be integrated into the health education curriculum at schools in STH-endemic areas. Such an integrated approach,
combining chemotherapy, sanitation and health education, has the potential to contribute to a considerable reduction, if not elimination of this most common and insidious group of intestinal parasites globally.

**Photograph title page:** Schoolchildren watching the educational cartoon ‘The Magic Glasses’, Linxiang City District, Hunan Province, China. (Photograph: Bieri 2010)
Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

  
  Incorporated as Chapter 3.

  
  Incorporated as Chapter 5.

  
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Conference presentations


- **Bieri FA**, Gray DJ, Williams GM, Li YS, Yuan LP, Li RS, Guo FY, Li SM, McManus DP. Video-based health education prevents soil-transmitted helminth (STH) infections in Chinese schoolchildren. In: First Forum on Surveillance Response System Leading to Tropical Disease Elimination, Shanghai, China, June 2012.

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Publications included in this thesis


Incorporated as Chapter 3.

For this systematic review, I was responsible for 90% of the literature search, 80% of the data extraction, and 85% of the drafting and writing. DG and DM were responsible for 10% of the literature search and DG, GR and DM were responsible for 20% of data extraction and 15% of the drafting and writing.


Incorporated as Chapter 5.

For this research paper, I was responsible for 100% of the literature review, 85% of the conceptualization and design of the research project, 85% of the fieldwork and data collection, 80% of the analysis and interpretation of data, and 80% of the drafting and writing, 70% for video development and 10% for the video production. DG, GW, GR, YL and DM were responsible for 15% of the conceptualization and design. YL, LY, YH, FG and SL were responsible for 15% of the fieldwork and data collection. DG, GW and DM were responsible for 20% of the analysis and interpretation of data. DG, GW, YL, GR and DM were responsible for 20% of the drafting and writing. DG, GW, DM, YL, LY, RL, YH, FG, SL were responsible for 30% of the video development, AB was responsible for 90% of the video production. RL was 100% responsible for the database.


For this research paper, I was responsible for 100% of the literature review, 75% of the conceptualization and design of the research project, 80% of the fieldwork and data collection, 80% of the analysis and interpretation of data, and 80% of the drafting and writing. DG, GW, GR, YL and DM were responsible for 25% of the conceptualization and design. YL, LY, FG and SL were responsible for 20% of the fieldwork and data collection. DG, GW and DM were responsible for 20% of the analysis and interpretation of data. RL was 100% responsible for the database. DG, GW, GR, YL and DM were responsible for 20% of the drafting and writing.

Contributions by others to the thesis

The contribution of others to this thesis includes: academic and editorial guidance from my supervisory team: Prof Donald McManus, Dr Darren Gray, Dr Yuesheng Li, Prof Gail Williams, A/Prof Andrea Whittaker; advice on project design by Dr Giovanna Raso; technical advice from Robert Li; data collection and data entry from our research teams in Hunan province in the People’s Republic of China, and production of the educational video ‘The Magic Glasses’ by Andrew Bedford and the team at 5th World Media, Brisbane.

Statement of parts of the thesis submitted to qualify for the award of another degree

None
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Fields of Research (FoR) Classification

FoR code: 1117, Public Health and Health Services, 80%
FoR code: 1108, Medical Microbiology, 20%
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5.1 Context

5.2 Publication

Chapter 6 Impact of a video-based health educational intervention on soil-transmitted helminth infections

6.1 Context

6.2 Publication

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<td>AIDS</td>
<td>Acquired immunodeficiency syndrome</td>
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<tr>
<td>ANZCTR</td>
<td>Australian New Zealand Clinical Trials Registry</td>
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<td>CATCH</td>
<td>Child and adolescent trial for cardiovascular health</td>
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<td>CD</td>
<td>City District</td>
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<td>CDC</td>
<td>Centres for Disease Control</td>
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<td>CI</td>
<td>Confidence interval</td>
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<td>COMMIT</td>
<td>Community intervention trial for smoking cessation</td>
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<td>CONSORT</td>
<td>Consolidated Standards of Reporting Trials</td>
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<td>DALYs</td>
<td>Disability-adjusted life years</td>
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<td>DRG</td>
<td>Disease Reference Group</td>
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<td>Epg</td>
<td>Eggs per gram (faeces)</td>
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<td>FGD</td>
<td>Focus group discussion</td>
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<tr>
<td>FRESH</td>
<td>Focusing Resources on Effective School Health</td>
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<td>GEE</td>
<td>Generalized Estimating Equation</td>
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<td>GIS</td>
<td>Geographic Information Systems</td>
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<td>GMEPG</td>
<td>Geometric mean of eggs per gram faeces</td>
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<td>HIV</td>
<td>Human immunodeficiency virus</td>
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<td>HPV</td>
<td>Human papillomavirus</td>
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<td>ICT</td>
<td>Information and Communication Technology</td>
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<tr>
<td>KAP</td>
<td>Knowledge, attitude and practice</td>
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<td>MDA</td>
<td>Mass drug administration</td>
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<td>MDGs</td>
<td>Millennium Development Goals</td>
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<td>NTD</td>
<td>Neglected Tropical Diseases</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>OR</td>
<td>Odds ratio</td>
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<td>PRISMA</td>
<td>Preferred Reporting Items for Systematic Reviews and Meta-Analyses</td>
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<td>QIMR</td>
<td>Queensland Institute of Medical Research</td>
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<td>RCT</td>
<td>Randomized controlled trial</td>
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<td>R &amp; D</td>
<td>Research and development</td>
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<td>SCI</td>
<td>Schistosomiasis Control Initiative</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<tr>
<td>STH</td>
<td>Soil-transmitted helminths</td>
</tr>
<tr>
<td>STI</td>
<td>Sexually transmitted infection</td>
</tr>
<tr>
<td>TDR</td>
<td>Special Programme for Research and Training in Tropical Diseases</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNICEF</td>
<td>United Nations Children's Fund</td>
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<td>UN</td>
<td>United Nations</td>
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<tr>
<td>WASH</td>
<td>Water, sanitation and hygiene</td>
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<td>WATSAN</td>
<td>Water and sanitation</td>
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<td>WHA</td>
<td>World Health Assembly</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Chapter 1

Introduction
1 Introduction

More than one third of the world population (2 billion)\(^1\) are infected with soil-transmitted helminths (STH), commonly known as intestinal worms. STH are a group of parasitic nematode worms, including four species: roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*). Infection is caused by oral ingestion of eggs from contaminated soil, food and un-sanitised hands (*A. lumbricoides* and *T. trichiura*) or by penetration of the skin by larvae in the soil (hookworms). STH eggs and larvae develop predominantly in moist soil in tropical and sub-tropical areas, where they are widespread.\(^2\)

STHs are intimately connected to rural poverty, inadequate sanitation and waste disposal, lack of clean water and poor hygiene, as well as limited access to health care and preventive measures such as health education. Even though STH rarely cause death, they impact significantly on public health and cause severe disability in the world’s poorest countries. Clinical manifestations include abdominal pain, diarrhoea, anaemia, intestinal obstruction and malnutrition. STH have been shown to have a negative impact on worker performance and child development, including stunted growth and reduced school performance, due to limited cognitive development.\(^3\) According to the World Health Organization (WHO), children and pregnant women are most at risk for STH infection and school-age children should be targeted for treatment.\(^4\)

Nevertheless, STH remain largely neglected by the medical and international community. STH belong to the group of Neglected Tropical Diseases (NTDs); 17 infectious diseases currently targeted for prevention and research by United Nations Development Programme (UNDP), World Bank and WHO. The estimates of the worldwide burden of STH have been shown to be variable ranging from 4.7-39.0 million disability-adjusted life years (DALYs).\(^5,6\) According to the World Bank, STH accounts for almost half of the global disease burden among children aged 5-14 years.\(^7\)

Even though STH prevalence in China was reduced considerably between the two national surveys in 1990 and 2003, STH still impact substantially on public health with an estimated 129 million infected people and children aged 5-14 years having the highest rates of infection.\(^8\) Major endemic foci are observed in the central, western and southern provinces (Yunnan, Hunan, Hainan, Guizhou, Sichuan, Guangxi, Chongqing, Hubei, Fujian, Jiangxi, and Anhui).\(^8\)
School-based helminthiasis control in the form of mass drug administration is promoted by WHO and conducted as a cost-effective way in many developing countries. Treating children can reduce overall transmission in the community, as they contribute considerably to the contamination of the environment with STH-egg laden faeces. However, long-term health benefits of mass drug administration are limited due to rapid reinfection and a need for preventative measures, such as behaviour change that can be facilitated through health education has been expressed repeatedly. Several studies have shown that an integrated approach, using combined chemotherapy, health education and improved sanitation, leads to a more significant reduction in helminth infections and better long term benefits. With the possible emergence of drug resistant helminths, additional interventions are required - particularly preventative measures - for the control of this disease of poverty. Existing STH interventions need to be optimized including the development of new control tools, in order to improve the impact and sustainability of control efforts.

This thesis describes the testing for the impact of an alternative control tool, based on an educational video, which was professionally developed within the course of this project (Chapter 5). The work described establishes proof of principle that health education increases knowledge, changes behaviour and reduces infection (Chapter 6), thereby contributing considerably to the evidence base for infectious disease prevention through health education. The educational tool including the video can be readily combined with, and integrated in, existing school-based control programs. If proven effective in other endemic settings, it provides a powerful and novel control tool, increasing the effectiveness and sustainability of current control programs.
Aims & objectives

Study objectives and hypothesis

The overall objective of the project was to determine whether a video-based health educational package, targeting STH prevention at school, has increased the students' knowledge and changed their behaviour in a way conducive to the prevention of parasitic worm infections.

We tested the hypothesis that: A video-based health educational package (for use in schools) targeting STH can increase student knowledge of the worms, their transmission, symptoms, treatment and prevention, and change behaviour, thus preventing infections in children.

This hypothesis was tested with the following specific aims:

1. To determine if the video-based health educational package (for use in schools) was effective in improving the schoolchildren’s knowledge of, and attitude to, STH, including STH transmission, symptoms, treatment, prevention and self-reported hygiene practice.
2. To determine if the video-based health educational package (for use in schools) was effective in changing the intervention group’s infection risk behaviour such that STH incidence decreases.
3. To determine if the video-based health educational package (for use in schools) was effective in preventing STH infection incidence in schoolchildren in Linxiang City District.

To measure the effect of the educational package, an un-matched cluster-randomized intervention trial was employed; targeting schoolchildren aged 9-11 years, Linxiang County, Hunan Province, China. Parasitological and questionnaire surveys were administered and hand washing practice was observed at baseline and at follow-up, 9 months after the intervention. Intervention schools received the video-based health education package, detailed in Chapter 6, whereas control schools received a generic and traditionally used health education poster developed by the Chinese Ministry of Health.
Linxiang City District, a rural agricultural area with STH prevalence >15% among schoolchildren was selected as the study area, based on a parasitological survey undertaken in October 2009. The study area and the criteria for its selection are described in detail in Chapter 4.

**Thesis outline**

This thesis consists of seven chapters and eight appendices. Chapter 1 provides an introduction including, aims, objectives and a thesis outline. Chapter 2 presents detailed background information and a review of current literature. Chapter 3 is a published literature review of preventive health educational videos targeting infectious diseases in schoolchildren. The paper presents the data from the eleven systematically reviewed studies in descriptive form and formulates informed guidelines for the planning and implementation of future video-based studies within the school setting. Chapter 4 describes the methods, study design and statistical analysis applied in this research. Chapter 5 is a submitted paper on the development of educational videos. The article describes the development of the cartoon video and the results of the formative research including risk factor assessment and video pilot-testing, in order to share this successful approach and to provide recommendations for the development of future health educational videos. Chapter 6 is a paper under review that describes the main results of the 9-month cluster randomized field trial in Hunan Province, China, testing the efficacy of the video-based educational package we have developed. Finally, Chapter 7 is an overall discussion of the key findings of this research, contribution to new knowledge in the field, practical applications of the findings, limitations of the studies, directions for future research and conclusions.

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Chapter 2

Background

This chapter provides a review of the current literature on biology, transmission, epidemiology, disease, prevention and control of soil-transmitted helminths. The importance of health education and behavioural theories for their effective control are discussed and current knowledge gaps and research priorities are identified.
2 Background

Soil-transmitted helminths (STHs) are a group of parasitic nematode worms, infecting humans through contact with parasite eggs or larvae that live predominantly in the moist soil of the tropics and sub-tropics. Adult STH worms reside in the human intestinal tract. The three main STH infections are roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and the hookworms (*Ancylostoma duodenale* and *Necator americanus*).

2.1 Taxonomy

This section shows the taxonomy for the three main STH infections.

*Ascaris lumbricoides* (Roundworm)

- Phylum: Nematoda
- Order: Ascaridida
- Family: Ascarididae
- Genus: *Ascaris*
- Species: *A. lumbricoides*
- Binomial name: *Ascaris lumbricoides* (Linnaeus, 1758)

*Trichuris trichiura* (Whipworm)

- Kingdom: Animalia
- Phylum: Nematoda
- Class: Adenophera
- Order: Trichurida
- Family: Trichuridae
- Genus: *Trichuris*
- Species: *T. trichiura*
- Binomial name: *Trichuris trichiura* (Linnaeus, 1771)
Hookworms

Kingdom: Animalia
Phylum: Nematoda

Class: Secernentea
Order: Strongiloidae
Family: Ancylostomatidae
Genus: *Necator*/ *Ancylostoma*
Species *Necator americanus* and *Ancylostoma duodenale*

### 2.2 Morphology

*Ascaris lumbricoides* (roundworm) is the largest nematode parasitizing the human intestine (Figure 1). Males are 2–4mm in diameter and 15–31 cm long. The males' posterior end is curved ventrally and has a bluntly pointed tail. Females are 3–6 mm wide and 20–49 cm long. The vulva is located in the anterior end and accounts for about a third of its body length. Uteri may contain up to 27 million eggs at a time with 200,000 being laid per day. Fertilized eggs are oval to round in shape and are 45-75 μm long and 35-50 μm wide with a thick outer shell (Figure 4).

![Figure 1: Ascaris lumbricoides.](http://medicalstate.tumblr.com)
**Trichuris trichiura** (whipworm) are pinkish-white worms, with a narrow anterior esophageal end and shorter and thicker posterior anus (Figure 2). They attach to the mucosa of the caecum of the host through their slender anterior end and feed on tissue secretions instead of blood. Females are 35–50 mm long and larger than males; measuring approximately 30–45 mm. Males have a coiled posterior end, whereas females have a bluntly round posterior. Eggs are barrel-shaped and brown (Figure 4).21

![Trichuris trichiura](image)

**Figure 2: Trichuris trichiura © 1999 University of California**

**Hookworms**

**Ancylostoma duodenale** worms are greyish white or pinkish with the head slightly bent in relation to the rest of the body, giving them the characteristic hook shape for which they are named (Figure 3). They possess well developed mouths with two pairs of teeth. While males measure approximately one centimetre by 0.5 millimetres, the females are often longer and stouter. Additionally, males can be distinguished from females based on the presence of a prominent posterior copulatory bursa.20

**Necator americanus** is very similar in morphology to *A. duodenale*. *N. americanus* is generally smaller than *A. duodenale* with males usually 5 to 9 mm long and females about 1 cm long. Whereas *A. duodenale* possess two pairs of teeth, *N. americanus* possesses a pair of cutting plates in the buccal capsule. Additionally, the hook shape is much more defined in *N. americanus* than in *A. duodenale*.20
Figure 3: *Ancylostoma duodenale*. (http://www.microbeworld.org/images/stories/twip/hookworm.jpg)

Figure 4: Soil-transmitted helminths eggs. © Oregon State Public Health Laboratories
2.3 Life cycle

The life cycles of *A. lumbricoides* and *T. trichiura* are similar (Figure 5 and 6); both species infect the host orally by ingestion of mature worm eggs on food or soil or via un-sanitized hands. Once swallowed, the eggs hatch in the intestine and the *A. lumbricoides* larvae migrate from the intestinal through the blood stream to the lungs, where they penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed. When they reach the small intestine, they develop into adult worms. Newly hatched *T. trichiura* larvae, in contrast, migrate directly to the colon, where they mature and wind their heads into the epithelium of the large intestine. From ingestion of infective eggs to oviposition by the adult female between two to three months are required. An adult roundworm can live one to two years and produces an average of 200,000 eggs per day. Female whipworms produce 3,000-20,000 eggs per day and their life span is approximately one year. The eggs are passed in faeces and then develop in moist, warm soil, maturing into infective eggs, thereby completing the life-cycle. (http://www.dpd.cdc.gov/dpdx/html/ascariasis.htm)

[Figure 5: Ascaris lumbricoides life cycle. © Centres for Disease Control and Prevention, Georgia, USA]

Adult worms 1 live in the lumen of the small intestine, where the females produce eggs, which are passed with the faeces 2. Unfertilized eggs may be ingested but are not infective. Fertile
eggs embryonate and become infective after 18 days to several weeks. After infective eggs are swallowed, the larvae hatch, invade the intestinal mucosa, and are carried via the portal, then systemic circulation to the lungs. The larvae mature further in the lungs (10 to 14 days), penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed. Upon reaching the small intestine, they develop into adult worms.

Figure 6: *Trichuris trichiura* life cycle. © Centers for Disease Control and Prevention, Georgia, USA

The unembryonated eggs are passed with the stool. In the soil, the eggs develop into a 2-cell stage, an advanced cleavage stage, and then they embryonate; eggs become infective in 15 to 30 days. After ingestion via soil-contaminated hands or food, the eggs hatch in the small intestine, and release larvae that mature and establish themselves as adults in the colon. The adult worms (approximately 4 cm in length) live in the cecum and ascending colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa. The females begin to oviposit 60 to 70 days after infection (Centers for Disease Control and Prevention, Georgia, USA).
Hookworm infections occur through contact with contaminated soil (Figure 7). The filariform larvae (L3, third-stage) enters the human body by penetrating the intact skin. The hookworm larvae then enter the circulatory system, penetrate the lungs, migrate via the respiratory system to the throat where they are swallowed and enter the intestinal tract. Hookworms mature in the small intestine where they attach to the intestinal wall and feed on blood with resultant blood loss by the host. Most adult worms die after one to two years, but the life span may be up to several years. Female N. americanus and A. duodenale produce 6,000-20,000 and 25,000-35,000 eggs per day, respectively (Figure 4). The eggs are passed in faeces and then hatch in moist, warm soil, maturing into filariform larvae, completing the life-cycle. (http://www.dpd.cdc.gov/dpdx/html/ascariasis.htm)

Figure 7: Hookworm life cycle. © Centers for Disease Control and Prevention, Georgia, USA
Eggs are passed in the stool, and under warm and moist conditions, larvae hatch in one to two days. The released rhabditiform larvae grow in the faeces and/or the soil, and after 5 to 10 days (and two molts) they become filariform (third-stage) larvae that are infective. These infective larvae can survive three to four weeks in moist and warm conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed. The larvae reach the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host. Most adult worms are eliminated in one to two years, but the longevity may reach several years. Some *A. duodenale* larvae, following penetration of the host skin, can become dormant (in the intestine or muscle). In addition, infection by *A. duodenale* may probably also occur by the oral and transmammary route. *N. americanus*, however, requires a transpulmonary migration phase (Centers for Disease Control and Prevention, Georgia, USA).

### 2.4 Transmission and risk factors

Factors influencing STH transmission can be divided into environmental and behavioural risk factors (Table 1). Two important environmental factors are climate and soil conditions, as STH larvae predominantly develop in tropical and sub-tropical climates, with warm temperatures, high humidity and moist soils. High and low land surface temperature and extremely arid environments limit STH transmission. Unhygienic sanitation, inadequate water supply and the use of untreated night soil fertilizer are man-made environmental factors favouring STH transmission.

Behavioural risk factors include toilet usage, wearing shoes, personal hygiene and habits such as washing hands and eating raw food. Occupations with high soil contact such as farming, also increase the risk of STH infection. Both environmental and behavioural risk factors commonly occur in poor socio-economic conditions, making poverty and limited education one of the key risk factors for STH transmission. Higher education and socio-economic status, however, have been shown to be positive predictors for improved hygiene behaviour, which in turn is protective against *A. lumbricoides, T. trichiura* infections.
Table 1: Factors influencing the transmission of STH (Ohta 2007, modified)\textsuperscript{23}

<table>
<thead>
<tr>
<th>Environmental</th>
<th>Behavioural</th>
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<tbody>
<tr>
<td>Tropical climate</td>
<td>Toilet usage</td>
</tr>
<tr>
<td>High humidity</td>
<td>Personal cleanliness</td>
</tr>
<tr>
<td>Unhygienic sanitation</td>
<td>Occupation (e.g. farmer)</td>
</tr>
<tr>
<td>Land surface temperature</td>
<td>Wearing shoes</td>
</tr>
<tr>
<td>Night soil fertilizer</td>
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2.5 Epidemiology and disease burden

2.5.1 Worldwide

Worldwide, 2 billion people are infected with soil-transmitted helminths (STH) mainly in the developing nations of Asia, Africa and Latin America.\textsuperscript{5} *Ascaris lumbricoides* is the most prevalent STH with an estimated 1 billion infections globally; and *Trichuris trichiura* and hookworm (*Necator americanus* and *Ancylostoma duodenale*) each infect approximately 600-800 million.\textsuperscript{5} Globally in 2010, the population living in areas suitable for transmission of at least one STH species was estimated at 5.3 billion, including 1.0 billion school-aged children. Among the individuals at risk, 69% live in Asia.\textsuperscript{22}

STH are widespread in tropics and subtropics with the highest rates of *A. lumbricoides* infection in China and Southeast Asia, in the coastal regions of West Africa and in Central Africa. Prevalence for *T. trichiura* is highest in Central Africa, Southern India and Southeast Asia. Hookworm infections are wide-spread through sub-Saharan Africa, South China and Southeast Asia\textsuperscript{2} (Figure 8).
Figure 8: The global distribution of (a) *Ascaris lumbricoides*, (b) *Trichuris trichiura* and (c) hookworm. White areas represent countries not included in the presented study.²
The worldwide burden of STH can be assessed in disability adjusted life years (DALYs), a measurement which combines the potential years of life lost due to premature death with the years of healthy life lost due to disease-specific illness or disability. The estimates quoted in the literature vary significantly, because of different assumption about infection on health and cognitive development. Lower estimates assume that the majority of hookworm infections do not result in anaemia or protein loss in the host, whereas the higher estimates account for long-term effects of infection such as anaemia and malnutrition, of particular importance in children. Estimates range from 4.7 million DALYs (Global Burden of Disease 2001) to 39 million DALYs. 39 million disability-adjusted life years (DALYs), puts the global disease burden by STH on par with malaria and tuberculosis. The most recent (2010) estimates are 5.2 million DALYs. According to the World Bank, STH cause 16.7 million DALYs – almost half of the global disease burden among children aged 5-14 years.

### 2.5.2 China

Nationwide, disease burden decreased in the wake of China’s rapid economic development. Chinese national surveys on STH prevalence were carried out in 1988-1992 (1990 survey) and in 2001-2004 (2003 survey). Between 1990 and 2003, the prevalences have decreased considerably from 44.6% to 12.7% for *Ascaris*, 17.4% to 4.63% for *Trichuris* and 14.6% to 6.1% for hookworms. Notwithstanding this substantial decrease in numbers of infected people from an estimated 923 million to 154 million from 1990 to 2003, STH still impact substantially on public health, affecting an estimated 86 million (*A. lumbricoides*), 29 million (*T. trichiura*) and 39 million people (hookworms) (2001-2004 National Survey, National Institute of Parasitic Diseases, 2005). Recent studies have indicated high prevalence (ranging from 56% to 93% for *A. lumbricoides*, *T. trichiura* and hookworm) and multi-parasitism (50%-80% individuals infected with at least 3 parasitic infections) in rural and remote villages in the mountainous Yunnan Province.

This indicates a strong spatial variety in prevalence within China, reflecting climatic, but also large socio-economic differences. The strong spatial diversity of China’s economic development has had an impact on the spatial distribution of soil-transmitted helminths. In the late 1980s the eastern and southern provinces were affected most, whereas now, the highest prevalences are observed across 11 central, western and southern provinces (Yunnan, Hunan, Hainan, Guizhou, Sichuan, Guangxi, Chongqing, Hubei, Fujian, Jiangxi, and Anhui) with children aged 5-14 years.
suffering from the highest infection rates. In northern China, *A. lumbricoides* is more prevalent than either the prevalence of *T. trichiura* and hookworm. To our knowledge, no disability adjusted life year (DALY) estimates are available for STH in China.

### 2.6 Disease in Humans

Intestinal parasitism generally produces clinical manifestations for moderate to high intensity infections or for infections with multiple parasites, whereas low intensity infections may remain unnoticed. Highest intensity infections most commonly occur in children. The clinical features of soil-transmitted helminth infections can be either due to acute manifestations associated with larval migration through skin and viscera or acute and chronic manifestations due to parasitism of the gastrointestinal tract by the adult worms. Migrating larvae cause damage to many of the tissues through which they pass. The major soil-transmitted helminth species produce characteristic clinical manifestations. For example *Ascaris* larval antigens can cause an inflammatory response and result in verminous pneumonia, which is commonly accompanied by wheezing, dyspnoea, cough, fever and even blood-tinged sputum during heavy infections. Reinfection causes more severe disease and children are more susceptible to pneumonitis. In terms of parasitism of the gastrointestinal tract, Ascariasis can cause lactose intolerance and malabsorption of vitamin A and other nutrients, partly causing malnutrition and stunted growth. Large numbers of *Ascaris* worms in the small intestine can cause abdominal distension and pain. Especially in young children with a small intestine lumen, adult worms can cause partial or complete obstruction, leading to intestinal perforation and peritonitis. Peritonitis can be fatal. A child with obstruction due to *Ascaris* has signs of peritonitis and a toxic appearance. In children with high fever, *Ascaris* worms tend to move and emerge from the nose or the anus. When adult worms enter the hepatobiliary tree or the pancreas, it results in hepatobiliary and pancreatic ascariasis, most commonly occurring in adults.

Adult whipworms preferentially live in the caecum, but also tend to appear in the colon and rectum in heavy infection. Trichuriasis can lead to inflammation of the intestinal mucosa at the site of attachment of large numbers of whipworm, resulting in colitis. Longstanding colitis causes signs and symptoms similar to inflammatory bowel disease, including chronic abdominal pain and diarrhoea as well as sequelae of impaired growth, anaemia and clubbed fingers. Even more serious is trichuris dysentery syndrome, a manifestation of a heavy whipworm infection, resulting in dysentery and rectal prolapsed.
The major pathology of hookworm infection results from intestinal blood loss, caused by adult parasite attachment to the mucosa of the small intestine. Hookworm disease occurs if the blood loss exceeds the nutritional reserves of the host, causing iron-deficiency anaemia. *A. duodenale* causes more blood loss than *N. americanus*. Clinical manifestations of hookworm disease are similar to those of iron-deficiency anaemia.\(^{33}\) Chronic protein loss from heavy hookworm infection can result in hypoproteinaemia and anasarca. Because of their reduced iron reserves, children, women of reproductive age, and pregnant women are frequently the ones most susceptible to developing hookworm anaemia.\(^{5}\)

Hookworm third stage larvae also migrate through the blood vessels to the lungs, but cause less severe pneumonitis than *Ascaris*. Hookworms penetrate the intact skin, causing several cutaneous syndromes, such as ground itch and rash on the hands and feet.\(^{33}\) Oral ingestion of *A. duodenale* larvae can result in Wakana syndrome, which is typically accompanied by nausea, vomiting, cough, pharyngeal irritation and hoarseness.\(^{5}\)

In general, STH infections most severely affect children. They are more prone to harbouring heavy infections,\(^{5}\) resulting in malnutrition that can dramatically affect both physical and mental child development. Infected children are stunted and their cognitive ability is reduced, leading to poor performance at school. Furthermore, their immune system is weakened, making them more prone to secondary infections. Chen et al\(^{8}\) report that the average height of children suffering from *Ascaris* infection is 2.51cm lower than that of healthy children and that their body weight was 2.28 kg lower after expelling the worms. Another study in rural areas in southern China showed that the overall prevalence of stunting was 25.6%, based on WHO child growth standards. Moderate to heavy infections were the main predictor for stunting.\(^{34,35}\)

Various epidemiological studies have shown that infections with multiple parasites can lead to clinically significant morbidity, even at low infection intensities. In most developing countries infections with multiple parasites are more common than single species infections and are therefore of high public health significance.\(^{31}\) A recent study has shown that chances of having anaemia for children with low-intensity polyparasite infections were nearly five times higher than for children without infection or with one parasite species at low intensity.\(^{31}\) A Brazilian study targeting 520 children\(^{36}\) found that children hosting both *Ascaris* and *Trichuris* suffered more severely from malnutrition than children hosting these parasites in isolation.
2.7 Diagnosis

Direct diagnosis of STH infection is by detection of eggs in the faeces. Different methods have been developed to detect helminth eggs in stool. In field studies, the Kato-Katz thick smear technique is most common, because of its simplicity and relatively low cost. It is used to examine a calibrated amount (40-50 mg) of faeces and is a simple, rapid way of quantitatively detecting infections recommended by WHO for monitoring control programs. Kato-Katz thick smear technique allows concurrent examination of STH and other parasites such as schistosomes. To maximize the sensitivity of the method, the standard procedure is to examine three slides each from two stool samples. Drawbacks of the Kato-Katz method include its low sensitivity for hookworm diagnosis and its inability to detect light and recently acquired infections. This limitation is of particular importance in countries where the prevalence and intensity of infections has been significantly reduced due to regular deworming. In these settings where the focus shifts from treatment to prevention, sustained reduction and, potentially, the elimination of STHs, diagnostic methods with higher sensitivity are urgently required.

Furthermore, the low sensitivity of a single (and even triplicate) Kato-Katz for the detection of hookworm infections is alarming. The glycerol used for slide preparation, destroys the thin shell of the hookworm eggs, and they can no longer be detected under a light microscope. WHO developed bench aids suggesting to read Kato-Katz thick smears within 30-60 min after preparation.

A promising method with higher sensitivity for low intensity infections and hookworms, the FLOTAC® technique, has been described recently for human and veterinary medicine. This method is facilitated by the FLOTAC® apparatus, which has been designed to carry out flotation in a centrifuge, followed by a cut of the apical portion of the floating suspension. This method can diagnose intestinal protozoa and helminth infections concurrently with high sensitivity. In a recent study carried out in Côte d’Ivoire, its performance for hookworm diagnosis has been shown to be superior to the Kato–Katz and a standard SAF–ether–concentration method.

The Formol-Ether Concentration method is another widely used method. It has the advantages of fixing the parasites, thus making the samples non-infectious, as well as preserving many types of cysts, which the Kato-Katz technique does not. In well equipped laboratories, DNA amplification tests can provide an alternative approach for STH diagnosis. These tests provide higher sensitivity and specificity than traditional coproparasitological approaches and can be used
for the quantification of egg numbers. However, they require expensive laboratory equipment and reagents and are therefore not applicable in resource-poor field settings.48

STH infections can also be identified indirectly by serological detection of parasite specific antigen-antibody complexes or by examination of intradermal hypersensitivity reaction to parasite antigens.49 These techniques can be applied in regions of low endemicity, where patients have low intensity infections and are egg-negative in parasitological examinations. However, expensive biochemical reagents and trained staff capable to run the tests are required and may not be available in remote areas. Furthermore, antibody responses may remain positive for up to 2 years after successful chemotherapy.50

In China, the Saturated Saline Flotation Method is frequently used to detect STH, especially for hookworm. Faeces are diluted in saturated saline solution, allowing the eggs to float. Consecutively, the solution is covered with a microscope slide. Eggs float to surface and stick to microscope slide when the slide is lifted quickly.51

2.8 Treatment

The benzimidazole anthelmintics, albendazole (400mg) or mebendazole (500mg) are commonly used to treat STH.5 Albendazole has limited efficacy for \textit{T. trichiura} and is therefore replaced by mebendazole, although repeated treatments are often necessary due to poor absorption of mebendazole in the gastrointestinal tract.5 Efficacy measures were the cure rate and the faecal egg count reduction using the McMaster egg counting technique to determine faecal egg counts. The highest cure rates were observed for \textit{A. lumbricoides} (98.2%) followed by hookworms (87.8%) and \textit{T. trichiura} (46.6%).52 However, cure rates can be 100% particularly in those with low intensity infections.53 Therapeutic efficacies, as reflected by the faecal egg count reductions, were very high for \textit{A. lumbricoides} (99.5%) and hookworms (94.8%) but significantly lower for \textit{T. trichiura} (50.8%).52

Part of the low efficacy of albendazole or mebendazole in \textit{T. trichiura} and \textit{N. americanus} may be due to benzimidazole-resistant genotypes in these parasites. Genetic polymorphism in β-tubulin, which causes benzimidazole resistance in livestock parasites, have recently been found in \textit{T. trichiura} and \textit{N. americanus}.54
To achieve the UN Millennium Development goals, new anthelmintic drugs are urgently needed.\textsuperscript{55} Recently, a new, oral single-dose anthelmintic that is active in an animal model of hookworm was discovered. In a single oral dose the cysteine protease inhibitor K11777 provides near cure (>90\%) of hookworm infection in hamsters. However, it will be necessary to define oral efficacy in other animal models, before K11777 can be tested in humans.\textsuperscript{56}

2.9 Prevention and Control

2.9.1 STH control worldwide

Worldwide, morbidity control in the form of targeted mass drug administration (MDA) is the major focus for STH control. The WHO strategy for soil-transmitted helminthiasis control is to treat once or twice per year pre-school and school-age children; women of childbearing age and adults at high risk in certain occupations (e.g. tea pickers and miners).\textsuperscript{57} Anthelminthic drugs are effective (see Treatment), cheap and safe and therefore mass drug administration to schoolchildren in STH endemic areas in low-income countries is recommended by WHO. Each infection can be classified into light, moderate and heavy intensity according to the thresholds established by a WHO Expert Committee\textsuperscript{57} shown in Table 3. Treatment frequency recommended by WHO depends on infection prevalence and intensity (Table 2). Treating children can reduce overall transmission in the community, as children considerably contribute egg contamination to the environment\textsuperscript{9} (Section 2.10.1).
Table 2: Recommended control strategies for STH infections in school-age children

<table>
<thead>
<tr>
<th>Category</th>
<th>Prevalence of any STH infection at baseline</th>
<th>Control strategy</th>
<th>Additional interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools in high-risk areas</td>
<td>≥50%</td>
<td>Treat all school-age children (enrolled and non-enrolled) twice a year&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Improve sanitation and water supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Provide health education</td>
</tr>
<tr>
<td>Schools in low-risk areas</td>
<td>≥20% and &lt;50%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Treat all school-age children (enrolled and non-enrolled) once a year</td>
<td>Improve sanitation and water supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Provide health education</td>
</tr>
</tbody>
</table>

<sup>a</sup> If the resources are available and the prevalence is towards the higher end of the interval, a third drug distribution might be added (in this case the frequency will be every 4 months).

<sup>b</sup> When the prevalence of any STH infection is under 20%, large scale preventive chemotherapy interventions are not recommended. Affected individuals should be treated on a case-by-case basis.

Table 3: Classes of intensity for STH

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Light-intensity infections [epg]&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Moderate-intensity infections [epg]</th>
<th>Heavy-intensity infections [epg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. lumbricoides</td>
<td>1 – 4999 epg</td>
<td>5000 – 49 999 epg</td>
<td>≥ 50000 epg</td>
</tr>
<tr>
<td>T. trichiura</td>
<td>1 – 999 epg</td>
<td>1000 – 9 999 epg</td>
<td>≥ 10000 epg</td>
</tr>
<tr>
<td>Hookworms</td>
<td>1 – 1999 epg</td>
<td>2000 – 3999 epg</td>
<td>≥ 4000 epg</td>
</tr>
</tbody>
</table>

<sup>a</sup> epg = eggs per gram of faeces.

In 2001, the 54th World Health Assembly (WHA) passed a resolution (WHA resolution 54.19) calling for periodic deworming of at least 75% of all school-aged children in highly endemic areas by 2010 and targeting other high risk groups (young children, women of childbearing age, occupational groups) through existing public health programs and channels. This strategy has been widely adopted by many control programmes including the Schistosomiasis Control Initiative (SCI). The SCI aims to administer anthelmintics to control seven of the most prevalent (Neglected Tropical Diseases (NTDs) (including STH) in sub-Saharan Africa with an emphasis on a school-based approach.
For long-term sustainability, the WHO recommends improved access to safe water and sanitation and improved hygiene behaviour through health education in addition to MDA. In 2003, preventive chemotherapy was combined with school nutrition programs in 30 countries and could therefore make use of existing infrastructure, which allowed a distribution at very low cost.

Costs for school-based treatment are estimated at 0.50 US$ per child per year where both schistosomiasis and the common intestinal worms are present. Where only the latter exist, the cost is less than 0.25 US$ per child per year. This price covers the cost of the drugs, their delivery, equipment, health education materials, training for implementing personnel, and monitoring and evaluation.

Over the past 10 years, significant progress has been made in controlling these infections. In 2010, about 314 million preschool and school-aged children (representing 31% of all children in the world at risk of soil-transmitted helminthiases) were dewormed. Despite this increase in treatment coverage, the target of reaching 75% of school-aged children by 2010 was not reached. In the ‘WHO roadmap to overcome the global impact of NTD’, released in January 2012, the goal was reset to 75% treatment coverage for children in endemic areas by 2020.

The announcement of the WHO roadmap to overcome the misery caused by NTDs has inspired public and private partners to collaborate in the fight of these devastating, but yet neglected diseases. In recent years, major pharmaceutical companies, the Bill & Melinda Gates Foundation, the governments of the United States, United Kingdom and United Arab Emirates and the World Bank announced substantial support to accelerate the control, elimination and possibly the eradication of these diseases. Measures mainly include sustaining or expanding current medicine donation programs to meet demand by 2020 and sharing expertise and compounds to promote research and development of new medicines. All partners also endorsed the ‘London Declaration on Neglected Tropical Diseases’ in which they pledged new levels of collaborative effort and tracking of progress in tackling 10 of the 17 neglected tropical diseases currently on WHO's list. http://www.who.int/neglected_diseases/London_meeting_follow_up/en/index.html

Even though other strategies for the control of STH such as intensified disease management, provision of safe water, sanitation and hygiene are advocated in the WHO roadmap, the main focus for STH control remains MDA. Health education is no longer explicitly mentioned as part of the
STH control strategy in this important policy document. However, it still forms part of the ‘WHO guide for managers of helminth control programs in school-aged children’. 

### 2.9.2 STH control in China

In China, STH prevalence has decreased remarkably between the National Surveys in 1990 and 2003, as described above. This is partly due to economic development and improved living conditions, but also due to national control efforts such as the deworming program launched by Chinese Ministry of Health in 2005. The program includes large-scale deworming with effective drugs in areas where infection rate of STH > 50% and for school-aged children and farmers in areas where infection rate of STH is > 10%. Intestinal helminthiasis control in primary and middle school students was carried out for 10 consecutive years in all the provinces and the mass deworming in rural area was conducted in some provinces. However, according to a WHO report published in 2008, only 1% of the at-risk population receives regular and periodic deworming. This may be an underestimation and does not reflect P.R. China’s rapid economic development and figures stated in the Chinese literature.

Our investigations in the study area have shown that deworming efforts including mass treatment were only carried out for a few years, starting in 2006, and then terminated. During the duration of this study, no intestinal helminthiasis control efforts were undertaken in the study area.

The aim of the ‘Chinese National Control Program on Important Parasitic Diseases’ (2006-2015) is to build hygienic sanitary latrines with 60% coverage in rural areas by 2010 and 80% by 2015. Another control strategy includes health education, aiming at raising awareness of STH prevention to 70% in China. Healthy behaviour rate should be above 60% and 80% by the end of 2010 and 2015 respectively. Our observations in the study area have revealed that the 2010 goal for both sanitary coverage and healthy behaviour have not been reached.

In most rural areas a network of several non-governmental organizations (NGOs) such as National Patriotic Health Campaign Committee, the All-China Women’s Federation, the Communist Youth League of China work with the local Centres for Disease Control (CDC) and schools, encouraging hygienic behaviours such as washing hands with soap before eating and not drinking unboiled water.
A three year (2007-2009) STH control program enrolling 2.8 million people in 10 demonstration areas in China has achieved major reduction of STH by 78.39% (8 areas targeting STH in Anhui, Jiangxi, Hunan, Guangxi, Hainan, Sichuan, Guizhou and Yunnan and 2 areas targeting liver fluke (Clonorchis sinensis) in Guangdong and Anhui province). Main findings of the control program were: 95.92% gained relevant hygiene knowledge (increase by 112.31%), 98.78% practice good hygiene in their daily life, (increase by 72.15%), 54.35% increase in use of safe toilets, 37.20% increase in safe water use. The program applied an integrated control strategy including: health education, control of infection source (e.g. construction of safe toilets, safe water supply) and treatment. The pilot study concludes that the control efforts in the demonstration plots was effective in controlling parasitic diseases and the strategies applying health education combined with the reduction of infectious sources meet the needs of rural people in China.

2.9.3 Need for integrated control

Globally, most control programs nowadays are highly dependent on MDA of anthelmintic drugs and require annual or biannual treatment of large numbers of at-risk populations, over prolonged periods of time. Recently, there has been considerable debate concerning the sustainability of STH control using MDA alone due to compliance issues and the recurrent treatment required in the absence of preventive control measures. The benefit of MDA has been questioned after a recently published Cochrane review by Taylor-Robinson and colleagues in 2012 which summarized the effects of de-worming on nutritional indicators, haemoglobin and school performance in 42 randomized controlled trials (RCTs) comprising a total of 65,000 participants. The review concluded that there is insufficient reliable information to determine whether de-worming has an effect on nutritional indicators, haemoglobin and school performance and, hence, the justification for de-worming programs is questionable. Further, it has repeatedly been shown that STH control programs which solely rely on chemotherapy are not sustainable and do not prevent reinfection. A systematic review analysing 24 studies using drug treatment targeting STH at 3, 6, and 12 months post-treatment has revealed pre-treatment prevalence levels of 26%, 68% and 94% respectively for A. lumbricoides. For T. trichiura, respective reinfection prevalence were 36%, 67% and 82% and for hookworm, 30%, 55% and 57%. An example from Sri Lanka showed that, after 10 years of mass deworming, prevalence in schoolchildren bounced back after cessation of preventive chemotherapy. In Zanzibar, after approximately 15 years of
chemotherapy-based control, infection prevalence was still high and anaemia was common, but helminth infection intensities were lower. The authors of the study in Zanzibar conclude that chemotherapy is effective in reducing infection intensities and morbidity, but has only limited effect on infection prevalence. 75

To avoid rapid reinfection, an integrated strategy combining MDA with transmission control based on improved sanitation, health education and behaviour change is needed. 9-11, 43, 54 Asaolu and Ofoezie 13 have shown that an integrated strategy results in larger reductions in prevalence, unattainable by chemotherapy alone. The role of health education in STH control is discussed in more detail in section 2.10.1.

Another reason why new integrated control strategies are urgently needed is the raising concern about the development of parasite resistance to albendazole and other anti-STH drugs due to continued treatment pressure by extensive mass drug administration. 76 The development of new drugs or vaccines for these diseases is a top priority. In 2000 the Sabin Vaccine Development program launched the Human Hookworm Vaccine Initiative, supported by the Bill & Melinda Gates Foundation. To date, the Human Hookworm Vaccine has shown promising laboratory results and early stage clinical trials for the hookworm vaccine are currently ongoing. 77

To plan, coordinate, monitor and survey STH control programs, geographic information systems (GIS) are a useful tool, facilitating the integration of social, epidemiological and environmental data on risk maps. The free open access Global Atlas for helminth infections (www.thiswormyworld.com) does not only provide a global information resource on the distribution of STH and schistosomiasis, but also presents a powerful evidence-based planning tool. This becomes increasingly important allowing the most efficient allocation of funds to the communities with the highest prevalence of infection and the greatest morbidity. 78

2.9.4 Social science implications for control of helminth infections

Insights provided by social science become increasingly important for the design of helminth control programs. Recent studies have shown that helminth control programs are more effective if interventions apply an interdisciplinary approach and go beyond diagnosis and treatment activities. 3 A major limitation for implementation of the control and elimination of helminthiasis in endemic
countries is the inadequate coverage and sustainability of programmes that are not only due to poverty but also to social, cultural, and political forces that remain understudied. To address these so-called social determinants of health, social science perspectives in parasitic and infectious disease control are essential. Figure 9 summarizes the social-ecological approach to research on STH as outlined in the ‘Research Agenda for STH control’.³

![Social-ecological approach to research on social and environmental determinants and health promotion in helminthiasis control.³](image)

In 2007, the UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) established an expert committee to examine the status of applied social science in tropical disease control and to integrate social sciences into the TDR. Attention to the social determinants resulted in an altered view of helminthiases, and greater appreciation of the social and biological contexts in which these diseases emerge and persist.⁷⁸

It has been shown that methods and community participatory research combining quantitative data, such as results of surveys or surveillance measures, with qualitative approaches are valuable tools to assess and understand attitudes and perceptions that are the precursors of human behaviour.⁷⁸
Community participation is also crucial to improve community health through NTD control programs, since it increases people’s autonomy, enabling them to make informed behavioural choices on the individual level. On national level, it fosters empowerment of developing countries in terms of access to health resources.\textsuperscript{3}

The ‘PRECEDE-PROCEED model’ has been used successfully in helminth disease control to facilitate health education and behaviour change by differentiating the roles of individuals, communities and outside influences on infection as well as to separate deliberate and non-deliberate health-related behaviours (Figure 10).\textsuperscript{78} The main purpose of the PRECEDE-PROCEED model is to provide a structure for planning and evaluating health behaviour change programs. The PRECEDE framework was developed in the 1970s by Green et al.\textsuperscript{79} PRECEDE stands for ‘Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation’. PRECEDE is based on the proposition that educational diagnosis should precede an intervention plan, in the same way that a medical diagnosis precedes a treatment plan. The PROCEED component (Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development) was added to the framework to recognize the importance of environmental factors that are determinants of health and health behaviour.

This model was important for the design of this study, since its approach addresses the concern that health education focuses too much on implementing programs and not enough on designing interventions that are strategically planned to meet demonstrated needs\textsuperscript{80}. In this thesis much importance was laid on developing a culturally tailored educational package which met the demonstrated needs of the target population.
Innovative interventions that are community-directed and school-based can increase treatment coverage and compliance, promote behavioural change, and promote community ownership of programs.3

2.10 Health education and health promotion

This section describes the two disciplines of health education and health promotion and discusses their importance for the control of STH. The World Health Organization defines health promotion and health education as follows: “Health promotion is a process of enabling people to increase control over their health and its determinants, and thereby improve their health. Health education is a process comprising of consciously constructed opportunities for learning and
communication designed to improve health information, health literacy, health knowledge and developing life skills which are conducive to the promotion of an individual and community’s health including that of the environment.”

(WHO: http://www.who.int/healthpromotion/about/HPR%20Glossary%201998.pdf). The aim of health education is to change human behaviour by increasing awareness of the health and social impacts of a disease.

Health promotion is a term of more recent origin than health education. According to WHO the focus has shifted from health education to health promotion, catalysed by the first International Conference on Health Promotion in Ottawa 1986. Health Promotion includes a broad approach not only directed at strengthening the skills of individuals, but also action directed towards changing social, environmental and economic conditions to alleviate their impact on public and individual health. Health education, however, mainly includes creating concrete opportunities for the community to improve their health by creating knowledge and developing skills.

According to this terminology, the current project can be categorized as health education project as it includes an intervention which is a constructed opportunity for children to improve health knowledge and skills. At this stage the project does not include policy making on a broader scale, but once the intervention material including the cartoon has proven effective, it can be the basis of a large scale health promotion campaign in China and beyond. However, definitions of health education and health promotion vary over place and time. In some countries, such as Australia, health education is considered a much narrower approach than health promotion. In the United States they are often used interchangeably. Although the term health promotion emphasizes efforts to influence the broader social context of health behaviour, the two terms remain closely linked and overlapping and are often used in combination.

### 2.10.1 Importance of health education for helminth disease prevention

The effectiveness of health education for the prevention of STH has been shown repeatedly. Integrated control programs, including school-based health education, have been highly successful in Japan and Korea. Within 37 years, Japan decreased STH prevalence from 64% in 1958 to 0.06% in 1995. In Korea, it took 26 years to decrease prevalence from 55% in 1971 to 0.06% in 1997. Japan has promoted international collaboration, creating a network to collect epidemiological information to improve STH and schistosomiasis control, extending their successful school-based
control method throughout Asia.\textsuperscript{23} The impact of knowledge on STH infection has been shown in various studies. In Thailand, where children with more knowledge on STH were less likely to get hookworm infections.\textsuperscript{10} In China, health education has had a positive effect on schoolchildren’s knowledge, attitude and practice and screening compliance regarding schistosomiasis.\textsuperscript{11,82-84}

The importance of health education in helminth disease prevention has recently been recognized in the ‘Research Agenda for Helminth Disease’ published in the journal \textit{PLoS Neglected Tropical Diseases}. Health education consolidates the benefits of MDA by reducing exposure risk through behavioural change and by increasing health-seeking behaviour. Therefore, health education, when integrated with water supply, sanitation, and housing programs is instrumental in sustaining the benefits of chemotherapy and preventing (re-) infection.\textsuperscript{3}

It is now widely accepted that the school system offers an ideal setting for deworming and delivery of health care messages\textsuperscript{85} with minimal financial input,\textsuperscript{86} since they can be integrated in existing vaccination and micronutrient supplementation programs (e.g. vitamin A)\textsuperscript{87} WHO has recognized the importance of schools to strengthen health promotion\textsuperscript{10,88} and has launched a Global School Health Initiative in 1995 which seeks to strengthen health promotion and education activities at the local, national, and global levels. The initiative is designed to improve the health of students, school personnel, families and other members of the community through schools.

The WHO provides detailed guidelines for introduction and maintenance of deworming programs (see section 2.9.1).\textsuperscript{89} Another school-based initiative was launched by UNESCO, UNICEF, WHO, Education International, and the World Bank to help countries in ‘Focusing Resources on Effective School Health (FRESH)’ including support for the distribution of anthelmintics through schools. The aim of the ‘FRESH’ partnership is to improve the health and nutrition of schoolchildren as a contribution to the global ‘Education for All’ efforts to ensure universal access to basic education. So far, more than 20 projects targeting 45 million school-aged children have been supported in Africa.\textsuperscript{90}

It has been recognized, that innovative health education approaches through multi- and mass media, can also improve community knowledge on STH, advocate community participation in control programs, and promote behavioural changes that support interventions.\textsuperscript{3}
2.10.2 Health education in China

China is a pioneer in implementing control measures for NTDs including health education, such as lymphatic filariasis and schistosomiasis. Its schistosomiasis control program that combines human and bovine chemotherapy with environmental modification, improved sanitation, health education and replacement of bovines with tractors in schistosomiasis endemic areas proved highly successful. The importance of health education for schistosomiasis control has been recognized, since it can help people change behaviour, thus preventing or reducing infection and encouraging communities to participate in schistosomiasis control programs. The control strategy for STH, including health education, proved so successful that it was adapted for the current national community and school-based STH control program (section 2.9), launched by the Chinese MOH in 2006. The STH control programs aims to integrate chemotherapy with health education initially and then in time, combine these with additional water, sanitation and hygiene (WASH) interventions.

The five-year action plan (2006-2010) is called “Hundreds of Millions Farmers’ Health Promotion Program” and aims at delivering health education to 80% of rural residents in China’s East and 60% in the western Regions. Additionally, 80% of all rural schools should offer health education as part of the curriculum. Our observations in the study area have shown that a learning module titled “Life and Health” is taught approximately once a week with the help of a colourful book. However, the teachers’ knowledge on the topics is limited and therefore the subject is neglected in some schools. Nevertheless, schools provide an efficient platform for health interventions in China, since enrolment in primary and junior secondary schools is high.

2.10.3 Behaviour theories

Various studies have shown that health promotion and health education programs are more successful when grounded on educational theories such as Social Learning Theory, Health Belief Models, Cognitive Theory of Multimedia Learning and Transtheoretical Model. However, health behaviour is too complex to be explained by a single theory. Therefore, models combine a number of theories to help understand a specific problem in a particular context. Nowadays, no single theory or conceptual framework dominates research or practice in health promotion and education and researchers tend to choose from a multitude of theories.
Glanz et al\textsuperscript{81} carried out four systematic reviews between 1998 and 2005 analysing hundreds of publications to identify the most frequently used theories in health education and promotion. Most frequently mentioned theories in health education from 1980 to 2005 were the Social Cognitive Theory, the Health Belief Model, Theory of Reasoned Action and Transtheoretical Model. Of significance for the current study are Social Learning Theory, Health Belief Model, Transtheoretical Model and Cognitive Theory of Multimedia Learning.

**Social Cognitive Theory**

The Social Cognitive Theory was built on theorization and research by Miller and Dollard,\textsuperscript{99} and Rotter.\textsuperscript{100} Based on principles of learning within the human social context, it was first known as Social Learning Theory\textsuperscript{101} and renamed Social Cognitive Theory when concepts from cognitive psychology were integrated that allowed understanding of human information processing capacities.\textsuperscript{102} Social Cognitive Theory looks at the interaction between people and their environments. The following list defines the key concepts of Social Cognitive Theory, which are important for this study. Behaviour change is more likely to occur, if these key concepts are met by a health education program.\textsuperscript{81}

- **Self-efficacy belief:** consists of a person’s belief about their ability to perform behaviours that bring desired outcomes.\textsuperscript{102}

- **Observational learning:** includes learning of new behaviours by exposure to interpersonal or media displays of them and is influenced by attention, retention, production and motivation.\textsuperscript{102}

- **Positive outcome expectations:** benefits for the individual are maximized, whereas costs are minimized.\textsuperscript{81}

- **Self-evaluative outcome** (how others see our behaviour) can be more important than social and material outcome for individuals.\textsuperscript{81}

The observational learning concept is of particular interest for this study. Many studies have shown that behaviour models are imitated most frequently when observers perceive the models as similar to themselves, making peer modelling a well-recognized method for influencing behaviour.\textsuperscript{103} Peer modelling has often been used in entertainment education. Hinyard and Kreuter\textsuperscript{104} showed that storytelling in the form of a narrative (entertainment education) may be more effective than the presentation of directly didactic or persuasive messages.\textsuperscript{81} However, even if
a health education project is implemented according to principles of the Social Cognitive Theory, it will only lead to behaviour change if the target group’s environment supports the new behaviours.\textsuperscript{97} The Social Cognitive Theory is a very broad theory that may be enhanced by blending concepts and methods from different theory and models such as the Health Belief Model, where outcome expectations are categorized and measured.\textsuperscript{81,97}

**Health Belief Model**

The Health Belief Model contains several primary concepts that predict why people will take action to prevent or to control illness conditions. These include the following:\textsuperscript{81}

- **Perceived susceptibility**: belief about the chances of experiencing a risk or getting a condition or disease.
- **Perceived severity**: belief about how serious a condition and its consequences are.
- **Perceived benefits**: belief in efficacy of the advised action to reduce risk or seriousness of impact.
- **Perceived barriers**: belief about tangible and psychological costs of the advised action.
- **Cues to action**: Strategies to activate “readiness” such as to provide how-to information and use appropriate reminder systems.
- **Self-efficacy**: confidence in one’s ability to take action.

The Health Belief Model is a powerful model because its main concept is perceived susceptibility which is a strong predictor of preventive health behaviour. However, the Health Belief Model does not address social and contextual issues. The educational package developed within this research project aimed to positively influence the schoolchildren’s perceived susceptibility to worms, in order to improve their behaviour thereby preventing infection.

**Transtheoretical Model**

The Transtheoretical Model is one of the most widely used models of health behaviour focusing more on changes in behaviour and less on cognitive variables such as perceived risk or
perceived barriers. The Transtheoretical Model assumes that it is necessary to raise people’s awareness of the harms associated with the exposures and the benefits to be achieved from behavioural change.\textsuperscript{81}

The model is based on two major constructs: stages of change and decisional balance. The stages of change are based on current behaviour and intention. The model implies a sequence of stages of behavioural change from those who have not adopted safer behaviour and do not intend to do so, or those who are unaware (Precontemplation), those who are thinking about adopting their behaviour (Contemplation), those who have adopted the behaviour (Action), and those who have adopted and regularly practice safer behaviour (Maintenance). Precontemplation and contemplation stages emphasize knowledge and emotional factors such as risk awareness, understanding vulnerability, coping with fear and educating about early treatment benefits. Action and maintenance stages emphasize environmental and social support such as convenience of access, social and practical supports and reminders of safe behaviour.\textsuperscript{81}

Decisional balance is a summary index of facilitators of change and barriers to change. The model argues that people are in different stages of readiness to make health behaviour changes and that they should receive interventions appropriate for their stage in the behaviour change process. The aim of the model is to design interventions that reach unmotivated individuals, and to identify means of facilitating movement from preceding stages of change to action and maintenance stages.\textsuperscript{105} Even though the Transtheoretical Model quickly became one of the most widely used models of health behaviour, it is also controversially discussed among researchers.\textsuperscript{81} Critical voices highlight that stages of change may be just another way of measuring behavioural intentions and these measures are very similar to intention measures that assess whether one is unlikely or likely to act.\textsuperscript{106} So stages of change and behavioural intentions are often highly correlated, suggesting a significant overlap in the two constructs.\textsuperscript{107} Correlation studies also successfully predict subsequent behaviour, which makes the additional contribution of the Transtheoretical Model less obvious (Glanz, 2008).

**Cognitive Theory of Multimedia Learning**

Cognitive Theory of Multimedia Learning is built on the assumption that multimedia instructional messages are more likely to lead to meaningful learning, if they are designed according to the functioning of the human mind.
According to Cognitive Theory of Multimedia Learning, people possess separate channels for processing verbal and visual materials (dual-channel assumption) (Figure 11), each channel can process only a small amount of material at a time (limited capacity assumption) and meaningful learning involves engaging in appropriate cognitive processing during learning (active-processing assumption).  

Multimedia instructional messages should be designed in such a way that they favour and prime the following five cognitive processes in the student while exposed to instructional multimedia. 

- selecting relevant words from the presented text or narration
- selecting relevant images from the presented illustrations
- organizing the selected words into a coherent verbal representation
- organizing selected images into a coherent pictorial representation
- Integrating the pictorial verbal representation and prior knowledge.

The Cognitive Theory of Multimedia Learning was central to this research. Our hypothesis that video-based health education was effective was, to a vast extent, based on this theory’s assumption.
that improving learning outcomes requires engaging different cognitive channels, in order to overcome the limited processing capacity of a single cognitive channel.\textsuperscript{108}

The importance of health education for STH is discussed in section 2.10.1. The relevance of behaviour theories for the production of an educational video is discussed in Chapter 5.

### 2.11 Knowledge gaps and research priorities

The Disease Reference Group on Helminth Infections (DRG4), established in 2009 by the Special Programme for Research and Training in Tropical Diseases (TDR), was given the mandate to review helminthiases research and identify research priorities and gaps. In April 2012, the journal *PLoS Neglected Tropical Diseases* published a collection of papers entitled ‘A Research Agenda for Helminth Disease’. The aim of the collection was to undertake a comprehensive review of recent advances in helminthiases research, identify research gaps, and identify priorities for a research and development agenda for the control and elimination of these infections.

Priorities were selected according to their potential for improving global health and achieving the Millennium Development Goals (MDGs) (Table 4).

<table>
<thead>
<tr>
<th>Core Theme</th>
<th>Priority\textsuperscript{b}</th>
<th>Description of Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions</td>
<td>1</td>
<td>Optimise existing interventions tools to maximise impact (taking into account polyparasitism) and sustainability. The tools include pharmaceuticals, vaccines, vector control, and eco-health approaches (access to clean water and sanitation, improved nutrition, education). Sustainability depends on minimising selection for drug resistance and maintaining community support for adequate coverage and compliance.</td>
</tr>
<tr>
<td>Interventions</td>
<td>2</td>
<td>Develop novel control tools that will improve impact and sustainability. The tools include new pharmaceuticals, vaccines, vector control methods, and eco-health approaches.</td>
</tr>
<tr>
<td>Epidemiology and surveillance</td>
<td>3</td>
<td>Improve existing/develop novel diagnostic tests, with particular reference to their performance regarding sensitivity, specificity, multiplex capacity, and ability to measure infection intensity/active infection. Sensitivity and specificity are mostly important to enable diagnosis of infection at low prevalence in elimination settings and to confirm cure/absence of particular infection.</td>
</tr>
<tr>
<td>Epidemiology and surveillance</td>
<td>4</td>
<td>Standardise and validate methodologies and protocols for diagnosis in monitoring and evaluation (M&amp;E) settings.</td>
</tr>
<tr>
<td>Interventions; environment and social ecology</td>
<td>5</td>
<td>Develop strategies incorporating delivery of multiple and combinations of interventions at various (individual, community, district, national) levels to maximise sustainability of control programmes in general and of integrated control programmes in particular.</td>
</tr>
<tr>
<td>Environment and social ecology</td>
<td>6</td>
<td>Develop strategies (taking gender issues into account) to increase community participation, ownership, and empowerment, as well as equity in access by communities and risk groups to health services.</td>
</tr>
<tr>
<td>Data and modelling</td>
<td>7</td>
<td>Develop and refine mathematical models to investigate relationships between infection and morbidities to aid programmes aiming to reduce the burden of disease (elimination of public health problem). Such models need to take into account cumulative effects of chronic disease for evaluation of disease burden and the impact on such burden of control interventions.</td>
</tr>
<tr>
<td>Data and modelling</td>
<td>8</td>
<td>Increase use and application of mathematical models to aid M&amp;E, surveillance, elimination efforts, and the design of sampling protocols as well as the monitoring of intervention efficacy, including drug resistance. These models should be linked to economic impact studies of the diseases and cost-effectiveness analyses of the interventions, their combinations, and their alternatives.</td>
</tr>
<tr>
<td>Fundamental biology</td>
<td>9</td>
<td>Define the determinants and impact of parasite modulation of the host–parasite relationship, including impact on the host response to concurrent infection with other helminth and non-helminth pathogens and to vaccination, and parasite responses, including immune responses to interventions.</td>
</tr>
<tr>
<td>Fundamental biology</td>
<td>10</td>
<td>Annotate parasite genomes and transcriptomes and develop tools for parasite functional genomics (and other “omics”) in key species.</td>
</tr>
</tbody>
</table>

Numbering of the ten top priorities does not reflect order of importance; instead, they are organised according to core theme; all the (inter-connected) priorities are to be addressed in parallel as each priority will benefit from accomplishing the others.

This thesis addresses priority 1, by providing evidence that a video-based health education is a highly efficacious tool to prevent STH in schoolchildren, which allows to optimize existing school-based interventions (eco-health approaches/improved education); priority 2 by developing a novel control tool that can improve the impact and sustainability of current control efforts (eco-health approaches); priority 5 by developing an effective integrated control approach that maximizes the sustainability of control programs. This thesis contributes significantly to the evidence base in the core theme ‘environment & social ecology’ identified in Gazzinelli et al., by assessing the impact of health education/health promotion on infection levels, a major research gap identified the same review series on helminth diseases in humans.

Additionally, this study contributes to the evidence base quantifying the impact of a video-based health educational intervention. Even though these popular tools are frequently used, scientific evidence assessing their impact is very limited (see Chapter 3).
Chapter 3

Impact of preventive health educational videos
3 A systematic review of preventive health educational videos targeting infectious diseases in schoolchildren

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3.1 Context

The value of multimedia in education has been discussed for over four decades. Indeed, television programs such as *Sesame Street*\textsuperscript{111} and *Between the Lions*\textsuperscript{112} have shown the positive effects of educational television on the reading and language development of young children. The value of a moving image in health education has been highlighted by the World Health Organization as early as 1988.

In the context of this thesis it was important to gain an overview of existing literature assessing the impact of preventive health educational videos targeting infectious diseases in schoolchildren. Therefore, this chapter provides a systematic literature review of preventive health educational videos targeting infectious diseases in schoolchildren. We included studies which evaluated interventions involving video-based health education in schools. In addition to assessing previous literature, the chapter also provides recommendations for establishing an evidence base for future studies. The key findings are combined with experiences we personally gained during the intervention trial in China, described in Chapter 6.

3.2 Publication

This chapter is presented as a published paper. A reprint of the article is presented in Appendix A.1.
Abstract

We carried out a systematic review of preventive health educational videos targeting infectious diseases in schoolchildren in order to formulate recommendations for establishing an evidence base for future studies. We included studies which evaluated interventions involving video-based health education in schools to improve knowledge and attitudes and to change behaviour regarding different infections. Behaviour changes or decreases in disease prevalence proved difficult to evaluate in the eleven studies we reviewed but the majority concluded that videos were well received by schools, teachers and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes. Overall, videos are invaluable health intervention tools, because they engage the audience and they effectively increase knowledge. However, there is a pressing need for more standardized, high-quality studies in order to build a more solid evidence-base for the design of future video-based interventions targeting infectious diseases in schoolchildren.

Introduction

The value of a moving image in health education was highlighted as early as 1988 when a manual published by the World Health Organization (WHO)\textsuperscript{113} pointed out that no other media creates such lively interest as television. Indeed, television programs such as Sesame Street\textsuperscript{111} and Between the Lions\textsuperscript{114} have shown the positive effects of educational television on the reading and language development of young children. Furthermore, the importance of involving schools to strengthen health education has been recognized.\textsuperscript{10,88} The WHO and other organizations have launched global school health programs (“Global School Health Initiative” in 1995 and “Focusing Resources on Effective School Health (FRESH))” which seek to strengthen health promotion and educational activities in schools at the local, national, and global levels.\textsuperscript{90} The studies reviewed here have sought to combine education and entertainment through multimedia in order to inform and engage children at the same time, and assesses the public health role for preventive educational videos targeting schoolchildren. The review is unique, being the first to critically analyse the public health value of school-based videos for infectious diseases. The key findings are combined with experiences we have personally gained during an intervention trial we are undertaking in China, which is assessing whether an educational video targeting soil-transmitted helminth (STH)
prevention at school widens the students’ knowledge and changes their behaviour, resulting in fewer STH infections. The overall aim of this review was to formulate recommendations for the successful planning, implementation, evaluation and reporting of video-based interventions in schools, with the long-term goal of establishing an evidence base for future studies.

Methods

Sources and selection criteria

Data for this review were identified, as of May 2012, by searching Medline, EMBASE, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, ISI Web of Knowledge, Informit, ERIC, A+ education, EdITLib (Education and Information Technology Digital Library), CSA Ilumina (Sociological Abstracts), ProQuest Social Science Databases, Anthropology Plus Basic Search and Google. As we found that not all relevant publications appeared when searching the databases above, the following journals were searched directly: Journal of School Health, Health Education Research, Health Education Behaviour, Journal of Epidemiology and Community Health, Preventive Medicine and BMC Public Health American Journal of Health Education. ‘Video’ refers to audio-visual material/films in both digital and analogue formats (e.g. DVD, MPEG-4, wav, wmv, and VHS videotapes). Video games, video recordings and community–based studies were excluded, because they focused on different media and target populations. The reference lists of identified studies were searched for further relevant information and European and American "grey literature" (NTIS, OpenSIGLE) databases were also reviewed. We used the terms impact, educational, video, health, DVD, film, school, school-based child, infect*, hygiene practice, risk behaviour, infection risk behaviour and behaviour change for our searches. The review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement115 (Figure 12).

We reviewed studies that evaluated interventions involving video-based health education in schools aimed at improving knowledge, attitudes and inducing behaviour changes for a wide range of medical conditions of public health relevance. The target group included primary school and secondary school students, aged 5-17 years. For simplicity and readability, the term ‘schoolchildren’ is used to describe both. The different types of study designs included randomized controlled trials (RCTs), pre-/post-test design and quasi-experimental and observational studies (Figure 12).
Records identified through database and journal searching (n=1243)

Records after duplicates removed (n=846)

Records screened (n=846)  Records excluded (n=790)

56 Full-text articles assessed for eligibility

11 Studies included in analysis

Studies included in quantitative synthesis (meta-analysis) (n=N.A.)

45 Full-text articles, excluded for the following reasons:
- Not infectious diseases (n=15)
- Community-based (n=12)
- Home-based (n=2)
- Targeting adults (n=6)
- Impact video not evaluated (n=8)
- Video recorded dramas (n=1)
- Review article (n=1)

Figure 12: Flow chart for the selection of articles on preventive educational videos targeting schoolchildren covered in the review
Data extraction

Data from each study were extracted into Tables, which recorded the aims, sample size, design, outcome measures and results. Both quantitative and qualitative outcome measures were assessed, according to the methodology applied in the study. The methodological quality of each study was assessed by testing for the following factors: randomization, inclusion of a control group, intervention design, outcome assessment, quality of results, sample size, study design and then categorized according to evidence-based medicine criteria\textsuperscript{116} (Table 5). RCTs were additionally ranked according to the validity scale presented by Jadad and colleagues (Table 6).\textsuperscript{117}

Results

Of a total of 1243 papers identified from our original searches reporting studies involving health educational videos, the majority were excluded for the following reasons: the intervention was not school-based; neither children nor infectious diseases were targeted; the video was not used for teaching but instead for video-recorded observations, video monitoring, video games or endoscopy. The review and selection process left us with eleven articles that met the inclusion criteria. Five of the school-based interventions targeted parasitic infections with the remainder being on sexually transmitted infection (STI) (specifically, five on human immunodeficiency virus/ acquired immunodeficiency syndrome (HIV/AIDS), and one on human papillomavirus (HPV). The aims, design and main outcomes for each of these studies are summarized in Table 5.

Types of interventions

Of the eleven reviewed studies, ten were directed at increasing student knowledge and raising their awareness.\textsuperscript{83,84,118-125} Six studies aimed at changing behaviour to prevent parasitic diseases\textsuperscript{82-84,121} and sexually transmitted infections.\textsuperscript{123,125} Seven trials tested the educational video against a control arm, involving conventional teaching aids such as posters and reading materials or no treatment/intervention.\textsuperscript{82-84,119,120,123,125}
<table>
<thead>
<tr>
<th>Authors</th>
<th>Aims</th>
<th>Sample size</th>
<th>Design (Evidence-based medicine level)</th>
<th>Outcome Measures</th>
</tr>
</thead>
</table>
| Schaalma et al.125       | Evaluating the effects of experimental AIDS/STD curriculum compared with current AIDS/STD education in Dutch schools | 2,430 (grades 9-10) | RCT (author: quasi-experimental design) (Level I) | **Knowledge:** 13% increase in knowledge on AIDS/STD ($P < 0.001$).  
**Attitude:** 3% higher risk appraisal ($P < 0.005$), 41% more positive attitudes ($P < 0.001$), 19% more positive perceptions ($P < 0.01$).  
**Behaviour:** lower student risk index (weighted, $P < 0.05$) |
| Yuan et al.84            | Test impact of video intervention on primary school students’ knowledge of schistosomiasis and their compliance for treatment. | 1,137 schoolchildren (grade 5) | RCT (author: quasi-experimental design) (Level I) | **Knowledge:** 83% increase ($P < 0.001$).  
**Attitude/Compliance:** 67% increase in willingness to submit a stool sample for diagnosis, 66% increase in willingness to submit a blood sample, 58% increase in willingness to take medication ($P < 0.001$). 11% increase in compliance rate for blood examination ($P < 0.001$).  
**Behaviour:** no statistically significant difference in participation for schistosomiasis examination ($P > 0.1$). |
| Yuan et al.83            | Test the effectiveness of video and accompanying booklet on water contact and schistosomiasis | 1,739 schoolchildren (grade 4) | RCT (Level I) | **Knowledge:** 41% increase ($P < 0.001$).  
**Attitude/Compliance:** not assessed.  
**Behaviour:** 71.4% of water-related activities in unsafe places undertaken by control group ($P < 0.001$). |
infection risk behaviour of primary school students.

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Participants</th>
<th>Design</th>
<th>Knowledge</th>
<th>Attitude/Compliance</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hu et al.</td>
<td>Examine the short-term effects of health education in the control of schistosomiasis, and to monitor the long-term impact on re-infection patterns.</td>
<td>120 schoolchildren (age: 6-15 years) 206 adult females 194 adult males Look at schoolchildren only?</td>
<td>RCT (Level I)</td>
<td>Knowledge: 92% increase (P &lt; 0.001). Attitude/Compliance: 80% increase in correct attitude towards chemotherapy (P &lt; 0.001). Behaviour: significant decrease in risky water contact (P: not reported).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huszti et al.</td>
<td>Test effects of a lecture or a film on AIDS knowledge and attitudes towards practicing preventive behaviours.</td>
<td>488 students (grade 10)</td>
<td>RCT (Level I)</td>
<td>Knowledge: significant increase (P &lt; 0.05). Attitude/Compliance: no significant effect on attitude towards AIDS patients (P: not reported). Attitudes toward practicing preventive behaviours: no significant effect (P: not reported). Behaviour: not assessed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torabi et al.</td>
<td>Assessing the impact of a school-based video intervention on HIV/AIDS in Russian students.</td>
<td>1,124 (grades 7-9)</td>
<td>Quasi-experimental design, no randomization (Level II-1)</td>
<td>Knowledge: significant increase in knowledge on HIV/AIDS prevention (P &lt; 0.01). Attitude: significant improvement in attitude scores (P &lt; 0.01). Behaviour: no significant change.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brabin et al.</td>
<td>Evaluate girls’ recall of film on HPV and cervical cancer.</td>
<td>1084 girls (age: 12-13 years)</td>
<td>Not indicated. No randomization. (Level II-1)</td>
<td>Knowledge: Girls 16% more likely to report having received enough information (P &lt; 0.0001) and 8% more likely to have wanted the vaccine (P = 0.015). Attitude/Compliance: Increasing awareness of the risks of sexual relationships (P = 0.015). Less reluctant to discuss the vaccine with boyfriend (P =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Authors</td>
<td>Study Details</td>
<td>Participants/Settings</td>
<td>Study Design/Level</td>
<td>Knowledge</td>
<td>Attitude/Compliance</td>
<td>Behaviour</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>--------------------</td>
<td>-----------</td>
<td>---------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Albonico et al. [118]</td>
<td>Reduce infection intensity of <em>A. lumbricoides</em> <em>T. trichiura</em> and hookworms. Reduce prevalence of <em>S. stercoralis</em> and amoebiasis.</td>
<td>1075 schoolchildren (age: 3-17 years)</td>
<td>Pre- and post-test design, no control (Level II-3 or III)</td>
<td>Knowledge: not assessed.</td>
<td>Attitude/Compliance: not assessed.</td>
<td>Behaviour: not assessed.</td>
</tr>
<tr>
<td>Locketz, L. [121]</td>
<td>Video, providing general facts about schistosomiasis, to encourage students to improve their personal hygiene.</td>
<td>13 elementary schools: (Grades 3-6)</td>
<td>Descriptive study. (Level III)</td>
<td>Knowledge: increase (P: not reported).</td>
<td>Attitude/Compliance: not assessed.</td>
<td>Behaviour: no significant change in personal hygiene habits.</td>
</tr>
</tbody>
</table>
Table 6: Methodological quality of the reviewed RCT studies ranked according to criteria defined by Jadad et al\textsuperscript{117}

<table>
<thead>
<tr>
<th>Rank</th>
<th>Study</th>
<th>Randomisation</th>
<th>Randomization points</th>
<th>Withdrawals/dropouts</th>
<th>Withdrawal/dropout points</th>
<th>Total points\textsuperscript{a}</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Schaalma et al.\textsuperscript{123}</td>
<td>Yes, two-stage sampling procedure</td>
<td>2</td>
<td>Yes, reason reported</td>
<td>1</td>
<td>3</td>
<td>Limited validity of response to questionnaire items on sexual behaviour. Short time span between baseline and follow-up (4 months).</td>
</tr>
<tr>
<td>2</td>
<td>Yuan et al.\textsuperscript{83}</td>
<td>Yes, coin toss</td>
<td>2</td>
<td>Not reported</td>
<td>0</td>
<td>2</td>
<td>Baseline 12 months before intervention. Follow-up questionnaire 3 months after intervention. P values were not always reported.</td>
</tr>
<tr>
<td>3</td>
<td>Yuan et al.\textsuperscript{84}</td>
<td>Yes, but not described</td>
<td>1</td>
<td>Not reported</td>
<td>0</td>
<td>1</td>
<td>Short intervention (2 months). Prevalence/re-infection not assessed. Timeline unclear.</td>
</tr>
<tr>
<td>4</td>
<td>Hu et al.\textsuperscript{82}</td>
<td>Yes, but not described</td>
<td>1</td>
<td>Not reported</td>
<td>0</td>
<td>1</td>
<td>12-year follow-up. Small sample size: only 120 schoolchildren and 200 adults.</td>
</tr>
<tr>
<td>5</td>
<td>Huszti et al.\textsuperscript{120}</td>
<td>Yes, but not described</td>
<td>1</td>
<td>Not reported</td>
<td>0</td>
<td>1</td>
<td>P values not always presented.</td>
</tr>
</tbody>
</table>

Note: \textsuperscript{a}without double-blinding criteria; maximum ranking possible, 3 points
Types of videos

The educational videos employed ranged from 15 to 22 minutes in duration with a median duration of 18 minutes; one outlier, however, lasted two hours. All the videos targeted children and were implemented at school; one study additionally targeted adults. In seven of the studies, the videos were developed within the research project; the remainder were either produced externally or the video production was not reported. In two studies, the content of the video was not described. With the exception of one study, each video was embedded in the school lesson and was combined with other teaching methods such as class discussions, role-plays, booklets and posters.

Outcome measures

The majority of the studies assessed quantitative measures; one non-RCT study focused additionally on qualitative outcomes. We summarized the results by endpoints - such as knowledge, attitude/compliance, and behaviour change - that were assessed in the majority of the studies, and which focused on outcomes that were directly related to the intervention. Two studies assessed changes in disease prevalence. A summary of the results (Figure 13) and the main conclusions for each of the studies follows:

- The video interventions increased student knowledge in all ten studies assessing knowledge, of which the results from eight were statistically significant.

- In six of eight studies assessing attitude/compliance, the video intervention had a positive effect on attitude and compliance for treatment. Except for one study, where P values were not reported, the study results were significant. The video had no significant impact on attitude/compliance in the other two studies.

- Two of six studies assessing behavior resulted in a statistically significant change; in the remainder, behavior change was not significant or a P-value was not reported.
• Of two studies which considered a change in prevalence,\textsuperscript{118,121} only one\textsuperscript{10} presented statistically significant results.

• Four studies demonstrated that the use of videos had a greater impact when combined with other methods such as discussions, role-plays and prevention training.\textsuperscript{82,84,122,125}

• Three papers\textsuperscript{84,121,125} showed that videos had a significant impact on knowledge, but limited impact on adaptive behaviour.

• The majority of the reviewed studies concluded that videos are promising and effective health education tools, with a positive impact on knowledge and attitudes.

• Overall, video-based interventions were well received by schools, teachers and children.

![Figure 13: The effectiveness of the video-based interventions](image-url)
Quality of the studies

Only five of the studies incorporated an RCT,\textsuperscript{82-84,120,123} A further four did not include or report a control arm,\textsuperscript{118,121,122,124} and two studies with a control arm did not allocate it randomly.\textsuperscript{119,125} Notably, power calculations were missing in all studies, the method chosen for allocation to intervention and control was either poorly reported or not at all, and the majority did not adhere to CONSORT reporting standards.\textsuperscript{126} Accordingly, we have assessed the quality of the studies according to evidence-based medicine criteria\textsuperscript{116} (Table 5). We additionally ranked the RCT studies, shown in Table 6, according to the validity scale of Jadad and colleagues.\textsuperscript{117}

Discussion

This review has shown that a number of school-based video interventions have been described for use against infectious diseases. Health education, through the use of innovative educational tools, has been advocated for the control of a number of the neglected tropical diseases (NTDs),\textsuperscript{82-84} and the prevention of sexually transmitted infections.\textsuperscript{119,120,122-125} We emphasize that the most recent study detected by our extensive search, was conducted in 2010, which indicates there is a clear need for more present-day research in the area.

It is noteworthy that the majority of the eleven studies we reviewed in detail concluded that videos were well received by schools, teachers and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes. Educational videos entertain, engage and inform at the same time, and these are important factors when targeting children due to their limited attention span. Furthermore, videos are more likely to induce behaviour change than text-based teaching methods, a principle much discussed in the observational learning concept.\textsuperscript{102} Compared with conventional teaching, videos can display real-life situations that the students are able to identify with. According to behavioural theories, this is beneficial for inducing behaviour change, since the target population has to recognize that: i) they are at risk (Health Belief Model: Perceived susceptibility\textsuperscript{81}); and ii) it is in their hands to change this situation (Social Cognitive Theory: self-efficacy\textsuperscript{102}). This cannot be achieved by traditional teaching methods. Therefore, videos
play an important role, especially when targeting behaviour change. Among the reviewed studies, the majority evaluated the impact of videos displaying real-life situations in the form of an entertaining dialogue or narrative, whereas in three studies the videos were purely instructional, providing facts in the form of a recorded lecture. It is of note that, among these, only one study, which combined the video with student exercises and discussion, reported a change in behaviour, although P-values were not reported. These latter findings confirmed the conclusions of studies targeting non-communicable diseases, showing that educational videos are more effective when combined with other methods.

Of the reviewed studies, five conducted RCTs, although only one was reported as such. The remainder was reported as controlled pre- post-test design, or quasi-experimental design with randomization. According to definition, quasi-experimental designs lack randomization; however, if they are randomized, they could be considered an RCT. The outcomes of the five RCTs were of reasonable validity, whereas those from the non-RCT studies have to be considered carefully, as the validity and generalisability of these trials is clearly limited, due to reduced statistical power, lack of a control arm, poor study design or inadequate reporting. Even with the RCTs, weaknesses in study design and reporting were evident. All the RCTs randomized study participants into intervention and control groups, but none described the process of randomization or sample size calculations. Also, attrition was poorly reported, with only one study reporting attrition, including precise numbers and the reasons for participant withdrawal. The non-RCT studies ranged from trials without randomization (level II-1) to descriptive studies (level III, lowest level), according to evidence-based medicine criteria (Table 5). The RCTs were, additionally, ranked according to the accepted validity scale (Table 6), but without including ‘blinding’ criteria, as blinding is not feasible for educational studies. Accordingly, the maximum achievable score is 3 points, which only one of the studies reached. We also identified other weaknesses in study design and implementation. Two studies recruited small study populations, potentially leading to insufficient statistical power.

The methodological weaknesses of some of these studies, the lack of quantitative results and indicators for statistical significance in several of the trials meant we were unable to carry out a meta-analysis or to draw evidence-based conclusions. Therefore, we have presented the data from the eleven studies in descriptive form only (Table 5).
We noticed a considerable inconsistency in the terminology for study design. In the older publications, and publications with a social science background, the term controlled pre-post-test design instead of RCT was used. Historically, RCTs were exclusively used for drug trials or to report results of scientific experiments. Nowadays, RCTs are also applied in the social sciences, psychology and education, with ‘clinical trial’ referring to all studies including an intervention targeting humans. Today, the terms controlled pre-post-test design and RCT are used interchangeably in the literature; both terms may be used to describe a study design as a ‘randomized controlled trial with a pre-test and post-test’.129

The field of health promotion is beset with an intense debate about appropriate evaluation methodologies. In some circles, RCTs are considered inappropriate for health promotion research.130 They are deemed to be too expensive, unethical as they withhold a program from some individuals and unsuitable to measure long-term and ‘soft’ health promotion outcomes, such as behaviour change.130 We do not share this point of view. As outlined in Rosen and others130 and from our experiences of undertaking randomized controlled trials131,132 a carefully designed and implemented RCT is a powerful evaluation tool for the assessment of health education/promotion, if the study is rigorously designed, implemented, evaluated and reported (see Box 1; Recommendations). Furthermore, a cluster randomized trial has significant advantages compared with an individual RCT design, as it allows for the measurement of direct and indirect effects of the intervention on the study population as a whole, and it accounts for potential confounding between interventions and controls. It also makes logical sense to randomize entire schools or classes for trial logistics. Many large trials, such as COMMIT (community intervention trial for smoking cessation) and CATCH (child and adolescent trial for cardiovascular health), have successfully used a cluster randomization approach.133,134 Lately, the value of carefully designed and implemented RCTs in the social sciences has gained increasing respect and popularity.135 However, the study design and evaluation methods have to be chosen carefully according to the research objectives, methods and outcome measures. RCTs may not always be the appropriate study design but, for the type of health education research evaluating innovative educational tools as outlined in this review, RCTs are appropriate and should be employed, if feasible. Regardless of the study design applied, rigorous planning, implementation and evaluation are crucial to provide internal validity to the study.
Conclusions

In order to build up an evidence-base with valid, comparable findings, a certain quality and degree of standardization in study design, study evaluation, type of control employed, outcome measures and follow-up time needs to be established and maintained. Our recommendations for the design, implementation and reporting of future school-based video interventions targeting infectious diseases are presented in Box 1. In brief, we recommend a thoroughly planned and implemented RCT design, a careful study preparation, professional development of the educational package including the video to be used, close monitoring throughout the trial, and rigorous reporting according to the CONSORT guidelines for reporting parallel group randomised trials\cite{21}.

Once a critical mass of appropriately designed, conducted and reported intervention studies have been completed according to our key recommendations presented in Box 1, a meta-analysis can be carried out to establish an evidence base for future research. The evidence base can help establish a new generation of educational videos, thereby creating powerful and cost-effective preventive tools to complement other interventions for infectious diseases such as drug treatment or improved sanitation.

| Box 1. Recommendations for studies using preventive educational videos targeting infectious diseases in schoolchildren |
| Study design: We recommend a RCT design where appropriate, as RCTs are considered the most robust form of evidence. For community and school-based interventions a cluster randomized design is preferred because it limits contamination, simplifies the logistics of the field work and measures both direct and indirect effects of the intervention. For interventions targeting individuals, however, an individually randomized controlled trial (RCT) is recommended. RCTs, including cluster randomized trials, have to be rigorously planned, implemented and reported. |
| Study preparation: The study has to be carefully planned and designed, including the incorporation of sample size calculations to assess the minimal sample size required. We highly recommend including local authorities in the project-planning phase. Prior to study |
commencement, informed consent has to be obtained from parents/legal guardians, teachers and the schools. As teachers are crucial for the smooth implementation of the project, they should be trained for their tasks in a dedicated workshop.

**Development of an educational package including the video:** The educational video should be produced professionally; hiring a professional audio-visual company and an experienced scriptwriter are essential. The costs for a professionally produced video can be considerable and have to be budgeted carefully. Sub-contracting future professionals at educational institutions (e.g. Film School) or engaging the local community as protagonists can reduce the production costs significantly. Incorporating the key messages in an entertaining, engaging narrative can prove both very popular and effective in schoolchildren and adults. Ideally, the educational material should be developed locally to account for cultural differences. In any case, involvement of the local community and the target group during the production of the video and its pre-testing in the study area are crucial. The video should be implemented as a teaching aid, not a teaching substitute, and should be combined with other teaching methods such as class discussions or role-plays.\(^{82,84}\)

**Video content:** The video should incorporate instructional messages into a real-life situation displaying correct behaviour rather than depicting a stand-alone instructional message. The knowledge can be integrated into an entertaining narrative, thereby informing and entertaining at the same time. Behavioural theories\(^ {81,102}\) and our own field experiences support these recommendations. Purely instructional messages can be delivered by the teacher, whereas real-life situations require audio-visual media and have the advantage that students can identify with the displayed situation, which encourages behaviour change.

**Monitoring and evaluation:** For quality control purposes, it is essential that the implementation of the video and teaching activities be closely monitored during the intervention. For the assessment of changes in knowledge, attitudes and behaviour practices after the intervention, standardized assessment tools in the form of questionnaires can be used. However, our personal observations have shown that self-reported behaviour and actual behaviour differ considerably, so we recommend carrying out direct behaviour observations using a simple standardized form.
**Reporting:** All procedures and results of the study should be rigorously reported adhering to CONSORT guidelines\(^2\)\(^1\) to contribute to an evidence base for video-based interventions and to allow researchers to extract essential information for future trial design purposes.

**Acknowledgements:** We thank the many colleagues and students who have supported our work on developing and testing an educational video in China to reduce soil-transmitted helminth (STH) infections at school.

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**Disclosure:** No potential conflict of interest relevant to this article was reported.
Chapter 4
Methods

This chapter provides an overview of the methods applied in the study including preliminary assessment, intervention trial, data management and statistical analysis. The development and production of the video are described in Chapter 5.
4 Methods

The principal aspect of this thesis comprised a 9-month cluster-randomized intervention trial. Before commencement of the intervention trial, a preliminary assessment was carried out to assess STH infection risk factors and to formulate key messages for the educational video. The methods employed for both the preliminary assessment and the cluster-randomized trial are described here. Development and testing of the educational video within the project are described in Chapter 5 and 6 respectively.

4.1 Preliminary assessments

4.1.1 Parasitological survey

Two pilot surveys in Linxiang City District in September 2009 and March 2010 were undertaken to provide an indication of the STH prevalence in the local schoolchildren. Faecal samples were collected from 209 (74 in rural schools/ 135 in urban schools) and 200 children (rural schools only) respectively; triplicate Kato-Katz thick smears were prepared from one stool sample per child.

The first preliminary survey in September 2009 indicated a hookworm prevalence of <1%, therefore, a second survey was conducted in March 2010, which only focused on hookworm. Kato-Katz smears were prepared within 3 hours to avoid the collapse and degeneration of hookworm eggs\textsuperscript{47}, and read microscopically within 30 min after preparation, under 400x magnification.\textsuperscript{37}

4.1.2 Formative research

Formative research including an assessment of the local context and STH infection risk factors was conducted in the study area in Linxiang City District in October 2009. An extensive community-based mixed methods approach involving input from the target group (schoolchildren) and key informants such as teachers, doctors and parents was applied. Previous knowledge, attitudes and practice regarding STH of the target group (schoolchildren, aged 9-10) was assessed in quantitative questionnaires (N=407) and qualitative drawing assessment including in-depth interviews (N=36). Risk factors of the natural and human environment such as transmission hot
spots, risk behaviour as well as the intellectual, emotional, social and cultural context of the target population were assessed in questionnaires, interviews, focus group discussions, ‘draw & write’ assessments, household and field observations. All data collection tools were developed in English and translated into Mandarin by Chinese researchers and educators at Hunan Institute of Parasitic Diseases for use in the field. The different methods, both qualitative and quantitative, were triangulated in order to assess one set of information from various angles and with different methods. To avoid researcher bias, the assessments were standardized and conducted by both Chinese and Western researchers (researcher triangulation). The formative research included the following methods (Appendix B):

1) A household survey which included household observations, infrastructure assessment and in-depth interviews with the head of each household (Appendices B.1 and B.2).

2) A knowledge, attitude and practice (KAP) questionnaire with grade 4 schoolchildren. The questionnaire consisted of multiple choice questions relating to demographics, medical history, favourite comics and cartoons, previous health education and knowledge of STH worms, their transmission, symptoms and treatment, attitude towards STH and self-reported hygiene practice such as hand washing, food handling, toilet use and wearing shoes (Appendix B.3).

3) A qualitative ‘draw & write’ assessment and semi-structured interviews, assessing the students’ previous STH knowledge (Figure 14; Appendix B.4).

4) Key informant interviews with teachers, parents, doctors and health education officials in order to identify STH risk factors (Appendix B.5).

5) Behaviour observations: observing and recording risk behaviour/ hygiene practice on video to identify STH risk factors.

6) Pilot testing the video package including questionnaire and focus group discussions with schoolchildren, teachers and parents (Figure 15; Appendix B.6).
4.1.3 Analysis for preliminary assessment

A Microsoft Access (Redmont, WA) database was used for data management. SAS (SAS Institute, Cary, NC) software was used for statistical analysis. For the parasitological survey, *A. lumbricoides*, *T. trichiura* and hookworm prevalence were described in percentages and infection intensity in geometric mean of eggs per gram faeces in infected. Frequencies of persons providing correct answers in the KAP questionnaire and household survey were expressed as percentages. Key informant interviews and interviews following the ‘draw & write’ assessment were translated.
simultaneously and notes were taken in both Chinese and English by two investigators. The interviews were recorded and transcribed in Chinese and translated into English for detailed analysis. Notes and transcripts were compared and analysed for content. Open-ended questions of the KAP questionnaire and ‘draw & write’ assessment were subject to quantitative content analysis. All the answers were read and scanned for content and answers with similar meaning were grouped into categories. Frequencies for each of these answer categories were calculated and expressed as percentages.

Observations in the field were recorded in writing and, where possible, on video camera by the candidate and researchers based at Hunan Institute of Parasitic Diseases. For the household survey a systematic infrastructure assessment was carried out using a standard observation form for each household.

For the video pilot test, schoolchildren, parents and teachers completed a short questionnaire on the key messages in the cartoon. Their answers formed the basis for a focus group discussion with 8-9 randomly selected students per school and all the parents and teachers present.

4.2 Video development and production

During the period December 2009 - June 2010, the educational video was developed by a professional audio-visual company located in Brisbane. A multidisciplinary team of parasitologists, epidemiologists, educators, and professional animators collaborated in order to translate STH risk factors into effective educational messages, thereby encouraging students to change their behaviour (see Chapter 5: Development of educational video).

4.3 Video pilot test

The pilot version of the educational video ‘The Magic Glasses’ was tested on Chinese schoolchildren, parents and teachers in the study area in Linxiang City District, separate from the study schools. To assess if key messages were understood, schoolchildren, parents and teachers filled in a short questionnaire. Answers and comments were discussed in focus group discussions (FGD), evaluated and used for revision of the pilot version of the video (Figure 16).
4.4 Selection of study area

Linxiang City District, a rural area with STH prevalence >15% among schoolchildren was selected as the study area (Figure 17), based on a parasitological survey undertaken in October 2009. We selected a rural study area with low to medium STH prevalence, since this setting is typical for STH endemic areas in rural China and thereby increases generalisability of the results. Furthermore, Linxiang City District is in reasonable proximity to our Chinese collaborators at the Hunan Institute of Parasitic Diseases. Their contacts at Linxiang Centre for Disease Control allowed us to rely on local knowledge and infrastructure to conduct the study and integrate local stakeholders from the outset.
4.5 Study Area

Legend:

★ Intervention schools

● Study schools

Figure 17: Study area and location of study schools in Linxiang City District, Hunan province, China

Linxiang City District, Hunan Province, China (Figures 17 and 18; Appendix F) covers an area of 1,754 km², has a temperate climate with abundant rainfall and has a population of approximately 500,000. Eighty percent of inhabitants work in the agricultural sector, with rice, fish, bamboo and tea being the most important produce. STH transmission in Linxiang City District is divided into two seasons – spring and autumn, when the warm and moist environmental conditions, are optimal for egg survival and larval development in soil. The overall STH prevalence in the local schoolchildren was 18% (17% Ascaris; 1% Trichuris); Hookworm prevalence was <1% in two preliminary surveys we undertook in Linxiang City District in September 2009 and March 2010.
Linxiang is similar to most poor rural settings in China’s southern and central provinces without particular economic or touristic interest and therefore with limited support by the central government. Rural areas such as our study area are abundant in China, where STH prevalence is higher than in the more developed areas and cities, but lower than in more remote rural areas (e.g. Yunnan). Across the study area, transmission factors such as sanitation, hygiene, environment, vegetation and climate, were homogeneous.

Figure 18: Study area (Photograph: F. Bieri 2009)

4.6 Intervention trial

4.6.1 Study design

To measure the effect of the educational package, an un-matched cluster-randomized intervention trial was employed, targeting schoolchildren aged 9-11 years, in Linxiang County, Hunan Province, China. The study design for the trial is shown in Figure 19. Parasitological and questionnaire surveys were administered at baseline and at follow-up, 9-months later.

A cluster randomized design was chosen because it limits contamination, simplifies the logistics of the field work and measures both direct and indirect effects of the intervention. We had sufficient clusters (38 schools) to justify an un-matched randomization. Since schools in the study were geographically close, the priority was to avoid contamination.
Intervention schools received the video-based health education package, detailed below, whereas control schools received a generic and traditionally used health education poster developed by the Chinese Ministry of Health.

**Figure 19: Study design of the intervention trial**
4.6.2 Sample size calculations

A design effect of 1.1 was estimated, based on preliminary survey data of 74 students across 4 schools in the study area. Sample size calculations were then undertaken for an individually randomized trial\textsuperscript{139} and multiplied by the design effect. Assuming an STH incidence of 6\% (typical of communities with 18\% prevalence) and an intervention efficacy of 50\%, 80\% power is achieved with 1639 students across both control and intervention arms. We enrolled 1934 students at baseline of which 1718 across 38 schools with a median of 42 students per school were included in the final analysis (Chapter 6, Figure 27b).

4.6.3 Sampling and randomization

Twenty one administrative villages with STH prevalence exceeding 15\% were selected in rural areas of Linxiang City District, Hunan Province, China. All rural schools in Linxiang City District with >15 students in grade 4 were selected and all children in grade 4 were recruited to participate. Sample size calculations revealed that 42 students per school were needed. Schools with less than 15 students in grade 4 could not meet these sample size conditions. In schools with > 15 and < 26 students in grade 4, grade 5 was added to meet the sample size conditions. Schools in the study were geographically close and to avoid contamination, we used a spatial sampling frame for randomization: schools within a radius of 3km were grouped, resulting in a total of 29 randomization units. These units (and the schools within) were randomly allocated either control or intervention status. Randomization was performed using random number generation in SAS.

Thirty eight schools with a total of 1718 students (median of 42 students per school) were selected for the study. Details on the schools and the student numbers/school are listed in Chapter 6, Supplementary Information, Table 9.

4.6.4 Baseline

Parasitological survey

At baseline, one stool sample was selected from each student – one plastic container per schoolchild was given to the class teacher who distributed them among his/her students. Faecal sample containers were labelled with the personal identification number (PID) and the date of distribution. Children were instructed to return the faecal sample to the school the next day. Faecal
samples returned later than 48 hours after defecation were not accepted. The faecal samples were collected by staff of the Linxiang Schistosomiasis Station and brought to collection points where samples were stored at 4°C.

Three slides per stool were prepared using the Kato-Katz thick smear technique\textsuperscript{37} within 24 hours after receipt of each stool sample. The samples were analysed for \textit{Ascaris lumbricoides} and \textit{Trichuris trichiura} eggs. All eggs were recorded on the stool examination form (Appendix C.1). The samples were read blind and eggs per gram of faeces were recorded in order to assess infection intensities. For a quality assurance, 10\% of the slides were rechecked by independent microscopists.

**Behaviour observations**

Ten intervention and 10 control schools were randomly selected and subjected to behaviour observations at baseline in September 2010. Student hand washing behaviour was observed covertly with special focus on hand washing after toilet use (Figure 20). Children participating in the study were identified with the help of a previously distributed tag. Behaviour observations were carried out twice: during a 10-minute break in the morning and the 30-minute lunch break. All observations were recorded on the observation forms (Appendix C.2).

![Figure 20: Behaviour observation and gravity-fed tap provided by this project (Photograph: F. Bieri)](image-url)
Installation of taps

Gravity-fed taps were installed near the toilets in all schools. In the behaviour observation schools (10 intervention and 10 control) the taps were installed in the last week of the summer holidays (30 Aug-3 Sept 2010). For the remaining schools, the taps were installed during the stool collection.

KAP questionnaire

All study participants were administered a Knowledge, Attitude and Practice (KAP) questionnaire (Appendix C.3) consisting of multiple choice questions relating to demographics, medical history, previous health education and knowledge of STH worms, their transmission, symptoms and treatment, attitude towards STH, and self-reported hygiene practice such as hand washing, food handling, toilet use and wearing shoes. The questionnaires were developed in English and translated into Mandarin. The students were instructed to fill in the questionnaire on their own, without copying from each other. The teachers guided the students through the questionnaire for questions 1-13. Questions 14-28 were completed by the students alone. Research staff were present to answer questions and to supervise the questionnaire at all times. No questionnaires were left at any of the schools so as to prevent students from studying the content for reassessment at follow-up.

4.6.5 Treatment and intervention

Teacher training workshop

A teacher training workshop with intervention school teachers and school heads was held prior to commencement of the trial. Teachers were instructed regarding their role during the intervention and written instructions were handed out to them (Appendices C.6; C.7 and F).

Treatment

At baseline all students were treated with albendazole (400mg single oral dose, as recommended by the WHO). Students were monitored for treatment compliance and side-effects by the research team and assisting health professionals. Treatment was recorded on the treatment form (Appendix C.4).
**Intervention: health education package including video**

After completion of the questionnaire, students in the intervention group watched the 12-minute educational cartoon twice. When watching for the second time, the students answered a few questions about the key messages in the cartoon (Appendix C.5). These questions provided the basis for the discussion with the teachers after the second video viewing. Please refer to Chapters 5 and 6 for more details on the development of the educational video and specifics of the intervention.

**Reinforcement**

The intervention was reinforced in the intervention schools in February 2011, when the video was again shown twice. As with the baseline intervention, the reinforcement included questions on the key messages of the video, which were discussed with the teachers.

**Student exercises: competitions**

Students in the intervention group participated in two competitions: firstly, a drawing competition emphasising the signs to warn others about STH infection at possible infection sites (October 2010) and secondly, an essay written about their personal response to fight worm infections (February 2011). Teachers were instructed during the teacher training workshop and written instructions were handed out to them (Appendices C.6 and C.7). The best warning signs and essays were awarded and displayed in the school classrooms.

**Quality check**

At the end of October 2011, CDC Linxiang monitored the completion of the drawing competition by visiting each intervention school and checking on whether the drawing competition had been completed. Further, all the schools were monitored for potential contamination between intervention and control schools. In March 2011, seven questions assessing the degree of interaction between intervention and control schools were addressed in a short oral questionnaire with the school head in the intervention schools (Appendix C.8).
4.6.6 Control: poster

The control group was exposed only to a wall poster on STH installed on a strategic location in the control schools. The poster entitled: ‘Control of Parasitic Diseases - Healthy Action’ was designed by the Chinese Ministry of Health, China CDC in 2007 (Figure 21). It includes the following short messages which are graphically illustrated:

- Wash hands before meals and after the toilet
- Wash fruit and vegetables if eating them raw
- Take anthelminthic drugs to keep you healthy
- Eat well cooked fish and shrimp
- Cut cooked and uncooked food separately
- Manage stool to eliminate worm eggs.

Figure 21: Control of Parasitic Diseases - Healthy Action’ Poster used in the Control and Intervention Schools (Chinese Ministry of Health, 2007)
4.6.7 Follow-up

The follow-up of the intervention was conducted 9 months after the baseline survey when the baseline outcome measures (KAP, infection incidence and hand-washing behaviour) were re-assessed. All procedures were repeated according to the baseline protocol, except for albendazole treatment, which was administered only to the positives at follow-up. The follow-up student questionnaire included additional questions assessing adverse events and video feedback (Appendix C.9). A timeline of the intervention is shown in Figure 22.
### 4.6.8 Trial Timeline

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**Stool collection**

**Stool analysis**

**Data entry**

Figure 22: Timeline for the intervention
4.7 Data management and statistical analyses

4.7.1 Data management

A Microsoft Access (Redmont, WA) database was used for data management. Data were double entered by trained staff at the Hunan Institute of Parasitic Diseases, Yueyang, Hunan Province, China. The data was checked for errors by an experienced data manager at University of Queensland, Brisbane, Australia.

4.7.2 Sample size calculations

For sample size calculations, please refer to section 2.6.2.

4.7.3 Statistical analyses

A detailed analysis plan was written before starting the data analysis. Details are shown below:

Statistical analysis used SAS software (SAS Institute, Cary, NC). Initial descriptive data analyses were performed to assess the distribution of the data, detect outliers, missing data and calculate frequencies, means, range of values, standard deviations and standard errors of key variables. Missing data were excluded from the analyses. Students who were missing at baseline or lost to follow up were excluded from the analyses (Chapter 6, Figure 27b).

Outcome measures

Primary end-points were incidence of STH infection, knowledge of, and attitude to, parasitic nematode worms comprising transmission, symptoms, treatment and prevention, and self-reported hygiene practice. The secondary end-point was a change in observed hygiene practice, typified by hand washing after toilet use at school. Only *Ascaris* and *Trichuris* were considered for incidence measurements, due to the very low hookworm prevalence in Linxiang City District. The efficacy of the educational
package was measured by comparing the knowledge, incidence and behaviour change across intervention and control schools. Microscopists and stool collecting staff were blind to the source of each stool sample. Study participants were not blinded, since this was not feasible in an educational intervention.

**Primary endpoints**

**Prevalence:** The prevalence of infection tells us what proportion of the study population is infected with STH.

\[
\text{Prevalence} = \frac{\text{No. of egg positive cases}}{\text{No. persons at risk} \times 100}
\]

At baseline, the overall STH prevalence and the prevalence of *A. lumbricoides, T. trichiura* were assessed as a binary variable: (0) not infected; (1) infected. The mean, median, standard deviation and 95% confidence interval were established. A logistic regression model was applied to compare the mean of prevalence in control schools versus mean of prevalence in intervention, resulting in an odds ratio (OR) for the estimation of the baseline difference between intervention and control (Chapter 6, Table 7).

**Incidence:** Since all the children were treated at baseline, the incidence of infection during the trial is the number of infected persons in the cohort found at the end of the trial (having been present during the entire trial), divided by the number of persons in the cohort present during the trial.

\[
\text{Incidence} = \frac{\text{No. of infections at end of trial}}{\text{No. of persons in cohort during the entire trial} \times 100}
\]
At follow up, the overall STH incidence and incidence of *A. lumbricoides, T. trichiura* were assessed as a binary variable: (0) not infected; (1) infected. The mean, median, standard deviation and 95% confidence interval were calculated. A logistic regression model was applied to compare mean of incidence in control schools versus mean of incidence in intervention, resulting in an odds ratio (OR) for the estimation of the intervention effect (Chapter 6, Table 7).

**Intensity**: The intensity of the infection was measured as geometric mean eggs per gram in the infected students. The mean, median, standard deviation and 95% confidence interval were calculated at baseline and follow-up. For the estimation of the intervention effect, a regression model was applied to compare the mean of intensity in the control schools versus mean of intensity in the intervention schools. The outcome was a ratio of geometric mean of intensity (Chapter 6, Table 7).

**Knowledge**: The overall score for knowledge, attitude, practice (KAP), was calculated as percentages of a total of 43 KAP questionnaire points. For questionnaire grading, percentages are expressed as percentage points. KAP data were analysed using regression analyses. The mean, median, standard deviation and 95% confidence interval of KAP were established at baseline and at follow-up. A regression model was applied to compare the mean of KAP in control schools versus mean of KAP in intervention, resulting in a difference in means for the estimation of the difference between intervention and control (Chapter 6, Table 8).

In addition to the overall knowledge scores, the individual components of the questionnaire (knowledge, attitude and practice) were calculated as percentages of the total possible questionnaire points for this section and modelled separately applying the same procedures as described above for KAP (Chapter 6, Supplementary Information).
Open-ended questions: Student questionnaire questions 7, 14a and 15a

A content analysis was carried out to analyse the open-ended questions. This included categorization of open-ended responses by the main theme and calculation of frequencies for answer categories. The answers of questions 14a and 15a were not included in the quantitative questionnaire analysis. In the case of question 7, the results can be categorized in correct/ incorrect answers, which can be quantitatively analysed. Responses to question 7 were part of the knowledge component in the questionnaire.

Secondary endpoint:

Behaviour: A mean percentage of students washing their hands after the toilet was calculated for each school and a Kruskal-Wallis test was used to calculate differences in hand washing practice observed among the intervention and control schools. The mean, median, standard deviation and 95% confidence interval of hand washing were calculated at baseline and at follow-up. A non-parametric Kruskal-Wallis test was chosen, because the sample size was small and the data were not normally distributed.

The main outcomes variables (KAP, prevalence, incidence, intensity, hand washing) were also presented on school level (Chapter 6, Supplementary Information and Appendix G).

Additional associations of interest included:

KAP versus incidence [(e.g. Are kids with higher KAP score less likely to contract STH (incidence)?]

   a) KAP versus hand washing (observed)
   b) Knowledge versus hand washing (observed)
   c) Knowledge versus self-reported hygiene practice (questionnaire)
d) Knowledge versus attitude  
e) Attitude versus incidence  
f) Attitude versus self-reported hygiene practice (questionnaire)  
g) Attitude versus hand washing (observed)  
h) Hand washing (observed) versus incidence  

**Statistical models and tests**  

Generalized Estimating Equation (GEE) models, accounting for clustering within schools, were used for the regression and incorporated potential confounders such as grade and sex. The results for incidence and KAP are shown both crude and adjusted for sex and school grade. GEE models for the KAP score were extended to include time by intervention effects to adjust for baseline knowledge. A logistic regression adjusted for sex and grade was used to look at the association between the different KAP components and infection.

A mean score was calculated for each school and a Kruskal-Wallis test was used to calculate differences in hand washing practice observed among the intervention and control schools. A Pearson test was applied for correlations between observed hand washing practice and KAP, and observed hand washing practice and incidence. A Spearman test was used for the correlation between observed hand-washing practice and knowledge.

**4.7.4 Trial reporting**  

The trial was reported according to Consolidated Standards of Reporting Trials (CONSORT)\textsuperscript{126} and a flow diagram showing the passage of study participants is shown in Chapter 6 (Figure 27b).
4.8 Ethic approval and trial registration

Written ethical approval was obtained from Hunan Institute of Parasitic Diseases, China, 28th August 2009 and QIMR Human Research Ethics Committee, 2nd September 2009 - Approval No. P1271. Before commencement of the intervention, written consent was obtained from all student participants’ parents or legal guardians (Appendix D). All students enrolled in the study received treatment. Identifying information, such as names were kept confidential, and all data was kept secure at all times. The trial was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12610000048088) on 18th January 2010. Web address of trial registry: (http://www.ANZCTR.org.au/ACTRN12610000048088.aspx).
Chapter 5

Development of an educational video
5 Development of an educational video for the prevention of soil-transmitted helminth infections in Chinese schoolchildren

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5.1 Context

A major aspect of the thesis involved the development, production and pilot testing of a video-based educational package.

We chose a community-based mixed methods approach involving input from target group (schoolchildren) and key informants such as teachers, doctors and parents in order to identify potential STH infection risks in the study area and to formulate key messages for the video.

This chapter describes the development of the cartoon video and the results of the formative research phase and video pilot-testing in order to share this successful approach and to provide recommendations for the development of future health educational videos.

5.2 Publication

This chapter is presented as a paper, which was submitted to the journal *PloS Neglected Tropical Diseases*.
Abstract

Background

With more than 2 billion people infected worldwide, the soil transmitted helminths (STH) are the most wide-spread and disabling chronic infections globally. To date, STH control efforts rely predominantly on recurrent mass drug administration (MDA) which does not prevent reinfection. Additional public health measures including novel health educational tools are required to augment MDA for sustained integrated control of STH. We describe the development of an educational cartoon video targeting STH infections in Chinese schoolchildren.

Methodology/Principal Findings

We applied an extensive community-based mixed methods approach involving input from the target group of 9-10 year old schoolchildren and key informants, such as teachers, doctors and parents, in order to identify potential STH infection risks in the study area and to formulate key messages for the video. The development of the educational cartoon video and its production included three major steps: formative research; video production; and pilot testing and revision. We found that most adults and approximately 50% of the schoolchildren were aware of roundworm (*Ascaris*) infection, but knowledge of transmission, prevention and treatment of STH was poor. Observations in the study area showed that unhygienic food practices such as eating raw and unwashed fruit or playing in vegetable gardens, previously fertilized with human faeces, posed major STH infection risks.

Conclusions/Significance

It was crucial to assess the intellectual, emotional, social and cultural context of the target population, prior to video production, in order to integrate the key messages of the video into everyday situations. Overall, our strategy for the development of the ‘The Magic Glasses’ video and its incorporation into a health education package proved highly successful and we provide a summary of recommendations for the development of future educational videos, based on our experiences in China.
Introduction

More than 2 billion people worldwide are infected with soil-transmitted helminths (STH), mainly in the developing nations of Asia, Africa and Latin America. STH are intestinal parasitic nematode worms intimately associated with rural poverty, inadequate sanitation and waste disposal, lack of clean water and poor hygiene, as well as limited access to health care and preventive measures through health education. STH comprise the most common of the 17 major neglected tropical diseases (NTDs) causing disabling chronic infections globally. Most at risk are children and pregnant women in developing countries, where STH infections are so common that children are most likely to harbour at least one if not several worm species. STH have been shown to have a negative impact on physical, intellectual, and cognitive development. To date, control efforts rely predominantly on recurrent mass drug administration (MDA) with albendazole or mebendazole but these deworming drugs do not prevent reinfection. It has been shown repeatedly that prevalence levels return to pre-treatment levels within 6-18 months after treatment cessation. Additional public health measures, such as health education, are required to augment MDA for sustained integrated control of STH leading to their elimination.

To this end, our multi-disciplinary, international team has produced a 12-minute animated narrative cartoon video, entitled “The Magic Glasses”, aimed at the prevention of STH infection in Chinese schoolchildren. The video was integrated into an educational package and its impact evaluated in an extensive single-blind unmatched cluster randomized controlled intervention trial in 38 schools involving 1718 schoolchildren aged 9-10 years over one school year. Schools were randomly assigned to the health education package, which included the cartoon video, or to a control package, where a health education poster only was used. Infection rates, knowledge and hand washing behaviour were assessed before and after the intervention (Bieri et al. submitted). The intervention proved highly successful with a significant impact evident across all outcome measures. Specifically, there was a 50% decrease in the incidence of STH infection in the intervention schools compared with the control schools (OR = 0.5, 95% CI 0.35-0.7, P<0.0001), unprecedented for educational interventions targeting STH. These are very promising results establishing proof of principle that the video-based health educational package widens student knowledge and changes behaviour, resulting in fewer STH infections.
This article describes the development of the cartoon video in detail and the results of the formative research phase and video pilot-testing in order to share this successful approach and to provide recommendations for the development of future health educational videos.

**Methods**

**Selection of study area**

Linxiang City District, a rural area with STH prevalence >15% among schoolchildren, was selected as the study area, based on a parasitological survey conducted in October 2009 prior to study commencement. We selected a rural study area with low to medium STH prevalence, since this setting is typical for STH endemic areas in rural China, thereby providing generalisability of the results. Furthermore, Linxiang City District is in reasonable proximity to our Chinese collaborators at Hunan Institute of Parasitic Diseases. Their contacts at Linxiang Centre for Disease Control allowed us to rely on local knowledge and infrastructure to conduct the study and integrate local stakeholders from the outset.

The development of the educational cartoon video and its production included three major steps: formative research; video production; and pilot testing and revision (Figure 23). Recommendations made by previous video-based studies, behavioural theories, didactic principles and teaching experience were taken into consideration. Furthermore, research was conducted on Chinese animation history and favoured Chinese cartoons to choose a cartoon popular among the student target group (Figure 24).

**Formative research**

Formative research including an assessment of the local context and STH infection risk factors was conducted in the study area in October 2009. We used the following definition of risk factor: ‘An aspect of personal behaviour or lifestyle, or an environmental exposure, which is associated with health-related conditions considered important to prevent.’

We applied an extensive community-based mixed methods approach involving input from the 9-10 year old student target group and key informants such as teachers, doctors and parents in order to identify potential STH infection risks in the study area and to formulate key messages for the video. The schoolchildren’s previous knowledge, attitudes, and practice regarding STH were
assessed in quantitative questionnaires (N=407), a qualitative drawing assessment and in-depth interviews (N=36).

Risk factors reflecting the natural and human environment such as STH transmission hot spots, behaviour conducive to STH infection as well as the intellectual, emotional, social and cultural context of the student target population were assessed in questionnaires, interviews, focus group discussions, ‘draw & write’ assessments, and household and field observations. The different qualitative and quantitative approaches were triangulated in order to assess one set of information from various angles and with differing methodologies. To avoid researcher bias, the assessments were standardized and conducted by both Chinese and Western researchers (researcher triangulation). The preliminary assessment included the following:

- **A household survey** including household observations, infrastructure assessment and in-depth interviews with the head of the household (N=10, age range: 32–75 years, grandparents in 7 households).
- **A knowledge, attitude and practice (KAP) questionnaire** with grade 4 schoolchildren (N=407; 9-10 year-old). Consisting: multiple choice questions relating to demographics, medical history, favourite comics and cartoons, previous health education and knowledge of STH, their transmission, symptoms and treatment, attitude towards STH and self-reported hygiene practice such as hand washing, food handling, toilet use and wearing of shoes.
- **Qualitative ‘draw & write’ assessment and semi-structured interviews**, assessing the schoolchildren’s previous STH knowledge (N=36; aged 9-10 years).
- **Key informant interviews** with teachers (one head of school, one teacher of mathematics) and parents, a paediatrician, a health officer at Linxiang Centre for Disease Control (CDC), and an education officer at Linxiang City District Health Bureau.
- **Behaviour observations** to record risk behaviour/hygiene practice on video to identify STH risk factors.
- **A video pilot test** which included a questionnaire and focus group discussions with schoolchildren (N=80), teachers (N=11) and parents (N=9) in Linxiang City District.
Observations in the field were recorded in writing and, where possible, on video camera. For the household surveys, a systematic infrastructure assessment was carried out using a standard observation form for each household (Supplementary Information).

For the video pilot test, schoolchildren, parents and teachers completed a short questionnaire on the key messages in the cartoon. Their responses formed the basis for focus group discussions with 8-9 randomly selected schoolchildren per school and all the parents and teachers present at the time of the pilot test.

Analysis

A Microsoft Access (Redmont, WA) database was used for data management.\textsuperscript{137} SAS (SAS Institute, Cary, NC) software was used for statistical analysis. Frequencies of persons providing correct answers in the knowledge, attitude and practice (KAP) questionnaire and household surveys were expressed as percentages. Key informant interviews and interviews following the ‘draw & write’ assessment were translated simultaneously and notes were taken in both Chinese and English by two investigators. The interviews were also recorded with the consent of the participant, transcribed into Chinese and later translated into English for further verification. Notes and transcripts were compared and analysed for content. Open-ended questions of the KAP questionnaire and ‘draw & write’ assessment were subject to quantitative content analysis where all the answers were read and scanned for content and a code list created. Answers with similar meaning were categorized according to the code list and frequencies for each of these answer categories were calculated and expressed as percentages.

Production of ‘The Magic Glasses’ video

In order to translate the assessed risk factors into effective educational messages that stimulate schoolchildren to change their behaviour, behavioural theories such as Social Cognitive Theory,\textsuperscript{81,101} Health Belief Model,\textsuperscript{81} Transtheoretical Model and Cognitive Theory of Multimedia Learning were consulted. The key messages were then presented to a multidisciplinary team of epidemiologists, education experts, animators and a script writer. Over the course of several brainstorming sessions a script for the cartoon narrative was drafted. During the script writing
process, Chinese scientists were consulted repeatedly for advice on China-specific cultural aspects. The script is a written document which describes the dialogue, environment and characters. From this, all other elements essential for cartoon development could be created: a storyboard to visualize camera shots and an animatic, turning the storyboard into a slideshow to pace and time the movie. Subsequently, concept artwork was created for all the assets presented in the script including the video characters, the environment and general cartoon style. Next, the resources were pooled together under the supervision of the cartoon director and each stage was continually reviewed, iterated and placed into the movie. Backgrounds were created alongside characters, which were animated scene by scene using Adobe Creative Suite, Autodesk 3DS Max and Motion-builder software, before adding the dialogue and sound. Throughout the process the results were discussed with the multidisciplinary team and the content adapted accordingly. Figure 23 illustrates the different production steps in the making of the cartoon video. The video was produced by a professional audio-visual company based in Brisbane, Australia. The first audio was recorded in Brisbane, Australia with Chinese film school students enrolled at Queensland University of Technology. According to feedback in the pilot survey, the audio was re-recorded using professional voice actors based in China.

**Video pilot test**

A pilot version of the educational cartoon was taken to the Linxiang study area for testing. The video was shown twice to schoolchildren, teachers and invited parents at school. To assess whether key messages in the video were understood, a short questionnaire was filled in by the audience during the second viewing. The answers were discussed in small focus group discussions (FGD) with the schoolchildren, teachers and parents. The audience was also asked to comment on the video and to make suggestions for improvement.
Figure 23: Flow diagram showing the steps involved in the development of “The Magic Glasses” video
Figure 24: From defining risk factors to the key messages presented in the video
Ethics

Written ethical approval for the study was obtained from the human ethics committees of the Queensland Institute of Medical Research, Australia and the Hunan Institute of Parasitic Diseases, China. Prior to commencement of the intervention, written informed consent was obtained from the parents or legal guardians of all student participants. The trial was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR12610000048088).

Results

The results of the formative research including risk factor assessment are structured according to thematic groups of importance for the development of the video. Examples of the schoolchildren’s drawings are shown in Figure 25.

Knowledge

Among all STH species, roundworm was the most well known with 90% (CI= 67-100) of adults and 51% (CI= 47-56) of schoolchildren having heard of it. 50% (CI= 12-88) of adults and 11% (CI= 8.6-14.2) of schoolchildren have heard of hookworm, but whipworm was unknown by adults, schoolchildren and key informants. Health and medical staff have heard of roundworm only whereas teachers were not aware of intestinal worms.

According to the student questionnaire, more than half of the schoolchildren did not know how they could get infected with STH (86%; CI= 75-98). A minority knew that infection with intestinal parasites could lead to abdominal pain (8%; CI= 0-17) and fatigue (3%; CI= 0-8). The majority (84%; CI= 82-100) knew they should pay attention to hygiene such as washing hands, fruit and vegetable, cook food and boil water. Many schoolchildren (83%; CI= 71-96) thought they could contract worms on unwashed fruit/vegetable such as apples or by playing in water and grassland. In a few cases, STH was mistaken for schistosomiasis, of which the transmission (water contact) was better known than that of
STH. Thirty percent (CI =25-34) of the parents/grandparents who were aware of disease caused by STH self-treated their children/grandchildren. All the parents included in the household survey and 38% (CI= 33-42) of schoolchildren erroneously thought treatment also prevented reinfection.

**Attitude**

The key informant interviews revealed that no health officer, doctor, parent or student considered STH infection as a major health problem in the area where the most commonly perceived diseases were cardiovascular problems, influenza, hepatitis B and short-sightedness. More than half of the schoolchildren (56%; CI=52-61) did not think they were at risk of contracting STH. Schoolchildren clearly associated STH with poor hygiene, as shown in the following statement: “If we pay attention to personal hygiene, it is not that easy for roundworms to enter our body.” Hygiene was mainly associated with safe food handling and drinking water, washing hands, but also included vague perceptions such as: “When we clean the floor, the dust will enter our body, which will lead to an infection.” Parents’ or grandparents’ knowledge and perception of STH had a considerable impact on the schoolchildren’s attitude; e.g. one student said: “Mum told me I’m infected if I have stomach ache.”

The majority of schoolchildren (74%; CI= 70-78) said they would be anxious if they had intestinal worms. One third (30%; CI=25-34) did not know why they were anxious, but some schoolchildren mentioned that they were afraid of contracting disease due to STH, because it could not be cured (7%; CI= 4-9), would cause (abdominal) pain and diarrhoea (9%; CI= 6-12) or even death (3%; CI= 1-4). Schoolchildren also believed that taking medicine could prevent reinfection: “I got this disease when I was young and I then took medicine, so I won’t have it anymore.”
Practice - self-reported behaviour

The results for self-reported behaviour, including hand washing and food handling practice; wearing shoes and working/playing in vegetable gardens were assessed in the household survey and the student questionnaire.

Health education and preferred media

According to the in-depth interviews with the teachers, health education was part of the curriculum in grades 3 and 4 for 1-2 weekly lessons on ‘Life and Health’. However, STH infections were not addressed in these lessons and the teacher’s knowledge of STH was generally poor. They did not know how the worms are contracted or infection prevented.

The schoolchildren’s favourite cartoons were episodes of ‘Pleasant Goat and Big Big Wolf’, a funny, colourful and fast-paced Chinese animated television series. Schoolchildren liked this series because it was funny (14%; CI= 10-17), interesting (12%; CI= 5-15) and the main character was clever (5%; CI=3-7); 26% (CI= 22-31) did not indicate why they liked it.

Important household and field observations

Behaviour conducive to STH infection was repeatedly observed in the study area and scenes reflecting these risks were integrated into the cartoon. One of the children’s favourite games was playing cards on the floor or ground which, if contaminated with STH eggs, poses a potentially serious infection risk. Children also played in vegetable gardens, previously fertilized with human faeces. They had close contact with soil and often ate raw and unwashed root vegetables such as radish and sweet potatoes. This reflected the earlier described perception of both adults and children that the most likely source of infection was eating raw and contaminated food. Another likely transmission pathway noted occurred through flies transporting STH eggs onto uncovered food.

Sanitation in the schools and households was poor with a lack of hand washing facilities and latrines with open manure pits. Soap was available in households, but in none of the schools visited. Most living room (93%; CI= 91-95) and bathroom floors (89%; CI= 86-91)
were either made of cement, porcelain or wood with only a few houses having unsealed floors. In the schools, the floors of toilets and classrooms were made of concrete, but the schoolyard was usually unsealed.

**Key messages**

The formative research and risk factor assessment led to the formulation of the following key messages:

- Always play in clean places.
- Avoid playing in vegetable gardens.
- Always use a toilet.
- Always wash your hands after the toilet and before eating.
- Always cover food.
- Wash fruit and vegetables if eating them raw. Cook food well.
- Always wear shoes or sandals.
- If you feel sick, go to the clinic for treatment.

These key messages were incorporated into the various scenes of the video, reflecting the environment of the target group in Linxiang. This process is illustrated in a flow diagram (Figure 24). The key messages were also compiled into a complementary pamphlet that was distributed during the course of the intervention (Figure 26 and Appendix E). Overall, the video displays correct behaviour and creates confidence that improvement in hygiene practice results in a positive health outcome. The video can be accessed online at:

http://www.qimr.edu.au/page/Home/Magic_glasses/

The video was combined with an educational package including classroom discussions, drawing and essay competitions and the pamphlet containing relevant messages on the transmission and prevention of STHs, in order to allow the schoolchildren to practice and consolidate the newly acquired knowledge.
Outcomes of the video pilot test

The FGD and questionnaire results showed that schoolchildren and adults could readily understand the key messages, with questions about infection risk and symptoms for STH being answered correctly by 82% (CI = 78-87) and 73% (CI = 67-79) of the children, respectively. All schoolchildren knew that yellow represented the colour of worms or worm
eggs in the narrative. The feedback for ‘The Magic Glasses’ was generally positive with one major criticism concerning the audio. As described above in the methods section, the language and voices recorded in Brisbane with Chinese film school students enrolled at Queensland University of Technology were too formal and did not match the general cartoon style. Therefore, with the help of young Chinese researchers familiar with the colloquial expression used by schoolchildren, the dialogue was reworded and the audio re-recorded using professional voice actors based in China.

**Local control efforts for STH**

According to health and education officials from Linxiang, a mass deworming program had been conducted in the study area between 1994-2004; although it had limited success due to a lack of communication between local authorities with schools and parents, resulting in poor STH treatment compliance.

**Discussion**

This article describes the successful development and pilot-testing of the cartoon video ‘The Magic Glasses’ targeting STH prevention in Chinese schoolchildren in Linxiang, Hunan Province. A community-based mixed methods approach was used for the formative research phase, assessing critical information for subsequent development of the video. We found that most adults and approximately 50% of the schoolchildren were aware of roundworm (*Ascaris lumbricoides*) infection, but knowledge of transmission, prevention and treatment of STH was poor. Only 37% of the children thought they were at risk of getting infected with STH. Parents who were aware of disease caused by STH self-treated their children (30% of household heads), but all the parents included in the household survey and 38% of schoolchildren erroneously thought treatment also prevented reinfection. Observations in the study area showed that unhygienic food practices such as eating raw and unwashed fruit or playing in the vegetable garden, previously fertilized with human faeces posed major STH infection risks.
According to the Health Belief Model, the level of awareness (perceived susceptibility)\textsuperscript{97} for a disease is a strong predictor of preventive health behaviour. Therefore, the lack of knowledge and awareness combined with the poor hygiene and sanitation in the Linxiang study area would likely lead to repeated infection with STH. This meant that alongside the key points informing about STH prevention, the educational cartoon video needed to include the following messages:

1) Raise awareness of STH among the target group. Message: ‘You are at risk of getting infected’ (perceived susceptibility).\textsuperscript{97}

2) Convince the target group that it is in their hands to change behaviour and thereby decrease infection risk (self-efficacy). Message: ‘You can protect yourself against STH by improving your hygiene practice.’\textsuperscript{81}

For this purpose it was absolutely crucial to assess the intellectual, emotional, social and cultural context of the target population, prior to video production, in order to integrate the key messages of the video into everyday situations that children could identify with. As highlighted by others\textsuperscript{81,142,143} an individual’s assimilation of scientific knowledge alone does not necessarily result in behavioural change. Behaviour is related to perceptions, values, power relationships and feelings; and cannot be changed simply with the acquisition of knowledge.

In order to obtain a clear understanding of the human and natural environment in Linxiang, both quantitative and qualitative research methods were applied, and the student target group, teachers, parents, health workers, education and health authorities were included in the formative research phase including STH risk factor and context assessment. Once the aims and key messages were formulated, a team of epidemiologists, educators, parasitologists and animators translated these key messages into the narrative, and this allowed us to develop a culturally tailored educational package that was both informative and engaging.\textsuperscript{108,144,145} Again, consulting behavioural models and didactic principles informed our need to bring the information across to induce behaviour change.
Overall, our strategy for the development of the ‘The Magic Glasses’ video and its incorporation into a health education package has proven highly successful. Therefore, we provide a summary of recommendations (Box 2) for the development of an educational video, based on our experiences in developing and testing ‘The Magic Glasses’. An educational video provides an ideal basis for health education at school, since it can readily be disseminated and re-used several times, which may substantially increase cost-effectiveness. A need for innovative and effective educational tools that can be integrated in existing NTD control efforts has been expressed in ‘A Research Agenda for Helminth Disease’ published in PLoS Neglected Tropical Diseases in April 2012. Interventions including health education to prevent STH reinfection such as the one presented in this thesis are urgently required to augment the sustainability and effectiveness of chemotherapy as part of an integrated approach. Furthermore, the video-based health educational tool presented here suitably complements the MDA approach advocated by the World Health Organization and might have major implications for the future control of STH.

The effectiveness of the video as a stand-alone intervention has not been trialled and could be the subject of future study. Stand-alone video interventions have the advantage that no previous teacher knowledge is required but we encourage combining the video with other teaching methods if used as part of a school-based intervention to reinforce and consolidate the educational message. Ideally, the wider community, especially parents, should be included in the intervention, as this increases household involvement impacting on increased levels of prevention. To achieve this, parents could be invited to participate in an annual school health day, whereby the video is shown and information on STH prevention is handed out. Another option to extend the educational intervention to a wider public would be to broadcast the video on television, where it could be integrated in a health promotion television series with each episode targeting a different topic of public health importance such as e.g. promoting a healthy diet or preventing road accidents. The television series can be reinforced regularly in order to repeat the message which increases sustainability of the program. Such long-term interventions have proven very effective in large-scale community health promotion trials applying a multidisciplinary approach. The current study confirms once more that a close collaboration between experts of different disciplines is
needed to develop successful public health interventions. The development of the cartoon video ‘The Magic Glasses’ is a positive example for a fruitful multidisciplinary collaboration. Therefore, we share our findings and recommendations for the development of future health promotional videos, which have the potential to contribute significantly to better global health.

**Box 2. Recommendations for the development of an educational video cartoon based on our experience in producing “The Magic Glasses”**

1) Involve the local community and the target group early on in the formative research phase including risk factor and context assessments.

2) Undertake careful formative research including assessment of risk factors and context using multiple, both quantitative and qualitative methods.

3) Translation of risk factors into educational key messages should be grounded in behavioural theories. 81

4) Ensure the video incorporates instructional messages into a real-life situation displaying correct behaviour embedded in the local context, rather than depicting a stand-alone instructional message. Ideally the educational material should be developed locally to account for cultural differences.

5) Ensure the video is produced professionally by hiring a professional audio-visual company and it is essential to involve an experienced scriptwriter.

6) Ensure the knowledge can be integrated into an entertaining narrative, thereby informing and entertaining at the same time.

7) Pilot test the video in the targeted area and include feedback from the local community and targeted group.

8) Ideally, combine the video with other teaching methods such as class discussions or role-plays, allowing children to practice, consolidate and repeat the newly acquired knowledge.
Chapter 6

Impact of a video-based health educational intervention on soil-transmitted helminth infections
6 Health-education package to prevent worm infections in Chinese schoolchildren

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6.1 Context

Previous studies have shown that health educational videos targeting schoolchildren are effective tools, with a positive impact on knowledge and attitudes. However, there had been comparatively few studies that have evaluated the impact of video-based interventions on disease incidence or quantified their efficacy as an independent control tool.

This chapter is the core chapter of the thesis. It presents the main methods and results of the cluster randomized intervention trial in 38 schools involving 1718 children aged 9-10 years over one school year and discusses the public health relevance of the findings.

6.2 Publication

This chapter is presented as a published paper. A reprint of the article is presented in Appendix A.2.
Abstract

Background

Soil-transmitted helminths (STH) are among the most prevalent of chronic human infections globally. Their control involves administration of benzimidazole anthelminthics but this does not prevent reinfection. We determined the effect of a video-based education package in rural schools of Linxiang City in China’s Hunan province, where STH are prevalent. The intervention aimed to increase knowledge of STH, induce behaviour change and reduce infection. *Ascaris lumbricoides* and *Trichuris trichiura* were considered for incidence outcome measurements as prior surveys indicated low hookworm prevalence in the targeted schools.

Methods

We conducted a single-blind unmatched cluster randomized intervention trial in 38 schools involving 1718 children aged 9-10 years over one school year. Schools were randomly assigned to the health education package, which included a cartoon video, or to a control package, where a health education poster only was used. Infection rates, knowledge and hand washing behaviour were assessed before and after the intervention. Drug (albendazole) treatment was given to all participants at baseline and all positive cases at follow-up.

Results

At follow-up, the intervention group experienced a 90% higher mean knowledge score (P<0.001), a two-fold higher percentage of children washing their hands after using the toilet (P<0.001) and a 50% lower incidence of STH (P<0.001), compared to the control group. No acute adverse events were observed immediately (15 minutes) after albendazole treatment.

Conclusions

The video-based health education package was not only highly efficacious in increasing student knowledge but it also led to significant behaviour change and highly reduced STH incidence within one school-year. We advocate integrated STH control and incorporating the
Chapter 6

health education package into the school curriculum in areas endemic for STH in China and beyond.

Introduction

A third of the world’s population is infected with soil-transmitted helminths (STH) mainly in the developing nations of Asia, Africa and Latin America. STH are intestinal parasitic nematode worms intimately associated with rural poverty, inadequate sanitation/waste disposal, a lack of clean water and poor hygiene and are common to areas with limited access to health care and preventive measures. STH are the most widespread of the 17 major neglected tropical diseases (NTDs). Roundworms (*Ascaris lumbricoides*) are the largest and most prevalent STH with an estimated 1 billion infections; whipworms (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*) each infect approximately 600-800 million. The estimates of the worldwide burden of STH have been shown to be variable ranging from 4.7-39.0 million disability-adjusted life years (DALYs). This variability is due to different emphases placed on the impact of STH on cognitive and health effects. The most recent (2010) estimates are 5.2 million DALYs; however, almost half of the global disease burden due to these worm infections afflicts children aged 5-14 years.

Chronic STH infection can lead to a range of clinical sequelae, including poor mental and physical development in children. Currently, morbidity treatment through mass drug administration (MDA) is the cornerstone of STH control but it does not prevent reinfection. Additional public health measures, such as health education, are required to augment MDA for sustained integrated control of the STH, representing a key element for achieving several of the UN Millennium Development Goals (MDGs).

STH are of major public health concern in China. Approximately 129 million are infected with children aged 5-14 years having the highest rates of infection across 11 Provinces in Southern, Central and Western China. We conducted a cluster-randomized intervention trial in rural schools in an area of China’s southern Hunan province to rigorously evaluate our hypothesis that a video-based health educational package targeting schoolchildren can influence their behaviour in a way conducive to the prevention of STH infections. The positive outcomes of the trial have potential implications for STH control not only in China but globally.
Methods

Design and study population

The study was carried out in rural Linxiang City District (CD), Hunan Province, where there is limited STH awareness or educational activities aimed at worm prevention (Chapter 4, Figure 18). It involved an unmatched cluster-randomized intervention trial in 38 schools (38 clusters) conducted over one school year (September 2010-June 2011) (Figure 27a). Schools were randomized into 19 intervention and 19 control schools (Figure 27a; Table 9). Intervention schools were given the video-based health education package (Figure 28), with control schools receiving a traditional health education poster (Chapter 4, Figure 22). Primary end-points were incidence of STH infection, knowledge and attitude to parasitic nematode worms (transmission, symptoms, treatment, prevention) and self-reported hygiene practice. The secondary end-point was a change in observed hygiene practice, typified by hand washing after school toilet use. *Ascaris* and *Trichuris* were considered for incidence measurements only, due to the very low hookworm prevalence in Linxiang CD. The study was conducted in accordance with the protocol and the statistical analysis plan, which were integrated in Chapter 4.
Select rural schools where > 15 Grade 4 students
Linxiang District, Hunan

Spatial Sampling Frame:
Group villages within 3km

Randomization

Control Schools (19)

Sept 2010

Baseline
• KAP questionnaire
• Parasitological survey
• Behaviour observation

Sept 2010

Treat all schoolchildren

Mar 2012

Post only

Intervention Schools (19)

Sept 2010

Education package including video

June 2011

Follow-up
• KAP questionnaire
• Parasitological survey
• Behaviour observation

June 2011

Treat positives

Figure 27: Study design (a) and enrolment and retention of students (b)
b) During the intervention 103 and 107 new students were recorded in the intervention and control schools, respectively. These students were excluded from the analysis.

**Intervention package**

The educational package included a 12-minute cartoon video entitled ‘The Magic Glasses’, which was the key component of the package, informing about STH transmission and prevention. This was complemented by classroom discussions, a pamphlet summarizing the key messages delivered in the cartoon, and drawing and essay writing competitions to reinforce these messages. Details of the implementation of the educational package are shown in Figure 28. A description of the development of the video is provided (Supplementary Information) and its front cover is shown in Figure 29. The video can be accessed online at:

http://www.qimr.edu.au/page/Home/Magic_glasses/


A specific teacher training workshop was held prior to commencement of the trial (see Figure 28 and section 4.6.5 for details).
<table>
<thead>
<tr>
<th>Date</th>
<th>Educational component</th>
<th>Aim</th>
</tr>
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<tbody>
<tr>
<td>Sept 2010</td>
<td>Teacher training workshop</td>
<td>Inform teachers about STH and their role during the intervention</td>
</tr>
<tr>
<td>Sept 2010</td>
<td>Baseline survey</td>
<td></td>
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<tr>
<td>Sept 2010</td>
<td><strong>Video, shown twice</strong>&lt;br&gt;Video and student questions&lt;br&gt;10-15min classroom discussion based on student questions</td>
<td>Inform about STH transmission and prevention&lt;br&gt;Repeat key messages, answer students’ questions</td>
</tr>
<tr>
<td>Oct 2010</td>
<td>Handout pamphlet</td>
<td>Key messages as take home message</td>
</tr>
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<td></td>
<td><strong>Drawing competition</strong>&lt;br&gt;Students draw warning signs for risk areas to warn others about worms&lt;br&gt;Three best drawings are awarded</td>
<td>Practice and reinforce new knowledge</td>
</tr>
<tr>
<td>Mar 2011</td>
<td><strong>Video, shown twice</strong>&lt;br&gt;Video and student questions&lt;br&gt;10-15min classroom discussion based on student questions</td>
<td>Reinforce knowledge about STH transmission and prevention. Repeat key messages and answer students’ questions</td>
</tr>
<tr>
<td>Mar 2011</td>
<td><strong>Essay competition</strong>&lt;br&gt;Write story about own actions taken to prevent worms&lt;br&gt;Three best essays are awarded</td>
<td>Practice and reinforce new knowledge</td>
</tr>
<tr>
<td>June 2011</td>
<td>Follow-up survey</td>
<td></td>
</tr>
</tbody>
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Figure 28: Video-based health education package
Study procedures

At baseline, one faecal sample was collected from all participating students, and a knowledge, attitude and practice (KAP) questionnaire administered to each. Faecal samples were examined microscopically using the Kato-Katz thick smear technique (Supplementary Information). The KAP questionnaire consisted of multiple choice and three open-ended questions relating to demographics, medical history, previous health education and knowledge of STH worms, their transmission, symptoms and treatment, attitude towards STH and self-reported hygiene practice such as hand washing, food handling, toilet use and wearing shoes (see questionnaire Appendices C.3 and C.9). The questionnaire was developed and piloted in collaboration with Chinese researchers and educators, based on experiences gained in previous trials and observations in the field.

Behaviour observations were carried out covertly by trained research staff on a randomly selected subsample of 10 intervention and 10 control schools. The observations were recorded at school level on a standardized form and focused on hand washing after using the toilet. As a reticulated water supply was absent at many locations, a 100-litre water container with a gravity-fed tap was installed in all intervention and control schools so as to avoid confounding.

Following baseline assessment, all intervention and control school participants were treated with albendazole (400mg single oral dose, recommended by WHO) and monitored for
treatment compliance. With this regimen, albendazole provides on average cure rates of 98% and 47% for *Ascaris* and *Trichuris*, respectively;\textsuperscript{52} however, efficacy can be 100% in those with low infection intensity.\textsuperscript{53}

At follow-up, all assessments and quality control measurements undertaken at baseline were repeated. Any student found STH-positive was albendazole-treated. Any adverse events resulting from the drug treatment were recorded following treatment and at follow-up (Table 11).

In order to monitor potential contamination between intervention and control schools, seven questions assessing the degree of interaction between intervention and control schools were addressed in a short oral questionnaire with the school head in the intervention schools in March 2011. The monitoring form is shown in Appendix C8.

**Sample size**

We estimated a design effect of 1.1 based on preliminary survey data of 74 students across 4 schools in the study area. Sample size calculations were then undertaken for an individually randomized trial\textsuperscript{139} and multiplied by the design effect. Assuming an STH incidence of 6% (typical of communities with 18% prevalence) and an intervention efficacy of 50%, 80% power is achieved with 1639 students across both control and intervention arms. We enrolled 1934 students at baseline of which 1718 across 38 schools with a median of 42 students per school were included in the final analysis (Figure 27b).

**Data management and statistical analysis**

A Microsoft Access (Redmont, WA) database was used for data management.\textsuperscript{137} Statistical analysis used SAS software (SAS Institute, Cary, NC). For binary data (e.g. incidence), a logistic regression model was applied, resulting in an odds ratio (OR) for the estimation of the intervention effect. Knowledge, attitude and practice scores were calculated as percentages of a total of 43 KAP questionnaire points. For questionnaire grading, percentages were expressed as percentage points. KAP data, including individual components, were analysed using regression analyses.

Generalized Estimating Equation (GEE) models, accounting for clustering within schools, were used for the regression and incorporated potential confounders such as grade
and sex. The results for incidence and KAP are shown both crude and adjusted for sex and school grade. GEE models for the KAP score were extended to include time by intervention effects to adjust for baseline knowledge. A logistic regression adjusted for sex and grade was used to look at the association between the different KAP components and infection.

A mean score was calculated for each school and a Kruskal-Wallis test was used to calculate differences in hand washing practice observed among the intervention and control schools. A Pearson test was applied for correlations between observed hand washing practice and KAP, and observed hand washing practice and incidence. A Spearman test was used for the correlation between observed hand-washing practice and knowledge.

**Study oversight**

Written ethical approval for the study was obtained from the human ethics committees of the Queensland Institute of Medical Research, Australia and the Hunan Institute of Parasitic Diseases, China. Prior to commencement of the intervention, written informed consent was obtained from the parents or legal guardians of all student participants. The trial was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR12610000048088). The authors are fully responsible for the study design, data collection, analysis, completeness of data reporting, fidelity of this report to the study protocol, and interpretation of the data.

**Results**

**Participant flow**

Of 1934 students enrolled, 216 were lost to follow-up (relocated to another school) (Figure 27b). In total, 1718 (88.7%) participants (893 in the control group, mean of 47 students per school; 825 in the intervention group, mean of 43 students per school) were used in the final analysis. There were 210 new students, registered at follow-up; however they were excluded from the analyses.
Infection prevalence and intensity

Infection rates are shown in Table 7. At baseline, the STH prevalence was 10.4% (95% confidence interval [CI], 8.46 to 12.2) in the control schools and 10.0% (95% CI, 8.08 to 11.9) in the intervention schools (approximately 9% *Ascaris*, 1% *Trichuris* in both groups) (odds ratio [OR], 0.99; 95% CI, 0.50 to 1.99); intensity (geometric mean, eggs per gram (GMEPG), in infected individuals was low, according to WHO categorization. There were no significant differences in prevalence at baseline between the control and intervention schools (P=0.98), between boys and girls (P=0.83) or between grades 4 and 5 (P=0.64) (N boys=976; N girls=739; N Grade 4=1641; N Grade 5=77).

After the 9-month intervention, STH incidence was 8.4% (8.4% *Ascaris*, 0% *Trichuris*; 95% CI, 6.58 to 10.22) in the control schools and 4.12% (4.12% *Ascaris*, 0% *Trichuris*; 95% CI, 2.76 to 5.48) in the intervention schools (adjusted for sex and school grade – OR, 0.5; 95% CI, 0.35 to 0.7; P<0.001) (Crude OR, 0.53; 95% CI, 0.38 to 0.74; P<0.001). Thus, the educational intervention showed a 50% efficacy (95% CI, 30 to 65) in preventing STH infection. Infection intensity was lower than at baseline and the difference between the control and intervention groups was not significant (P=0.12). The follow-up incidence was higher in boys than in girls (P=0.002), but no significant difference was found between grades 4 and 5 (P=0.2).
### Table 7: Infection rates in the control and intervention schools

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Control Schools (95% CI)</th>
<th>Intervention Schools (95% CI)</th>
<th>Intervention vs Control (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prevalence [%]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>10.4 (8.46-12.2)</td>
<td>10.0 (8.08-11.9)</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td></td>
<td></td>
<td>0.99 (0.50 - 1.99)</td>
<td>0.98</td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td></td>
<td></td>
<td>0.95 (0.50-1.84)</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>Incidence [%]</strong></td>
<td></td>
<td></td>
<td></td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>8.40 (6.58-10.2)</td>
<td>4.12 (2.76-5.48)</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td></td>
<td></td>
<td>0.50 (0.35- 0.70)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td></td>
<td></td>
<td>0.53 (0.38-0.74)</td>
<td>0.0002</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td></td>
<td></td>
<td></td>
<td>Ratio of geometric mean</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>143.5 (114.9-179.1)</td>
<td>219.4 (173.0-278.3)</td>
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</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td></td>
<td></td>
<td>2.87 (0.96-8.58)</td>
<td>0.06</td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td></td>
<td></td>
<td>2.25 (0.92- 5.49)</td>
<td>0.07</td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>38.3 (34.7-42.3)</td>
<td>44.4 (40.8-48.3)</td>
<td>Ratio of geometric mean</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td></td>
<td></td>
<td></td>
<td>1.12 (0.97-1.29)</td>
<td>0.12</td>
</tr>
<tr>
<td>[geometric mean epg in</td>
<td></td>
<td></td>
<td></td>
<td>1.13 (0.98- 1.30)</td>
<td>0.09</td>
</tr>
<tr>
<td>infected]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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*Adjusted for sex and grade
Knowledge, attitude, practice (KAP)

Overall KAP changes are shown in Table 8; changes at the school level and the detailed KAP data are presented in Supplementary Information, Tables 9 and 10. At baseline, the intervention group scored 5.66 percentage points higher (95% CI, 2.58 to 8.74; standard deviation [SD], 12.66) than the control (SD, 11.45; P=0.0008 adjusted for sex and grade). There was no significant difference in baseline KAP between boys and girls (P=0.55), whereas grade 5 achieved, on average, 7 points more than grade 4 (P<0.001). At follow-up, students who were exposed to the intervention, scored, on average, 33 percentage points (95% CI, 28.50 to 37.11; SD, 15.13) higher in the KAP questionnaire than the control group students (SD, 14.35; P<0.001 adjusted for sex and grade). After adjusting for baseline knowledge score, this intervention effect (difference of differences) was 24.9 percentage points (95% CI 23.4 to 26.4, P<0.001) Girls achieved 1.7 percentage points more than boys (P=0.02), but there was no significant difference between grades 4 and 5 (P=0.25).

Across the entire study population, overall KAP in uninfected children was 9.88 percentage points (95% CI, 5.75 to 14.01) higher than in infected students (P<0.001) and the correlation between KAP and observed hand washing practice was moderate but significant (0.64; P=0.008). There was a moderate but significant correlation between KAP and hand washing in the intervention (0.66; P=0.05) and in the control (0.77; P=0.04) schools.

Knowledge score was associated with both self-reported (beta=0.13, P< 0.001) and observed (rho = 0.57; P=0.02) behaviour. Overall, knowledge was a significant predictor of incidence of infection (P<0.001) – the risk of infection decreased by 20% per 10 percentage points of knowledge score (P<0.001). Attitude was also a significant predictor of infection incidence – the risk of infection decreased by 10% per 10 percentage points of attitude score (P=0.0046). We did not see a significant association between attitude and self-reported behaviour, or between self-reported behaviour and infection incidence, which may be due to measurement error in self-reports. We conclude that knowledge, provided by the intervention, was the major factor directly influencing hygiene behaviour change, thus preventing infection.
Changes in observed hand washing

Changes in hand washing practice are shown in Table 8. At baseline, 54.0% of students in the control group and 46.0% in the intervention group washed their hands (P=0.61). This increased to 98.9% in the intervention group at follow-up but remained the same in the control group (54.2%) (P=0.0048).

Table 8: Knowledge, attitude, practice (KAP) and change in observed hand washing practice in the control and intervention schools

<table>
<thead>
<tr>
<th></th>
<th>Control Schools (95% CI)</th>
<th>Intervention Schools (95% CI)</th>
<th>Intervention vs Control (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
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<td><strong>KAP [%-point]</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>26.25 (25.5-27.0)</td>
<td>30.7 (29.8-31.5)</td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>5.66 (2.58-8.74)</td>
<td>0.0008</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>5.07 (2.11-8.04)</td>
<td>0.0008</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>33.4 (32.49-34.4)</td>
<td>63.3 (62.3-64.4)</td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>32.8 (28.9-36.8)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>32.6 (28.7-36.6)</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td><strong>Hand washing [%]</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>366</td>
<td>54.0 (37.6-70.4)</td>
<td>46.0 (14.7-77.3)</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>- 8.0 (-25.4-41.4)</td>
<td>0.40**</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>377</td>
<td>54.2 (19.7-88.7)</td>
<td>98.9 (97.4-100.3)</td>
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</tr>
<tr>
<td>Crude</td>
<td></td>
<td>44.6 (10.1-79.1)</td>
<td>0.0048**</td>
<td></td>
</tr>
</tbody>
</table>

* Adjusted for sex and grade

** from Kruskal-Wallis analysis of variance
Monitoring

The monitoring in March 2011 showed that in fourteen of the nineteen intervention schools the responsible teacher did not mention the project to teachers of other schools. The four schools exchanging project-related information interacted either with other intervention schools or non-study schools; only one intervention school interacted with a control school.

Adverse events

No acute adverse events were observed immediately (15 minutes) after albendazole treatment. However, some recall adverse events were reported in the follow-up questionnaire (Table 11); these could be attributable to any childhood illness. Albendazole is considered safe for administration to children over one year of age and its use is advocated by WHO for the control of STH.\textsuperscript{150}

Discussion

The educational package we trialled resulted in 50% efficacy in preventing STH infection in Chinese school children. This was due to an increase in knowledge and improved hygiene practice and establishes proof of principle that the video-based health educational intervention increases students’ knowledge with regard to STH transmission and changes behaviour, resulting in fewer STH infections. A clear correlation between KAP and STH incidence was evident as, across the entire study population, uninfected students scored, on average, ten percentage points higher in the KAP questionnaire than infected students. Knowledge was the major factor influencing hygiene behaviour, thus preventing infection. A correlation was also observed between KAP and observed behaviour in both intervention and control groups.

It is noteworthy that baseline KAP scores were slightly higher in the intervention schools compared with the controls, attributable to contamination in the intervention schools, due to teachers imparting knowledge onto students following a specific teacher training workshop prior to commencement of the trial. When adjusted for the baseline score, the knowledge difference between the two groups of students at follow-up was reduced by about 24% of the total reduction and remained significant. Monitoring information indicated that no relevant exchange had occurred between the children from the intervention and control schools.
Children are a major risk group for STH and schools provide a cost-effective means of delivering interventions to students and to the rest of the community, a feature recognized by WHO for strengthening health promotion,\textsuperscript{10,88,150} through their launch of the Global School Health Initiative. Whereas health educational videos targeting schoolchildren have been shown to have a positive impact on knowledge and attitudes\textsuperscript{82-84,118,119,121,125,145,148}, few studies have evaluated the impact of video-based interventions on disease incidence or quantified their efficacy as an independent control tool.\textsuperscript{118,121,148} This rigorously conducted randomized control trial provides convincing evidence of the impact of a video-based health education package in changing behaviour and lowering the risk of STH infection.

Absolutely critical for the development of this successful educational package was the early community involvement of health and education officials, health workers, teachers, parents and students and our thorough assessment of the risk factors, knowledge, attitudes and practices for STH.\textsuperscript{151} This allowed us to develop a culturally tailored educational package that was both informative and engaging.\textsuperscript{108,144,145} The video displays correct behaviour in the form of an entertaining narrative and creates confidence that improving hygiene practice is in the target group’s hands, resulting in a positive health outcome.\textsuperscript{81,97}

As indicated, de-worming by MDA is effective for morbidity control in STH infections but it does not prevent re-infection, and once terminated, worm prevalence returns to pre-treatment levels within 6-18 months.\textsuperscript{26,69,70} WHO currently advocates MDA, targeting pre-school and school-age children, women of child-bearing age and adults at high risk but health education is not part of the recently published (2012) WHO roadmap for NTD control.\textsuperscript{61} Extensive coverage has been achieved thanks to generous drug donations by pharmaceutical companies and the successful integration of deworming programs in school health initiatives supported by UN programs, the WHO and the World Bank, facilitated through the Ministries of Health and Education in low income countries.\textsuperscript{30}

There has been considerable recent debate concerning the sustainability of STH control using MDA alone due to compliance issues and the recurrent treatment required in the absence of preventive control measures.\textsuperscript{26,66-72} Further, there is growing concern about the potential development of parasite resistance to albendazole and other anti-STH drugs as a result of continued treatment pressure.\textsuperscript{76} It is considered inevitable that drug resistance will develop in human nematodes given the number of species infecting sheep and other livestock that are now resistant to anti-helminthic compounds due to continuous and extensive drug
Indeed, this may already have happened in Ghana where a high rate of albendazole treatment failure has been observed in hookworm infections. Therefore, interventions that prevent STH reinfection (such as improvements in hygiene achieved through health education) are required to augment chemotherapy as part of an integrated approach, whereby chemotherapy reduces morbidity and prevalence, and preventive interventions (e.g. health education) prevent reinfection, thus reducing incidence. This will limit the number of treatment cycles required for effective control and subsequently reduce the treatment pressure, as well as creating a more sustainable long-term approach to control.

The effective video-based health educational tool we have developed, for use in schools, suitably complements the current approach to STH control advocated by WHO. Furthermore, it can readily be incorporated into current ongoing STH de-worming programs, such as in sub-Saharan Africa and the Chinese national STH control program which involves community and school-based control, initially aiming at integrating chemotherapy with health education and, subsequently, combining these approaches with additional water, sanitation and hygiene (WASH) interventions.

Further studies are now required to determine the adaptability of our video-based health educational package across different cultural settings and as part of a multi-component integrated package for STH control. Such an approach has the potential to contribute to a considerable reduction, if not elimination of the most common group of intestinal parasites worldwide, thereby helping to improve the health and livelihood of two billion of the world’s poorest people.

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We thank Andrew Bedford, director of the cartoon ‘The Magic Glasses’ and the team at Star City Media for producing a professional and effective educational cartoon. Many thanks to our collaborators at Hunan Institute of Parasitic Diseases in Yueyang and our colleagues at Linxiang CDC for their substantial contribution to the fieldwork in China. Thanks also to the teachers, parents and children who participated in this study in Linxiang County, Hunan Province, China.
# Chapter 6: Supplementary Information

## Table 9: Primary outcomes per school

<table>
<thead>
<tr>
<th>Name of School</th>
<th>School Number</th>
<th>Randomization Unit</th>
<th>Grade 4 student numbers</th>
<th>Grade 5 student numbers</th>
<th>Baseline Prevalence (CI) [%]</th>
<th>Follow-up Incidence (CI) [%]</th>
<th>Baseline knowledge score (CI) [%]</th>
<th>Follow-up knowledge score (CI) [%]</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daling</td>
<td>1</td>
<td>M1</td>
<td>15</td>
<td>0.0</td>
<td>6.7 (0.0-21.0)</td>
<td>34.3 (25.6-40.2)</td>
<td>69.3 (66.6-72)</td>
<td>Intervention</td>
<td></td>
</tr>
<tr>
<td>Wanghe</td>
<td>2</td>
<td>M1</td>
<td>17</td>
<td>5.6 (0.0-18.4)</td>
<td>5.9 (0.0-18.4)</td>
<td>31.3 (23.8-38.7)</td>
<td>59.7 (50.5-69.0)</td>
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<td></td>
</tr>
<tr>
<td>Nanmu</td>
<td>6</td>
<td>M3</td>
<td>11</td>
<td>0.0</td>
<td>0.0</td>
<td>26.5 (21.7-31.3)</td>
<td>78.3 (73.5-83.1)</td>
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</tr>
<tr>
<td>Zhongzhou</td>
<td>7</td>
<td>M6</td>
<td>36</td>
<td>0.0</td>
<td>5.6 (0.0-13.4)</td>
<td>35.4 (32.3-38.5)</td>
<td>71.7 (67.2-76.2)</td>
<td>Intervention</td>
<td></td>
</tr>
<tr>
<td>Jianshan</td>
<td>8</td>
<td>M6</td>
<td>43</td>
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<td>0.0</td>
<td>44.5 (39.2-49.2)</td>
<td>63.9 (59.1-68.7)</td>
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<td>6.3 (0.0-19.6)</td>
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<td>12</td>
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<td>50</td>
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<td>18</td>
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<td>95</td>
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<td>3.2 (0.0-6.7)</td>
<td>25.3 (22.7-27.5)</td>
<td>60.9 (58.0-63.7)</td>
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<td>5.9 (0.0-14.2)</td>
<td>32.8 (29.3-36.7)</td>
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<td>Taokuang</td>
<td>27</td>
<td>M19</td>
<td>43</td>
<td>12.5 (0.3-18.3)</td>
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<td>31.5 (28.6-34.4)</td>
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<td>Yuantan</td>
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<td>101</td>
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<td>3.2 (0.0-7.6)</td>
<td>33.6 (29.0-36.5)</td>
<td>71.1 (68.3-73.8)</td>
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<td></td>
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<td>Changtang 1</td>
<td>30</td>
<td>M24</td>
<td>113</td>
<td>17.6 (11.3-25.9)</td>
<td>5.3 (1-9.5)</td>
<td>27.3 (25.2-29.26)</td>
<td>66.1 (64.1-68.2)</td>
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<tr>
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<td>M15</td>
<td>60</td>
<td>15.2 (5.7-24.3)</td>
<td>3.3 (0.0-8.0)</td>
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<td>Hefan</td>
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<td>35.7 (32.5-39.3)</td>
<td>71.9 (67.9-76.0)</td>
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<td>Yanglousi</td>
<td>35</td>
<td>M6</td>
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<td>32.5 (28.0-35.8)</td>
<td>72.2 (68.3-76.0)</td>
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<tr>
<td><strong>Total student number intervention</strong></td>
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<td><strong>11</strong></td>
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<tr>
<td>Name of School</td>
<td>School Number</td>
<td>Randomization Unit</td>
<td>Grade 4 student numbers</td>
<td>Grade 5 student numbers</td>
<td>Baseline Prevalence (CI) [%]</td>
<td>Follow-up Incidence (CI) [%]</td>
<td>Baseline knowledge score (CI) [%]</td>
<td>Follow-up knowledge score (CI) [%]</td>
<td>Group</td>
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<tr>
<td>Xiaoyuan</td>
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<td>M2</td>
<td>20</td>
<td>16</td>
<td>7 (0.0-17.8)</td>
<td>8.3 (0.0-17.8)</td>
<td>27.2 (23.4-31.2)</td>
<td>33.5 (28.0-39.0)</td>
<td>Control</td>
</tr>
<tr>
<td>Xinqiu</td>
<td>4</td>
<td>M2</td>
<td>29</td>
<td></td>
<td>2.9 (0.0-10.5)</td>
<td>13.8 (0.4-27.1)</td>
<td>22.8 (17.2-25.0)</td>
<td>25.0 (20.4-29.5)</td>
<td>Control</td>
</tr>
<tr>
<td>Xinqun</td>
<td>5</td>
<td>M2</td>
<td>96</td>
<td></td>
<td>6.1 (1.3-11.1)</td>
<td>7.3 (2.0-12.6)</td>
<td>28.4 (26.2-30.8)</td>
<td>34.5 (31.8-37.1)</td>
<td>Control</td>
</tr>
<tr>
<td>Qilichong</td>
<td>9</td>
<td>M7</td>
<td>21</td>
<td></td>
<td>3.9 (0.0-14.7)</td>
<td>19.0 (0.7-37.4)</td>
<td>28.2 (23.8-32.6)</td>
<td>29.5 (24.4-34.5)</td>
<td>Control</td>
</tr>
<tr>
<td>Tandu</td>
<td>11</td>
<td>M9</td>
<td>26</td>
<td></td>
<td>20.7 (5.7-40.4)</td>
<td>15.4 (5.0-30.3)</td>
<td>26.6 (19.4-30.1)</td>
<td>33.1 (27.5-38.8)</td>
<td>Control</td>
</tr>
<tr>
<td>Shengtang</td>
<td>13</td>
<td>M11</td>
<td>10</td>
<td></td>
<td>0.0</td>
<td>30.0 (0.0-64.6)</td>
<td>29 (21.7-35.7)</td>
<td>23.7 (18.5-28.9)</td>
<td>Control</td>
</tr>
<tr>
<td>Yangtian</td>
<td>16</td>
<td>M14</td>
<td>12</td>
<td></td>
<td>20 (0.0-41.4)</td>
<td>8.3 (0.0-26.7)</td>
<td>29.5 (22.3-38.1)</td>
<td>38.1 (29.8-46.4)</td>
<td>Control</td>
</tr>
<tr>
<td>Shatuan</td>
<td>19</td>
<td>M17</td>
<td>17</td>
<td>18</td>
<td>7.5 (0.0-18.3)</td>
<td>11.4 (0.3-22.5)</td>
<td>29.1 (24.1-32.7)</td>
<td>32.3 (28.3-36.4)</td>
<td>Control</td>
</tr>
<tr>
<td>Yannan</td>
<td>20</td>
<td>M17</td>
<td>13</td>
<td>19</td>
<td>0.0</td>
<td>12.5 (0.4-24.6)</td>
<td>35.2 (33.6-38.6)</td>
<td>35.5 (31.2-39.8)</td>
<td>Control</td>
</tr>
<tr>
<td>Guangping</td>
<td>21</td>
<td>M18</td>
<td>19</td>
<td>13</td>
<td>0.0</td>
<td>3.1 (0.0-9.5)</td>
<td>22.6 (17.6-27.0)</td>
<td>30.9 (25.6-36.2)</td>
<td>Control</td>
</tr>
<tr>
<td>Xinjian</td>
<td>23</td>
<td>M20</td>
<td>45</td>
<td></td>
<td>11.1 (1.6-20.7)</td>
<td>8.9 (0.24-17.5)</td>
<td>24.8 (21.3-27.5)</td>
<td>33.3 (29.5-37.2)</td>
<td>Control</td>
</tr>
<tr>
<td>Shaping</td>
<td>24</td>
<td>M21</td>
<td>21</td>
<td></td>
<td>0.0</td>
<td>9.5 (0.0-23.2)</td>
<td>25.3 (21.2-33.8)</td>
<td>20.0 (15.5-24.6)</td>
<td>Control</td>
</tr>
<tr>
<td>Honglou</td>
<td>25</td>
<td>M20</td>
<td>29</td>
<td></td>
<td>2.9 (0.0-10.5)</td>
<td>17.2 (2.6-31.9)</td>
<td>25.8 (21.1-30.4)</td>
<td>28.2 (22.0-34.4)</td>
<td>Control</td>
</tr>
<tr>
<td>Changcheng</td>
<td>26</td>
<td>M14</td>
<td>25</td>
<td></td>
<td>0.0</td>
<td>8.0 (0.0-19.4)</td>
<td>33.4 (29.5-36.0)</td>
<td>36.6 (30.9-42.3)</td>
<td>Control</td>
</tr>
<tr>
<td>Baiyangtian</td>
<td>32</td>
<td>M25</td>
<td>117</td>
<td></td>
<td>15.8 (8.7-22.0)</td>
<td>6.0 (1.6-10.3)</td>
<td>20.6 (18.5-21.7)</td>
<td>29.4 (27.1-31.7)</td>
<td>Control</td>
</tr>
<tr>
<td>Hengpu</td>
<td>33</td>
<td>M26</td>
<td>47</td>
<td></td>
<td>13.5 (4.3-25.5)</td>
<td>4.3 (0.0-10.3)</td>
<td>25.3 (22.6-28.6)</td>
<td>29.3 (24.6-33.7)</td>
<td>Control</td>
</tr>
<tr>
<td>Dinghu</td>
<td>36</td>
<td>M28</td>
<td>108</td>
<td></td>
<td>27.9 (18.4-35.3)</td>
<td>9.3 (3.7-14.8)</td>
<td>25.4 (23.6-27.5)</td>
<td>37.0 (34.2-39.7)</td>
<td>Control</td>
</tr>
<tr>
<td>Nieshi</td>
<td>37</td>
<td>M29</td>
<td>122</td>
<td></td>
<td>9.7 (4.5-15.2)</td>
<td>4.1 (0.5-7.7)</td>
<td>27.8 (25.2-30.0)</td>
<td>41.7 (39.1-44.4)</td>
<td>Control</td>
</tr>
<tr>
<td>Baiyun</td>
<td>38</td>
<td>M14</td>
<td>50</td>
<td></td>
<td>0.0</td>
<td>6.0 (0.0-12.8)</td>
<td>26.5 (22.7-28.3)</td>
<td>32.6 (28.9-36.3)</td>
<td>Control</td>
</tr>
</tbody>
</table>

**Total student number control**

| 827 | 66  |

---

Chapter 6
Table 10: Knowledge, attitude and practice (self-reported behaviour) in the control and intervention schools

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Control Schools (95% CI)</th>
<th>Intervention Schools (95% CI)</th>
<th>Intervention vs Control Difference in means</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge [%-point]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>19.0 (18.1-19.9)</td>
<td>24.5 (23.5-25.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>6.62 (2.91-10.33)</td>
<td></td>
<td>0.0005</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>6.02 (2.53-9.51)</td>
<td></td>
<td>0.0007</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>26.4 (25.4-27.5)</td>
<td>58.8 (57.6-60.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>35.8 (31.2-40.4)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>35.6 (31.0-40.2)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td><strong>Attitude [%-point]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>35.7 (33.7-37.7)</td>
<td>45.9 (43.7-48.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>14.5 (8.53-20.4)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>14.0 (7.85-20.2)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>42.1 (39.6-44.5)</td>
<td>65.4 (63.0-67.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>30.2 (20.7-39.8)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>30.0 (20.6-39.94)</td>
<td></td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td><strong>Practice [%-point]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1934</td>
<td>51.9 (50.51-53.3)</td>
<td>51.6 (50.2-53.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>0.14 (-2.98-3.26)</td>
<td></td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>0.23 (-3.36-2.90)</td>
<td></td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Follow-up</td>
<td>1718</td>
<td>55.5 (54.2-56.9)</td>
<td>61.3 (59.8-62.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted*</td>
<td></td>
<td>6.02 (2.47-9.57)</td>
<td></td>
<td>0.0009</td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td></td>
<td>5.81 (2.2-9.32)</td>
<td></td>
<td>0.0012</td>
<td></td>
</tr>
</tbody>
</table>

* Adjusted for sex and grade
Table 11: Adverse events reported at follow-up

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentage of children reporting an event [%] +</th>
<th>Overall</th>
<th>Control group</th>
<th>Intervention group</th>
</tr>
</thead>
<tbody>
<tr>
<td>I felt dizzy</td>
<td>11.4</td>
<td>12.9</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>I felt sick</td>
<td>11.3</td>
<td>14.9</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>I had diarrhoea</td>
<td>14.7</td>
<td>17.1</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>I had to vomit</td>
<td>4.6</td>
<td>5.1</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Other$</td>
<td>19</td>
<td>16</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

+ All children treated at baseline and present at follow-up were included.

*The adverse events were assessed with the following question in the follow-up questionnaire:

**How did you feel after the worm treatment? (more than one answer possible)**

(1) I felt good.
(2) I felt dizzy.
(3) I felt sick.
(4) I had diarrhoea.
(5) I had to vomit.
(6) Other (please specify):………………………….

$ Reported in this category were: 'weakness' (4 children), 'abdominal pain' (1 child) and 'headache' (1 child).
Chapter 7
General Discussion and Conclusions
7 General discussion and conclusions

The overall major objective of the study was achieved by providing proof of principle that an education package including an educational video, targeting STH prevention at school increases students' knowledge and changes their behaviour, resulting in fewer STH infections. The following specific aims were reached (Chapter 1):

1. The video-based health educational package was effective in improving the schoolchildren’s knowledge of, and attitude to, STH, including STH transmission, symptoms, treatment, prevention and self-reported hygiene practice.
2. The video-based health educational package was effective in changing the intervention group’s infection risk behaviour such that STH incidence decreased.
3. The video-based health educational package was effective in preventing STH infection incidence in schoolchildren in Linxiang City District.

The major research outputs resulting from the study included:

A. A systematic literature review on the impact of video-based health education targeting infectious diseases and recommendations for the planning and implementation of studies testing educational interventions.

B. Successful development, production and testing of a novel health educational cartoon video ‘The Magic Glasses’ targeting STH in schoolchildren and recommendations for the production of video-based educational interventions.

C. Provided evidence, based on a randomized controlled trial (N=1718) on the efficacy of a video-based health education package in increasing knowledge, improving hygiene behaviour and preventing infection.

The contribution of this thesis to new knowledge will now be discussed in detail and will be followed by an appreciation of the public health significance and practical applications of the findings, a consideration of the limitations of the study and directions for future research.
Chapter 7

7.1 Contribution of new knowledge to the field

7.1.1 A systematic review of preventive health educational videos targeting infectious diseases in schoolchildren

A number of previous studies had shown that school-based educational videos are effective interventions in changing student behavior\(^5\), \(^6\) and improving knowledge and attitudes.\(^7\) However, the existing literature had never been systematically reviewed. The review integrated into this thesis was the first to systematically review school-based video interventions targeting infectious diseases in order to draw evidence-based conclusions on their effectiveness.

The majority of the eleven studies reviewed concluded that videos were well received by schools, teachers and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes. However, due to the methodological weaknesses of some of these studies, the lack of quantitative results and indicators for statistical significance in several of the trials, and inconsistent reporting, it was not possible to carry out meta-analyses or draw evidence-based conclusions. We identified a pressing need for more standardized, high-quality studies in order to draw evidence-based conclusions on the value of educational videos targeting infectious diseases.

Data from eleven studies were presented in descriptive form (Chapter 3) and formulated informed guidelines for the planning and implementation of future video-based studies within the school setting. The key findings were combined with experiences we had personally gained during the intervention trial described in Chapter 6.

In conclusion, once a critical mass of appropriately designed, conducted and reported intervention studies have been completed according to the key recommendations presented (Chapter 3, Box 1), meta-analyses can be undertaken to establish an evidence base for future research. This can then help establish a new generation of educational videos, thereby creating powerful and cost-effective preventive tools for infectious diseases and complementing other interventions such as drug treatment and/or improved sanitation.

7.1.2 Development of an educational video preventing soil-transmitted helminth in schoolchildren

A major aspect of the thesis involved the development, production and pilot testing of a video-based educational package. We chose a community-based mixed methods approach involving input
from target group (schoolchildren) and key informants such as teachers, doctors and parents in order to identify potential STH infection risks in the study area and to formulate key messages for the video. This approach was chosen according to recommendations made by previous studies assessing the impact of multimedia on learning \(^{144,145,151}\) and behavioural theories. \(^{81,108}\) These studies recommended presenting the information in the video in terms of the intellectual, emotional, social and cultural context of the target population.

We assessed risk factors of the natural and human environment such as transmission hot spots, high-risk behaviour for infection, as well as the intellectual, emotional, social and cultural context of the target population in questionnaires, interviews, focus group discussions, ‘draw & write’ assessments, and household and field observations. The outcomes of the risk factor assessment were then translated into key messages for the video. ‘The Magic Glasses’ video was produced and can be accessed online at:

http://www.qimr.edu.au/page/Home/Magic_glasses/

The community-based mixed methods approach we applied was absolutely critical for the development of the culturally tailored educational package. Assessing specific needs of the target population, local customs, STH infection risk factors and integrating them in the educational package guided by behavioural theories proved a very successful approach (Chapter 6). An earlier study entitled ‘Safe in the city’, \(^{157}\) a successful video designed for the prevention of sexually transmitted diseases in clinic waiting rooms inspired us to pilot test ‘The Magic Glasses’ video and to incorporate the target group’s feedback in the revised version. Apart from ‘Safe in the City’, studies that have included the assessment of the theoretical background; and previous literature in the production and testing of the educational video are rare. Therefore, the experiences gained in this thesis contribute significantly to the evidence base in the field of educational video development and are summarized as recommendations for future studies (Chapter 6).

7.1.3 Video-based health education prevents soil-transmitted helminth infections in Chinese schoolchildren

The educational package we developed and trialled resulted in a 50% efficacy in preventing STH infection in Chinese schoolchildren, unprecedented for health education targeting STH. This was due to an increase in knowledge and improved hygiene practice. The study established proof of principle that the video-based health educational intervention widens student awareness and changes behaviour, resulting in fewer STH infections. A clear correlation between knowledge and
STH incidence was evident, as across the entire study population, uninfected students scored, on average, 10 points higher in the KAP questionnaire than infected individuals. Knowledge was the major factor influencing hygiene behaviour, thus preventing infection. This positive impact on the outcomes was clearly attributable to the intervention as no other STH control efforts, were implemented in the study area at the same time.

Previous studies have shown that health educational videos targeting schoolchildren are effective tools, with a positive impact on knowledge and attitudes. However, there had been comparatively few studies that have evaluated the impact of video-based interventions on disease incidence or quantified their efficacy as an independent control tool. In fact, in 2002 a WHO report on prevention and control of schistosomiasis and soil-transmitted helminthiases concluded that health education efforts are promising, but there is missing evidence about the effects of these different health education tools on disease control. Ten years after the WHO report, a collection of articles published in the journal *PLoS Neglected Tropical Diseases* - ‘A Research Agenda for Helminth Disease’ - provided a comprehensive review of recent advances in helminthiases research, identified research gaps and formulated priorities for a research and development (R & D) agenda for the sustainable control and elimination of helminth infections. The authors concluded that existing control tools need to be optimized and novel control tools, including health education methods, improving the impact and sustainability of current control efforts are urgently required. They also highlighted the importance of developing an effective integrated control approach to maximize the sustainability of control programs.

The findings of this thesis contribute substantially to the research needs identified in the ‘Research Agenda for Helminth Disease’ by providing valid and highly significant quantitative evidence on the potential impact of video-based public health interventions in the form of a rigorously planned, implemented and reported randomized controlled trial. Moreover, the study provides recommendations for the development of effective video-based health educational material that can readily be applied in other endemic areas and for other infectious diseases.

7.2 Public health significance of findings: Translation into policy and practice

7.2.1 Limitations of control strategies to date

Given the tremendous global burden NTDs cause in the most deprived communities, the announcement of the WHO roadmap to overcome the misery caused by these diseases has
inspired public and private partners to collaborate in the fight against these neglected diseases. In recent years, major pharmaceutical companies, the Bill & Melinda Gates Foundation, the governments of the United States, United Kingdom and United Arab Emirates and the World Bank announced substantial support to accelerate the control, elimination and possibly the eradication of these diseases.

Measures mainly include sustaining or expanding current MDA programs to meet the UN Millennium Development Goals by 2020 and by sharing expertise and compounds to promote research and development of new drugs. All partners also endorsed the ‘London Declaration on Neglected Tropical Diseases’ in which they pledged new levels of collaborative effort and tracking of progress in tackling 10 of the 17 neglected tropical diseases currently on WHO's list (http://www.who.int/neglected_diseases/diseases/en/).

Even though significant progress has been made in controlling STH infections over the past 10 years, with 314 million pre-school and school-aged children (representing 31% of all children in the world at risk of soil-transmitted helminthiases) dewormed in 2009, the UN Millennium Development Goal of treating 75% of school-aged children at risk by 2010 has not been reached. In the ‘WHO roadmap to overcome the global impact of NTD’, released in January 2012, the goal was reset to 75% treatment coverage for children in endemic areas by 2020.

Even if this ambitious goal is achieved by 2020, concerns regarding the sustainability of MDA remain. For the last 20 years, rapid reinfection rates after treatment cessation have repeatedly been reported.\(^{159-161}\) Further, compliance issues and donor fatigue has arisen in areas where treatment needs to be repeated regularly.\(^{66-68,71,72}\) Enthusiasm in the community wanes, especially when the community was not previously informed and respectfully engaged about the program. Drug supply in remote areas can be difficult and may distract from other priorities in resource-poor local health centres, weakening local health systems.\(^{162}\) Moreover, there is growing concern about the potential development of parasite resistance to albendazole and other anthelmintics as a result of continued treatment pressure.\(^{76}\) It is considered inevitable that drug resistance will develop in human nematodes given the many examples of drug-resistant species infecting sheep and other livestock that are already resistant to anthelmintic compounds due to extensive drug use.\(^{152-154}\)

The benefit of MDA has been intensely debated after a recently published second edition of a Cochrane review by Taylor-Robinson and colleagues in 2012 which summarized the effects of de-worming on nutritional indicators, haemoglobin and school performance in 42 randomized controlled trials (RCTs) comprising a total of 65,000 participants.\(^{73}\) The review concluded that there is insufficient reliable information to determine whether de-worming has an effect on nutritional
indicators, haemoglobin and school performance and, hence, the justification for de-worming programs is questionable.\textsuperscript{73} This report has stimulated intense debate among the NTD community and its methods of analysis and study selection criteria have been criticized by MDA advocates. The debate is ongoing and is being continually updated in a PLoS Medicine blog that can be visited at: http://blogs.plos.org/speakingofmedicine/2012/07/18/should-deworming-policies-in-the-developing-world-be-reconsidered

\subsection*{7.2.2 Practical application of the findings}

For all the reasons listed above, interventions preventing STH reinfection, such as improvements in hygiene achieved through health education, are urgently required to augment the effect of chemotherapy as part of an integrated approach. Chemotherapy effectively reduces morbidity and infection prevalence, and preventive interventions such as health education prevent reinfection, thereby reducing incidence. In the long term, this will lead to a reduction in treatment cycles required for effective control and reduce the treatment pressure, resulting in a more sustainable approach to control. Indeed, there are studies that have shown that interventions combining MDA with health education and improved sanitation are more effective than chemotherapy alone.\textsuperscript{3,13}

In my opinion, the only way to reach the UN Millennium Development Goals\textsuperscript{26} is through integrated control efforts comprising a multi-component strategy including chemotherapy, improved sanitation and health education and not to a combined purely MDA-based control of several NTDs. The need for health education and additional public health measures, including novel, effective and easy-to-use educational control tools, has repeatedly been advanced.\textsuperscript{54,163-167} The literature indicates that strategies involving health education and behaviour change have been poorly implemented in practice and culturally sensitive and evidence-based control strategies that address the social, cultural and behavioural dimensions of disease are urgently required.\textsuperscript{78} The effective video-based educational package we developed is a novel, evidence-based and culturally sensitive educational tool that suitably complements the current approach to STH control advocated by the WHO. It can readily be incorporated into current ongoing STH de-worming programs, such as in sub-Saharan Africa\textsuperscript{156} and the Chinese national STH control program, which involves community and school-based control, initially aiming at integrating chemotherapy with health education and subsequently combining these approaches with additional water, sanitation and hygiene (WASH) interventions.\textsuperscript{8}
Considering the currently ongoing negotiations for a global NTD control strategy with the WHO Roadmap, the London Declaration (January 2012, http://www.who.int/neglected_diseases/London_meeting_follow_up/en/index.html) and recent efforts in translating the London Declaration into action (November 2012, http://www.unitingtocombatntds.org/content/uniting-combat-ntds-translating-london-declaration-action), the findings of this thesis are not only highly topical but may also have major implications for the future control of STH infections worldwide. If we strive to improve global health grounded in principles of evidence-based medicine then trials like the one presented here will play an important role in establishing an evidence-base for the selection of novel, effective control tools.

7.2.3 Scaling up: China and beyond

A multi-step process is needed for scaling-up and future application of a particular intervention package as a public health tool. A first step involves scaling up of the educational package developed for STH within China as a school-based intervention. In a second and third step the successful intervention package can be tested and applied in other Asian countries and then across STH-endemic areas in Latin America and Africa.

For scaling-up, it is essential that authorities and policy makers at the local, provincial and national levels are involved from the beginning. China CDC plays a major role and needs to be involved in order to gain national support and approval of the novel educational tool through all levels of policy making in China. Such collaborations must aim at a genuine transfer of ownership. Scaling-up also requires a dedicated institution and strong national leadership to advocate and coordinate scaling-up activities. Further, any novel intervention strategy needs to be well advocated at the national and international levels, a feature successfully invoked by the current large-scale MDA programs for STH control.

China is in an ideal position to undertake an integrated public health strategy that combines MDA with health education and improved sanitation for the control of STH, as it has already successfully pioneered integrated control measures, which included health education, for other NTDs such as lymphatic filariasis and schistosomiasis. Due to economic development, improved sanitation and raised living standards, STH prevalences have decreased considerably in Eastern China, whereas endemic hot spots remain in remote rural areas of Yunnan, Sichuan and Guizhou Provinces. Worldwide, China’s economic and political influence is increasing rapidly and expectation for China to take the lead in transferring its NTD control and elimination know-how and to provide support for NTD control in sub-Saharan Africa has already been raised.
In addition to scaling up on a school basis, the intervention can be expanded to the wider community for example through different communication channels such as mass media. Previous studies have shown that mass media can improve knowledge in communities about the prevention of the diseases that afflict them, advocate community participation in control programs, and promote behavioural changes that support interventions. The recent advances in Information and Communication Technology (ICT) can be a driving factor in the promotion of universal access to education. However, advances in technology alone, do not necessarily lead to successful health education programs; collaborations, partnerships and networks that provide the infrastructure, support and leadership for up-scaling are needed.

7.3 Project advocacy and handover in China

The details of the intervention and the results of the trial were presented to different groups and stakeholders in China on a number of occasions. A dissemination workshop was held in April 2012 when the video was handed over to the Linxiang Ministry of Health and the Linxiang Centre for Disease Control. The Deputy Mayor of Linxiang City and officials from the following institutions were present: National Centre for Disease Control, Shanghai; the Provincial Department for Schistosomiasis Control, Changsha, Hunan; The Hunan Institute of Parasitic Diseases, Yueyang; Linxiang Ministries for Health and Education and the Linxiang Centre for Disease Control, Linxiang, Hunan Province, China.

The results of the study were also presented orally at the ‘First Forum on Surveillance Response System Leading to Tropical Diseases Elimination’, Shanghai in June 2012. The results and the video were shown to national key figures in National Parasitic Disease Control such as Prof Zhou Xiao-Nong, Director of the National Institute of Parasitic Diseases at the Chinese Centre for Disease Control and Prevention, based in Shanghai. The video was also presented to UNICEF China, who showed interest in integrating the video into their health education program.

Further, a meeting was held with the senior editor Mr Zhou Yongjin for electronic and audio-visual publishing at the People’s Medical Publishing House in Beijing. He expressed interest in publishing the video and entering the competition for assessment by two national Chinese programs.  

Media releases on project activities are shown in Appendix H.
7.4 Application of research methods and outputs to other STH endemic areas

The research methods and strategies developed to produce the video and to test the efficacy of educational interventions on STH infection could readily be applied to other STH-endemic areas. Recommendations for the design of control programs and the development of video-based health educational packages were provided in Chapters 5 and 6, respectively.

External validity: although the video was specifically tailored for the Linxiang study area, the intervention would likely be effective in other STH-endemic areas in China with similar infection prevalence and a predominantly Han population. As discussed in section 7.6.2, the effectiveness of the video in higher prevalence settings and with different ethnic minorities needs further investigation.

7.5 Limitations of study

This study established infection rates for *Ascaris* and *Trichuris*, since hookworm prevalence in Linxiang City District was very low. The baseline prevalence in this study predominantly consisted of *Ascaris*, implying that a reduction in infection mainly refers to *Ascaris*. However, the intervention effect is expected to be very similar on *Trichuris* due to their common pathway of transmission. Future studies in areas with higher hookworm prevalence can provide additional information regarding the intervention effect on hookworm infections.

Following baseline assessment, all intervention and control school participants were treated with albendazole (400mg single oral dose, recommended by WHO) and monitored for treatment compliance. With this regimen, albendazole provides, on average, cure rates of 98% and 47% for *Ascaris* and *Trichuris*, respectively; however, efficacy can be 100% in those with low infection intensity.\(^{52}\) Given the predominant species in the study area was *Ascaris* and infection intensities for both *Ascaris* and *Trichuris* were low, children were not re-checked for remaining infections after treatment. However, cases where the treatment was not effective were negligible especially in light of the highly significant difference in infection incidence between intervention and control. Further, the main trial outcome was not affected, since conditions were the same in both intervention and control groups.

For the parasitological survey, a single faecal sample was used and analysed with the Kato-Katz technique. The literature indicates that a single Kato-Katz might underestimate infection prevalence.\(^{171}\) Again, should the infection prevalence be an underestimation of the true prevalence,
this is the case for both intervention and control arms and does not influence the trial results. Therefore, we could not justify the extensive resources required for multiple Kato-Katz analysis.

As described above, the video was part of an educational package including classroom discussions, essay and drawing tasks and a pamphlet with the key messages. The effect of the intervention package was measured as a whole and we did not establish the impact of the educational video in isolation. In a future study, it would be valuable to measure the impact of the video alone, without additional input (see 7.6.1), however, this might be difficult to measure, since an individual teacher’s contribution in the intervention cannot be isolated and will vary in different schools. Also, previous literature has recommended that educational videos should be used as a teaching aid, not a teaching substitute and that they are much more effective when combined with other teaching methods. If the aim is to achieve the maximum impact by the intervention, the video should be combined with other methods. The difference between ‘video alone’ and ‘video combined’ can be established in a sub-group analysis.

The methodology used in this study is ‘best practice’ for the implementation of randomized controlled trials and the results indicated a large and highly significant difference between intervention and control schools for all outcome measures. The limitations were minor and did not affect the main trial outcome.

7.6 Directions for future research

7.6.1 Further evaluation of the educational package

Follow-up studies could provide information on a number of additional outcomes measuring the impact of the video-based educational package. These include measures of cost-effectiveness, such as, for example, establishing how much the educational intervention costs per child and per infection averted. This can be measured both including and excluding development and production costs of the cartoon video. Further, the impact of the educational video alone, without the entire educational package could be established in a specifically designed trial or subgroup analysis. Future trials may also aim to investigate the impact of the educational package on different school-grades and in combination with improved water and sanitation (WATSAN). Moreover, observed hygiene practice could be more extensively assessed in addition to hand washing, e.g. around household food preparation. From the educational perspective, other knowledge gaps include the impact of the intervention on cognitive development of the children. In addition to our quantitative
KAP measurements, follow-up studies could also qualitatively assess and evaluate the effect of knowledge increase on practice, infection rate and morbidity.

Other knowledge gaps include the impact of purely school-based interventions on the wider community and comparing the effectiveness of school-based versus community-based interventions.

7.6.2 Research needs for scaling-up

For a potential scaling-up of the control package developed within this thesis, follow-up studies are required to establish to what extent the educational package is culturally adaptable and effective in other STH-endemic areas. Future research should also investigate the feasibility of converting the video-based intervention into different multimedia formats such as a television series and the impact of making it accessible for the wider community. The effectiveness of these different intervention strategies and media also need to be established scientifically. Additionally, the adaptability of the approach to other diseases/conditions of public health relevance where control efforts include behaviour change can be investigated.

7.6.3 Research needs for sustainable control of STH

In order to establish the impact of the educational package under different conditions and in different environments, a number of tools are urgently required. For example, the development of new (field compatible) diagnostics for STH, allowing a more accurate evaluation of the intervention impact. More accurate diagnostic tools for surveillance become increasingly important with decreasing infection intensities and prevalence and should therefore be a top research priority.

Alternative control strategies

As discussed above, current STH control programs are highly vulnerable should anthelmintic resistance develop and spread, as is possible following years of MDA. Therefore, new drugs and vaccines are urgently needed if sustainable control and future elimination of STH is to be achieved. In this respect, the Human Hookworm Vaccine developed by the Sabin Institute has shown promising laboratory results and early stage clinical trials for the hookworm vaccine are currently ongoing.
Planning tools

In order to guarantee that the increased availability of funds to control STH is allocated to areas of greatest need, online resources such as the Global Atlas of Helminth Infection (www.thiswormyworld.org) provide policy makers and organisations in endemic countries with relevant information for planning purposes. Therefore, research in this field should be a top priority.172

7.7 Conclusion

The health education package study provides valid and highly significant quantitative evidence in form of a rigorously planned, implemented and reported randomized controlled trial and contributes substantially to the evidence base assessing the impact of video-based public health interventions. The results of this study are highly topical, since the effectiveness and the sustainability of STH control using MDA alone has been questioned due to compliance issues and the recurrent treatment required in the absence of preventive control measures.26,66-73,26,66-73 A need for innovative and effective educational tools that can be integrated in existing NTD control efforts has been expressed in ‘A Research Agenda for Helminth Disease’ published in PLoS Neglected Tropical Diseases in April 2012. Interventions including health education to prevent STH reinfection such as the one presented in this thesis are urgently required to augment the sustainability and effectiveness of chemotherapy as part of an integrated approach.

Additionally, the effective video-based health educational tool developed within this research suitably complements the current approach to STH control advocated by WHO and it can be readily adapted to different cultural settings and combined with existing school-based MDA programs at low extra cost as part of an efficient integrated control program and potentially preventing millions of STH infections in other areas with high STH endemicity in Asia, Latin America and sub-Saharan Africa.

Further studies are now needed to assess the adaptability of the educational package to different cultural settings and as part of a multi-component integrated package for STH control. An approach using a multi-component integrated package has the potential to contribute to a considerable reduction of the most common group of intestinal parasites worldwide, thereby helping to improve the health and livelihood of the most deprived communities.
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Appendix A.1: Systematic review of preventive health educational videos targeting infectious diseases in schoolchildren

This appendix presents a reprint of the published paper.

Franziska A. Bieri, Darren J. Gray, Giovanna Raso, Yue-Sheng Li, and Donald P. McManus

Systematic review of preventive health educational videos targeting infectious diseases in schoolchildren

INTRODUCTION

The value of a moving image in health education was highlighted as early as 1988 when a manual published by the World Health Organization pointed out that no other media creates such lively interest as television. Television programs such as Sesame Street, Between the Lions, and Blue’s Clues, have shown the positive effects on cognitive development of young children. In the school setting, educational videos have proven effective interventions in changing student behavior and improving knowledge and attitudes. Furthermore, the importance of involving schools to strengthen health education has been recognized. The World Health Organization and other organizations have launched global school health programs (Global School Health Initiative in 1995 and Focusing Resources on Effective School Health [FRESH]), which seek to strengthen health promotion and educational activities in schools at the local, national, and global levels. The studies reviewed here have sought to combine education and entertainment through multimedia to inform and engage children at the same time, and assesses the public health role for preventive educational videos targeting schoolchildren.

The approach we have taken in this review is unique, being the first to systematically review school-based video interventions targeting infectious diseases. Furthermore, we have formulated informed guidelines for the evaluation of future video-based studies within the school setting. The key findings are combined with experiences we have personally gained during an intervention trial we are undertaking in China, which is assessing whether an educational video targeting soil-transmitted helminth (STH) prevention at school widens the students’ knowledge and changes their behavior, resulting in fewer STH infections. Initially, the objective of this review was to assess the public health value of video-based interventions. However, a limited number of studies assessing the impact of health educational videos for infectious diseases at school were found, and some were of poor scientific quality, making it difficult to conduct a meta-analysis. However, we provide a descriptive summary of the results and make recommendations for studies using preventive educational videos targeting infectious diseases in schoolchildren based on our own experience in China.

METHODS

Sources and selection criteria. Data for this review were identified, as of May 2012, by searching Medline, EMBASE, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, ISI Web of Knowledge, Informit, ERIC, A+ education, EdTILib (Education and Information Technology Digital Library), CSA Illumina (Sociological Abstracts), Pro Quest Social Science Databases, Anthropology Plus Basic Search and Google. As we found that not all relevant publications appeared when searching these databases, the following journals were searched directly: Journal of School Health, Health Education Research, Health, Preventive Medicine, BMC Public Health and American Journal of Health Education. In addition to standard biomedical databases, major educational and anthropologic databases such as ERIC, A+ education, and Pro Quest Social Science Databases and educational journals were selected because they index publications that specifically relate to the reviewed topic and which might not have been covered by Medline. Video refers to audio-visual material/films in digital and analogue formats (e.g. DVD, MPEG-4, wav, wmv, and VHS videotapes). In community-based studies, the target population includes children and adults. Therefore, the method, didactic approach, and overall setting of the intervention are different, making it difficult if not impossible to compare the outcomes with school-based interventions targeting school-children only.

The reference lists of identified studies were searched for further relevant information and European and American gray literature (NTIS, OpenSIGLE) databases were also reviewed. Gray literature is defined as “that which is produced on all
levels of government, academics, business, and industry in print and electronic formats but which is not controlled by commercial publishers. We used the terms impact, educational, video, health, DVD, film, school, school-based child, infect*, hygiene practice, risk behavior, infection risk behavior, and behavior change for our searches. The review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (Figure 1).

We reviewed studies that evaluated interventions involving video-based health education in schools aimed at improving knowledge, attitudes, and inducing behavior changes for a wide range of medical conditions of public health relevance. The target group included primary school and secondary school students 5–17 years of age. For simplicity and readability, the term schoolchildren is used to describe both of these types of students. The different types of study designs included randomized controlled trials (RCTs), pre-/post-test design, and quasi-experimental and observational studies (Figure 1). We noticed a considerable inconsistency in the terminology for study design. In the older publications, and publications with a social science background, the term controlled pre-post-test design instead of RCT was used.

**Data extraction.** Data from each study were extracted into tables, which contained the aims, sample size, design, outcome measures, and results. Quantitative and qualitative outcome measures were assessed according to the method applied in the study. The method quality of each study was assessed by testing for the following factors: randomization, inclusion of a control group, intervention design, outcome assessment, quality of results, sample size, and study design, and then categorized according to evidence-based medicine criteria (Table 1). The RCTs were additionally ranked according to the validity scale presented by Jadad and others (Table 2).

**RESULTS**

Of 1,243 papers identified from our original searches reporting studies involving health educational videos, most were excluded for the following reasons: the intervention was not school-based; neither children nor infectious diseases were targeted; and the video was not used for teaching but instead for video-recorded observations, video monitoring, video games, or endoscopy. The review and selection process left us with 11 articles that met the inclusion criteria. Five of

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**Figure 1.** Flow chart for selection of articles on preventive educational videos targeting schoolchildren included in the review. N.A. = not applicable.
Studies & Aims | Sample size | Design (evidence-based medicine level) | Outcome measures
---|---|---|---
Hu and others\textsuperscript{20} | Evaluating the effects of experimental AIDS/STD curriculum compared with current AIDS/STD education in Dutch schools | 2,430 (grades 9–10) | RCT (author: quasi-experimental design) (level I) | Knowledge: 13% increase in knowledge on AIDS/STD ($P < 0.001$); Attitude: 3% higher risk appraisal ($P < 0.005$), 41% more positive attitudes ($P < 0.001$), 19% more positive perceptions ($P < 0.01$); Behavior: lower student risk index (weighted, $P < 0.05$)

Yuan and others\textsuperscript{24} | Test impact of video intervention on primary school students’ knowledge of schistosomiasis and their compliance for treatment | 1,137 schoolchildren (grade 5) | RCT (author: quasi-experimental design) (level I) | Knowledge: 83% increase ($P < 0.001$); Attitude/compliance: 67% increase in willingness to submit a fecal sample for diagnosis, 66% increase in willingness to submit a blood sample, 58% increase in willingness to take medication ($P < 0.001$), 11% increase in compliance rate for blood examination ($P < 0.001$); Behavior: no statistically significant difference in participation for schistosomiasis examination ($P > 0.1$)

Yuan and others\textsuperscript{23} | Test the effectiveness of video and accompanying booklet on water contact and schistosomiasis infection risk behavior of primary school students | 1,739 schoolchildren (grade 4) | RCT (level I) | Knowledge: 41% increase ($P < 0.001$); Attitude/compliance: not assessed; Behavior: 71.4% of water-related activities in unsafe places undertaken by control group ($P < 0.0001$). Overall 10% decrease of unsafe water contact from pre- to post intervention ($P$ not reported)

Hu and others\textsuperscript{25} | Examine the short-term effects of health education in the control of schistosomiasis, and to monitor the long-term impact on re-infection patterns | 120 schoolchildren (age = 6–15 years), 206 adult females, 194 adult males | RCT (level I) | Knowledge: 92% increase ($P < 0.001$); Attitude/compliance: 80% increase in correct attitude towards chemotherapy ($P < 0.001$); Behavior: significant decrease in risky water contact ($P$ not reported)

Huszti and others\textsuperscript{17} | Test effects of a lecture or a film on AIDS knowledge and attitudes towards practicing preventive behaviors | 488 students (grade 10) | RCT (level I) | Knowledge: significant increase ($P < 0.05$); Attitude/compliance: no significant effect on attitude towards AIDS patients ($P$ not reported). Attitudes toward practicing preventive behaviors: no significant effect ($P$ not reported); Behavior: not assessed

Torabi and others\textsuperscript{12} | Assessing the impact of a school-based video intervention on HIV/AIDS in Russian students | 1,124 (grades 7–9) | Quasi-experimental design, no randomization (level II-1) | Knowledge: significant increase in knowledge on HIV/AIDS prevention ($P < 0.01$); Attitude: significant improvement in attitude scores ($P < 0.01$); Behavior: no significant change

Brabin and others\textsuperscript{16} | Evaluate girls’ recall of film on HPV and cervical cancer | 1,084 girls (age = 12–13 years) | Not indicated, no randomization (level II-1) | Knowledge: girls 16% more likely to report having received enough information ($P < 0.0001$) and 8% more likely to have wanted the vaccine ($P = 0.015$); Attitude/compliance: ceasing awareness of the risks of sexual relationships ($P = 0.015$). Less reluctant to discuss the vaccine with boyfriend ($P = 0.008$). Behavior: not assessed

Stevenson and Davis\textsuperscript{11} | Assess impact of culturally similar and culturally dissimilar health education videos on HIV/AIDS knowledge, beliefs, and prevention. | 111 African-American adolescents (age = 14–15 years) | Uncontrolled trial (level II-3) | Knowledge: increase ($P = 0.05$). Quantitative assessment not clearly described; Attitude/compliance: no impact on prevention beliefs, cultural beliefs and safer alternative options; Behavior: not assessed

Albonico and others\textsuperscript{15} | Reduce infection intensity of Ascaris lumbricoides, Trichuris trichiura, and hookworms. Reduce prevalence of Strongyloides stercoralis and amebiasis | 1,075 schoolchildren (age = 3–17 years) | Pre- and post-test design, no control (level II-3 or III) | Knowledge: not assessed; Attitude/compliance: not assessed. Behavior: not assessed; Prevalence: 44% decrease in intestinal parasites ($P < 0.001$); Intensity: 15%, 47%, and 68% decrease for A. lumbricoides, T. trichiura, and hookworms, respectively

(Continued)
the school-based interventions targeted parasitic infections with the remainder being on sexually transmitted infections (specifically, five on human immunodeficiency virus/acquired immunodeficiency syndrome, and one on human papillomavirus. The aims, design, and main outcomes for each of these studies are summarized in Table 1.

**Types of interventions.** Of 11 reviewed studies, 10 were directed at increasing student knowledge and raising their awareness. Six studies aimed at changing behavior to prevent parasitic diseases and sexually transmitted infections. Seven trials tested the educational video against a control arm involving conventional teaching aids such as posters and reading materials or no treatment/intervention.

**Types of videos.** The educational videos used ranged from 15 to 22 minutes in duration with a median duration of 18 minutes; one outlier, however, lasted two hours. All videos targeted children and were implemented at school; one study additionally targeted adults. In seven of the studies, the videos were developed within the research project; 15,16,18,20,22,25 of which the results were statistically significant.16,18–21,23,25 In six studies,16,19,20,22,24,25 assessing attitude/compliance, the video intervention had a positive effect on attitude and compliance for treatment. Except for one study, where P values were not reported, the study results were significant. The video had no significant impact on attitude/compliance in the other two studies. Two of six studies assessing behavior resulted in a statistically significant change; in the remainder, behavior change was not significant or a P value was not reported. Of two studies that

### Table 2

Method quality of reviewed RCT studies ranked according to criteria defined by Jadad and others

<table>
<thead>
<tr>
<th>Rank</th>
<th>Study</th>
<th>Randomization</th>
<th>Withdrawal points or dropouts</th>
<th>Withdrawal or dropout points</th>
<th>Total points</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Schaalma and others14</td>
<td>Yes, two-stage sampling procedure</td>
<td>2</td>
<td>Yes, reason reported</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Yuan and others3</td>
<td>Yes, coin toss</td>
<td>2</td>
<td>NR</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Yuan and others4</td>
<td>Yes, but not described</td>
<td>1</td>
<td>NR</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Hu and others</td>
<td>Yes, but not described</td>
<td>1</td>
<td>NR</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Huszti and others7</td>
<td>Yes, but not described</td>
<td>1</td>
<td>NR</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

* NR = not reported.
† Without double-blinding criteria; maximum ranking possible = 3 points.
An RCT. Conventions were well received by schools, teachers, and children. Impact on knowledge and attitudes. Overall, video-based interventions are promising and effective health education tools, with a positive impact on knowledge, but limited impact on adaptive behavior. Most reviewed studies concluded that videos are significant in knowledge, but limited impact on adaptive behavior. Most reviewed studies concluded that videos are promising and effective health education tools, with a positive impact on knowledge and attitudes. Overall, video-based interventions were well received by schools, teachers, and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes. Overall, video-based interventions were well received by schools, teachers, and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes.

Quality of the studies. Only five of the studies incorporated an RCT. An additional four studies did not include or report a control arm, and two studies with a control arm did not allocate it randomly. Notably, power calculations were missing in all studies, the method chosen for allocation to intervention and control was either poorly reported or not reported, and most did not adhere to CONSORT reporting standards. Accordingly, we have assessed the quality of the studies according to evidence-based medicine criteria (Table 1). We additionally ranked the RCT studies, shown in Table 2, according to the accepted validity scale14 (Table 1). We additionally ranked the RCT studies, shown in Table 2, according to the accepted validity scale14 (Table 1). We additionally ranked the RCT studies, shown in Table 2, according to the accepted validity scale14 (Table 1). We additionally ranked the RCT studies, shown in Table 2, according to the accepted validity scale14 (Table 1). We additionally ranked the RCT studies, shown in Table 2, according to the accepted validity scale14 (Table 1).

DISCUSSION

This review has shown that a number of school-based video interventions have been described for use against infectious diseases. Health education, through the use of innovative educational tools, has been advocated for the control of a number of the neglected tropical diseases and the prevention of sexually transmitted infections. We emphasize that the most recent study detected by our extensive search was conducted in 2010 which indicates there is a clear need for more present-day research in the area.

It is noteworthy that most of the 11 studies we reviewed in detail concluded that videos were well received by schools, teachers, and children, and are promising and effective health education tools, having a positive impact on knowledge and attitudes. We observed that educational videos entertain, engage, and inform at the same time, and these are important factors when targeting children because of their limited attention span. Furthermore, videos are more likely to induce behavior change than text-based teaching methods, a principle much discussed in the observational learning concept.

Videos can display correct behavior for students such that they can learn through direct observation. According to behavioral theories, observing correct behavior is beneficial for inducing behavior change. The target population has to recognize that 1) they are at risk (Health Belief Model: perceived susceptibility); and 2) it is in their hands to change this situation (Social Cognitive Theory: self-efficacy). This recognition is more difficult to achieve by traditional teaching methods. Therefore, videos play an important role, especially when targeting behavior change.

Among the reviewed studies, most evaluated the impact of videos displaying real-life situations in the form of an entertaining dialogue or narrative, whereas in three studies, the videos were purely instructional, providing facts in the form of a recorded lecture. It is of note that, among these studies, only one study, which combined the video with student exercises and discussion, reported a change in behavior, although $P$ values were not reported. These latter findings confirmed the conclusions of studies targeting non-communicable diseases, showing that educational videos are more effective when combined with other methods.

Of the reviewed studies, five conducted RCTs, although only one was reported as such. The remainder was reported as controlled pre-post-test design, or quasi-experimental design with randomization. According to definition, quasi-experimental designs lack randomization. However, if they are randomized, they could be considered an RCT. The outcomes of the five RCTs were of reasonable validity, whereas those from the non-RCT studies have to be considered carefully because the validity and generalizability of these trials is clearly limited because of reduced statistical power, lack of a control arm, poor study design, or inadequate reporting. Even with the RCTs, weaknesses in study design and reporting were evident. All RCTs randomized study participants into intervention and control groups, but none described the process of randomization or sample size calculations. Also, attrition was poorly reported; only one study reported attrition, including precise numbers and the reasons for participant withdrawal. The non-RCT studies ranged from trials without randomization (level II-1) to descriptive studies (level III, lowest level), according to evidence-based medicine criteria (Table 1). The RCTs were additionally ranked according to the accepted validity scale (Table 2), but without including blinding criteria because blinding is not feasible for educational studies. Accordingly, the maximum achievable score is three points, which only one of the studies reached. We also identified other weaknesses in study design and implementation. Two studies recruited small study populations, potentially leading to insufficient statistical power.

The methodological weaknesses of some of these studies, the lack of quantitative results and indicators for statistical significance in several of the trials meant we were unable to conduct a meta-analysis or to draw evidence-based conclusions. Therefore, we have presented the data from the 11 studies in descriptive form only (Table 1), and made recommendations for development of video-based interventions on the basis of our experience.

As outlined by Rosen and others and from our experiences of undertaking randomized controlled trials a carefully designed and implemented RCT is a powerful evaluation tool for the assessment of health education/promotion if the
study is rigorously designed, implemented, evaluated, and reported (Table 3). However, the study design and evaluation methods have to be chosen carefully according to the research objectives, methods and outcome measures. The RCTs may not always be the appropriate study design, but for the type of health education research evaluating innovative educational tools as outlined in this review, RCTs are appropriate and should be used, if feasible. Regardless of the study design applied, rigorous planning, implementation, and evaluation are crucial to provide internal validity to the study.

**Table 3**

Recommendations for studies using preventive educational videos targeting infectious diseases in schoolchildren

| Study design | We recommend a randomized control trial (RCT) design where appropriate because RCTs are considered the most robust form of evidence. For community and school-based interventions, a cluster randomized design is preferred because it limits contamination, simplifies the logistics of the field work, and measures direct and indirect effects of the intervention. However, for interventions targeting persons, an individual RCT is recommended. The RCTs, including cluster randomized trials, have to be rigorously planned, implemented, and reported. |
| Study preparation | The study has to be carefully planned and designed, including the incorporation of sample size calculations to assess the minimal sample size required. We highly recommend including local authorities in the project-planning phase. Before study commencement, informed consent has to be obtained from parents/legal guardians, teachers, and the schools. Because teachers are crucial for the smooth implementation of the project, they should be trained for their tasks in a dedicated workshop. |
| Development of an educational package including the video | The educational video should be produced professionally: hiring a professional audio-visual company and an experienced scriptwriter are essential. The costs for a professionally produced video can be considerable and have to be budgeted carefully. Sub-contracting future professionals at educational institutions (e.g., film school) or engaging the local community as protagonists can reduce the production costs significantly. Incorporating the key messages in an entertaining, engaging narrative can prove popular and effective in schoolchildren and adults. Ideally, the educational material should be developed locally to account for cultural differences. In any case, involvement of the local community and the target group during the production of the video and its pre-testing in the study area is crucial. The video should be implemented as a teaching aid, not a teaching substitute, and should be combined with other teaching methods such as class discussions or role plays. |
| Video content | The video should incorporate instructional messages into a real-life situation displaying correct behavior rather than depicting a stand-alone instructional message. The knowledge can be integrated into an entertaining narrative, thereby informing and entertaining at the same time. Behavioral theories and our own field experiences support these recommendations. Purely instructional messages can be delivered by the teacher, whereas real-life situations require audio-visual media and have the advantage that students can identify with the displayed situation, which encourages behavior change. |

**Monitoring and evaluation** | For quality control purposes, it is essential that the implementation of the video and teaching activities be closely monitored during the intervention. For assessment of changes in knowledge, attitudes, and behavior practices after the intervention, standardized assessment tools in the form of questionnaires can be used. However, because our personal observations have shown that self-reported behavior and actual behavior differ considerably, we recommend carrying out direct behavior observations using a simple standardized form. |

**Reporting** | All procedures and results of the study should be rigorously reported adhering to Consolidated Standards of Reporting Trials guidelines to contribute to an evidence base for video-based interventions and to enable researchers to extract essential information for future trial design purposes. To build up an evidence base with valid, comparable findings, a certain quality and degree of standardization in study design, study evaluation, type of control used, outcome measures and follow-up time needs to be established and maintained. On the basis of our experience, we recommend a thoroughly planned and implemented RCT design, a careful study preparation, professional development of the educational package, including the video to be used, close monitoring throughout the trial, and rigorous reporting according to the Consolidated Standards of Reporting Trials guidelines for reporting parallel group randomized trials. |

To date, there are insufficient data to draw conclusions on the value of video-based educational interventions on the basis of the published literature. Therefore, further studies are needed to refine their use in the prevention of neglected tropical diseases.

Once a critical mass of appropriately designed, conducted, and reported intervention studies have been completed according to our key recommendations shown in (Table 3), a meta-analysis can be conducted to establish an evidence base for future research. The evidence base can help establish a new generation of educational videos, thereby creating powerful and cost-effective preventive tools to complement other interventions for infectious diseases such as drug treatment and/or improved sanitation.

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REFERENCES


Appendix A.2: Health-Education Package to Prevent Worm Infections in Chinese Schoolchildren

This appendix presents a reprint of the published paper.

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Health-Education Package to Prevent Worm Infections in Chinese Schoolchildren

Health-Education Package to Prevent Worm Infections in Chinese Schoolchildren


BACKGROUND
Soil-transmitted helminths are among the most prevalent sources of human infections globally. We determined the effect of an educational package at rural schools in Linxiang City District, Hunan province, China, where these worms are prevalent. The intervention aimed to increase knowledge about soil-transmitted helminths, induce behavioral change, and reduce the rate of infection.

METHODS
We conducted a single-blind, unmatched, cluster-randomized intervention trial involving 1718 children, 9 to 10 years of age, in 38 schools over the course of 1 school year. Schools were randomly assigned to the health-education package, which included a cartoon video, or to a control package, which involved only the display of a health-education poster. Infection rates, knowledge about soil-transmitted helminths (as assessed with the use of a questionnaire), and hand-washing behavior were assessed before and after the intervention. Albendazole was administered in all the participants at baseline and in all the children who were found to be positive for infection with soil-transmitted helminths at the follow-up assessment at the end of the school year.

RESULTS
At the follow-up assessment, the mean score for the knowledge of helminths, calculated as a percentage of a total of 43 points on a questionnaire, was 90% higher in the intervention group than in the control group (63.3 vs. 33.4, P<0.001), the percentage of children who washed their hands after using the toilet was nearly twice as high in the intervention group (98.9%, vs. 54.2% in the control group; P<0.001), and the incidence of infection with soil-transmitted helminths was 50% lower in the intervention group than in the control group (4.1% vs. 8.4%, P<0.001). No adverse events were observed immediately (within 15 minutes) after albendazole treatment.

CONCLUSIONS
The health-education package increased students’ knowledge about soil-transmitted helminths and led to a change in behavior and a reduced incidence of infection within 1 school year. (Funded by UBS Optimus Foundation, Zurich, Switzerland; Australian New Zealand Clinical Trials Registry number, ACTRN1261000048088.)
A third of the global population, mainly in developing countries, is infected with soil-transmitted helminths, which are intestinal parasitic nematode worms.\textsuperscript{1} Infection with these parasitic worms is associated with poverty in rural locations, inadequate sanitation and waste disposal, a lack of clean water, and poor hygiene and is common in areas with limited access to health care and preventive measures.\textsuperscript{2} Roundworms (Ascaris lumbricoides) are the largest and most prevalent soil-transmitted helminths, accounting for 1 billion infections; whipworms (Trichuris trichiura) and hookworms (Necator americanus and Ancylostoma duodenale) each infect 600 million to 800 million persons. Estimates of the worldwide burden of infection with soil-transmitted helminths range from 4.7 million to 39.0 million disability-adjusted life-years\textsuperscript{1-3}; the most recent estimate (2010) is 5.2 million disability-adjusted life-years.\textsuperscript{3} The variation in the estimates is due to different emphases placed on the effect of the infection on health (both cognitive function and physical health).\textsuperscript{1} Almost half the global disease burden due to these worm infections is borne by children 5 to 14 years of age.\textsuperscript{4}

Chronic infection with soil-transmitted helminths can lead to a variety of clinical sequelae, including poor mental and physical development.\textsuperscript{1,4} Mass drug administration is the cornerstone of infection control, but this approach does not prevent reinfection. Additional public health measures, such as health education, are required for sustained, integrated control of the infection—a key element in achieving several of the United Nations Millennium Development Goals.\textsuperscript{2}

Soil-transmitted helminths are a major problem in China, with 129 million infections across 11 provinces. The rates of infection are highest among children 5 to 14 years of age.\textsuperscript{5} We conducted a cluster-randomized intervention trial at rural schools in the southern Hunan province to test the hypothesis that a health-education package targeting schoolchildren can influence behavior in a way that is conducive to the prevention of infection with soil-transmitted helminths. Positive outcomes would have potential implications for control of the infection not only in China but also globally.

METHODS

STUDY DESIGN
We conducted the study in rural Linxiang City District, Hunan province, China, where there is limited awareness of soil-transmitted helminth infection and limited educational activity aimed at its prevention (see Fig. S1 in the Supplementary Appendix, available with the full text of this article at NEJM.org). The study was an unmatched, cluster-randomized intervention trial involving 38 schools (38 clusters) and was conducted over the course of 1 school year (September 2010 through June 2011) (Fig. 1A). The schools were randomly assigned, in a 1:1 ratio, to an intervention package (19 schools) or a control package (19 schools) (Fig. 1A, and Table S1 in the Supplementary Appendix). Intervention schools were provided with a health-education package (Table 1), whereas control schools received the health-education poster that was normally displayed in schools (Fig. S2 in the Supplementary Appendix). The primary end points were the incidence of infection with soil-transmitted helminths, knowledge about and attitude toward parasitic nematode worms (transmission, symptoms, treatment, and prevention), and self-reported hygiene practice. The secondary end point was a change in hygiene practice, with hand-washing after use of the toilet at school, as observed by research staff, used to assess hygiene. Only the incidences of ascaris and trichuris infections were assessed; the incidence of hookworm infection was not measured as part of the study, owing to the very low prevalence of such infection in Linxiang City District.

STUDY OVERSIGHT
The human ethics committees at the Queensland Institute of Medical Research, Australia, and the Hunan Institute of Parasitic Diseases, China, gave written approval for the study. Before commencement of the intervention, written informed consent was obtained from the parents or legal guardians of all the student participants. All the authors assume full responsibility for the design of the study; the collection, analysis, interpretation, and completeness of the data; and the fidelity of this report to the study protocol, which is available at NEJM.org.
**Intervention Program**

The educational package included a 12-minute cartoon, entitled “The Magic Glasses,” that informed children about the transmission and prevention of soil-transmitted helminths. The presentation of the cartoon was complemented by classroom discussions, display of the same poster that was used for the control group, dissemination of educational materials, and follow-up activities targeting knowledge, attitudes, and practices (KAP) through questionnaires, parasitologic surveys, and behavior observations.

### Figure 1. Study Design and Enrollment and Retention of Students.

Rural schools in Linxiang City District, Hunan, China, with more than 15 students in grade 4 were selected to participate in the trial (Panel A). A spatial sampling frame was used for randomization: schools within a radius of 3 km were grouped, resulting in a total of 29 randomization units comprising 38 schools. A total of 1934 students were enrolled in the study, of whom 216 were lost to follow-up (Panel B). During the study period, 103 new students in the intervention schools and 107 in the control schools were registered; data from these students were excluded from the analyses. KAP denotes knowledge, attitudes, and practices.
tion of a pamphlet summarizing the key messages delivered in the cartoon, and drawing and essay-writing competitions to reinforce the messages. Details of the implementation of the educational package are provided in Table 1. A description of the development of the cartoon is provided in the Supplementary Appendix, and the front cover is shown in Figure 2. The cartoon can be accessed at NEJM.org or at www.qimr.edu.au/page/Home/Magic_glasses. A specific teacher-training workshop was held before commencement of the trial (for details, see the protocol, available at NEJM.org).

STUDY PROCEDURES
At baseline, we obtained one fecal sample from each participating student and administered a questionnaire regarding knowledge, attitudes, and practices (KAP questionnaire) related to soil-transmitted helminths. Fecal samples were examined microscopically at the diagnostic laboratory of the Linxiang Center for Disease Control with the use of the Kato–Katz thick-smear technique. For quality control, 10% of the slides were rechecked by independent microscopists at the Hunan Institute of Parasitic Diseases. The agreement between the quality check and the initial data was 99.2% (see the Supplementary Appendix). The KAP questionnaire (see the final protocol) consisted of multiple-choice questions, as well as three open-ended questions, regarding demographic characteristics; medical history; previous health education and knowledge about helminths, the means of transmission, and the symptoms and treatment of infection; the student’s attitude toward soil-transmitted helminths; and self-reported hygiene practices with respect to hand-washing, handling food, using the toilet, and wearing shoes. Students were considered to have a positive (or correct) attitude toward soil-transmitted helminths if they were aware of the risk of infection and intended to change their behavior to prevent an infection; students were considered to have a negative (or wrong) attitude if they did not recognize the health risks of soil-transmitted helminths and the importance of correct behavior (e.g., good hygiene). A higher score on the questionnaire indicated a more positive attitude. The questionnaire was developed and piloted in collaboration with Chinese researchers and educators, on the basis of experiences gained in previous trials and observations in the field. Scores on the KAP questionnaire were calculated as percentages of a total of 43 points; differences between groups are expressed as percentage points.

In a randomly selected subsample of 10 inter-

<p>| Table 1. Health-Education Package about Soil-Transmitted Helminths (STH) in Intervention Schools. |</p>
<table>
<thead>
<tr>
<th>Date</th>
<th>Educational Component</th>
<th>Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2010</td>
<td>Teacher-training workshop</td>
<td>Inform teachers about STH and their role during the intervention</td>
</tr>
<tr>
<td>September 2010</td>
<td>Baseline survey</td>
<td></td>
</tr>
<tr>
<td>September 2010</td>
<td>Video shown twice Student questions 10–15 min classroom discussion based on student questions</td>
<td>Inform about STH transmission and prevention Repeat key messages and answer students’ questions</td>
</tr>
<tr>
<td>October 2010</td>
<td>Handout pamphlet</td>
<td>Key messages as take-home message</td>
</tr>
<tr>
<td></td>
<td>Drawing competition Students draw warning signs for risk areas to warn others about worms Three best drawings are given awards</td>
<td>Practice and reinforce new knowledge</td>
</tr>
<tr>
<td>March 2011</td>
<td>Video shown twice Student questions 10–15 min classroom discussion based on student questions</td>
<td>Reinforce knowledge about STH transmission and prevention Repeat key messages and answer students’ questions</td>
</tr>
<tr>
<td>March 2011</td>
<td>Essay competition Write story about own actions taken to prevent worms Three best essays are given awards</td>
<td>Practice and reinforce new knowledge</td>
</tr>
<tr>
<td>June 2011</td>
<td>Follow-up survey</td>
<td></td>
</tr>
</tbody>
</table>
vention and 10 control schools, trained research staff observed students’ behavior covertly during morning and lunch breaks on 1 day in each school. The observations were recorded at the school level on a standardized form and focused on hand-washing after toilet use. Since a piped-water supply (which provides clean water) was lacking at many locations, a 100-liter water container with a gravity-fed tap was installed at all intervention and control schools to avoid confounding.

After the baseline assessment, all the participants in the intervention and control schools were given albendazole (a 400-mg single oral dose, as recommended by the World Health Organization [WHO]). Albendazole was supplied by the Chinese government and paid for by the Hunan Institute of Parasitic Diseases. Participants were directly observed taking the medication. With this regimen, albendazole results in average cure rates of 98% for ascaris and 47% for trichuris; however, the efficacy can be 100% in persons with a low intensity of infection.

At the follow-up visit at the end of the school year, all the assessments and quality-control measurements that had been performed at baseline were repeated. Any student who had a positive test for soil-transmitted helminths was treated with albendazole. Any adverse events resulting from the drug treatment were recorded after the initial treatment and, in children who had a positive test at the follow-up visit, after retreatment (Table S3 in the Supplementary Appendix).

To monitor potential confounding due to interaction between teachers and students at the intervention schools and at the control schools, a short oral questionnaire consisting of seven questions was administered to the head of each of the intervention schools in March 2011 to assess the degree of interaction between intervention schools and control schools. The monitoring form is provided in the protocol.

**Statistical Analysis**

We estimated a design effect of 1.1 on the basis of preliminary survey data from 74 students across 4 schools in the study area. We then estimated the sample size that would be required for an individually randomized trial and multiplied the result by the design effect. Assuming an incidence of infection with soil-transmitted helminths of 6% (which is typical of communities in which the prevalence of such infection is 18%), we estimated that we would need to enroll a total of 1639 students for the study to have 80% power to show a relative reduction of 50% in the incidence of infection with the intervention. We enrolled 1934 students at baseline, of whom 1718 students in 38 schools (median, 42 students per school) were included in the final analysis (Fig. 1B).

A Microsoft Access database was used for data management. The statistical analysis was performed with the use of SAS software (SAS Institute). For binary data (e.g., incidence), a logistic-regression model was applied, resulting in an odds ratio for the estimate of the intervention effect. Data from the KAP questionnaire, including the individual components, were analyzed with the use of regression analyses.

Generalized-estimating-equation models, accounting for clustering within schools, were used for the regression analysis and incorporated potential confounders such as school grade and sex. The incidence of infection with soil-transmitted helminths and the scores on the KAP questionnaire are reported as both unadjusted values and values adjusted for sex and school grade. To adjust for baseline knowledge about soil-transmitted helminths, generalized-estimating-equation models for the scores on the KAP questionnaire were extended to include effects of the interaction between time and intervention. A logistic-regression analysis, adjusted for sex and school grade, was used to determine the association between the various components of the KAP questionnaire and infection.

The mean percentage of students observed to have washed their hands after using the toilet was calculated for each school, and a Kruskal–Wallis test was used to calculate differences between
the intervention and control schools in observed hand-washing practice. A Pearson test was applied for correlations between observed hand-washing practice and the mean KAP score per school and between observed hand-washing practice and the incidence of infection with soil-transmitted helminths. A Spearman test was used to determine the correlation between observed hand-washing practice and knowledge about soil-transmitted helminths.

### RESULTS

#### PARTICIPANTS

Of 1934 students enrolled, 216 were lost to follow-up because of relocation to another school (Fig. 1B). A total of 1718 participants (88.8%) were included in the final analysis: 893 in the control schools, with a mean of 47 students per school, and 825 in the intervention schools, with mean of 43 students per school. There were 976 boys and 739 girls in the study (information on sex was not available for 3 students); 1641 of the students were in grade 4, and 77 in grade 5. During the study period, 210 new students (103 in the intervention schools and 107 in the control schools) were registered, but data from these students were excluded from the analyses.

#### PREVALENCE AND INTENSITY OF INFECTION

The rates of infection with soil-transmitted helminths are shown in Table 2. At baseline, the prevalence of infection was 10.4% (95% confidence interval [CI], 8.5 to 12.2) in the control schools and 10.0 (95% CI, 8.1 to 11.9) in the intervention schools (odds ratio in the intervention schools, adjusted for sex and school grade, 0.99; 95% CI, 0.50 to 1.99). Among the approximately 10% of children in each group who were infected, approximately 9% were infected with ascariasis, and 1% with trichuriasis; the intensity of the infection, assessed as the geometric mean number of eggs per gram of feces, was low, according to the WHO categorization. There were no significant differences in the prevalence of infection at baseline between the control and intervention schools (P=0.98), between boys and girls (P=0.83), or between children in grade 4 and children in grade 5 (P=0.64).

After the 9-month intervention, the incidence of infection with soil-transmitted helminths was 8.4% (95% CI, 6.6 to 10.2) in the control schools and 4.1% (95% CI, 2.8 to 5.5) in the intervention schools (odds ratio in the intervention schools, adjusted for sex and school grade, 0.50; 95% CI, 0.35 to 0.70; P<0.001; unadjusted odds ratio, 0.53; 95% CI, 0.38 to 0.74; P<0.001). Thus, the educational intervention was associated with 50% efficacy (95% CI, 30 to 65) in preventing infection with soil-transmitted helminths. All the infections in both groups involved ascariasis. The intensity of the infection was lower at the 9-month follow-up than at baseline in both groups, with no significant between-group difference (P=0.12).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control Schools</th>
<th>Intervention Schools</th>
<th>Odds Ratio or Ratio of Geometric Mean, (95% CI)</th>
<th>Unadjusted</th>
<th>P Value</th>
<th>Adjusted</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of infection at baseline — % (95% CI)</td>
<td>10.4 (8.5–12.2)</td>
<td>10.0 (8.1–11.9)</td>
<td>0.95 (0.50–1.84)</td>
<td>0.89</td>
<td>0.99 (0.50–1.99)</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>Incidence of infection at follow-up — % (95% CI)</td>
<td>8.4 (6.6–10.2)</td>
<td>4.12 (2.8–5.5)</td>
<td>0.53 (0.38–0.74)</td>
<td>&lt;0.001</td>
<td>0.50 (0.35–0.70)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Intensity of infection at baseline — no./g§</td>
<td>143.5 (114.9–179.1)</td>
<td>219.4 (173.0–278.3)</td>
<td>2.25 (0.92–5.49)</td>
<td>0.07</td>
<td>2.87 (0.96–8.58)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Intensity of infection at follow-up — no./g§</td>
<td>38.3 (34.7–42.3)</td>
<td>44.4 (40.8–48.3)</td>
<td>1.13 (0.98–1.30)</td>
<td>0.09</td>
<td>1.12 (0.97–1.29)</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

*At baseline, there were 1005 students in the control schools and 929 students in the intervention schools. At follow-up, there were 893 students in the control schools and 825 in the intervention schools. CI denotes confidence interval.
†Odds ratios for the intervention schools as compared with the control schools are shown for the prevalence and incidence of infection; the ratios of the geometric mean (intervention:control) are shown for the intensity of infection.
‡Values were adjusted for sex and school grade.
§The intensity of the infection was assessed as the geometric mean number of eggs per gram of feces.
The incidence of infection at the follow-up assessment was higher among boys than among girls (P = 0.002), but there was no significant difference in the incidence between children in grade 4 and those in grade 5 (P = 0.20).

**Knowledge, Attitudes, and Practices**

Overall changes in scores on the KAP questionnaire are shown in Table 3; changes at the school level and the results with respect to components of the questionnaire are shown in Tables S1 and S2 in the Supplementary Appendix. At baseline, the scores, calculated as percentages (±SD) of a total of 43 points on the questionnaire, were higher by 5.7 percentage points (95% CI, 2.6 to 8.7) in the intervention group than in the control group (30.7±12.7 vs. 26.3±11.5; P<0.001, with adjustment for sex and school grade). There was no significant difference in baseline scores on the KAP questionnaire between boys and girls (P = 0.55), whereas children in grade 5 scored, on average, 7 points higher than did children in grade 4 (P<0.001). At the follow-up assessment, students who were exposed to the intervention scored, on average, 32.8 percentage points higher than did students in the control group (63.3±15.1 vs. 33.4±14.4; P<0.001, adjusted for sex and grade). After adjustment for the baseline score on the knowledge component of the questionnaire, the intervention effect (difference in differences) was 24.9 percentage points higher than did children in grade 5 (P=0.25).

In an analysis of the entire study population, the overall score on the KAP questionnaire was higher by 9.9 percentage points (95% CI, 5.8 to 14.0) among uninfected students than among infected students (P<0.001), and the correlation between the score on the KAP questionnaire and observed hand-washing practice was moderate but significant (Pearson correlation coefficient, 0.64; P=0.008). In an analysis according to group assignment, there was a moderate but significant correlation between the score on the KAP questionnaire and hand washing both in the intervention schools (0.66; P=0.05) and in the control schools (0.77; P=0.04).

The score on the knowledge component of the KAP questionnaire was associated with both self-reported behavior (beta=0.13, P<0.001) and observed behavior (Spearman rank-correlation coefficient rho=0.57, P=0.02). Overall, knowledge was a significant predictor of the incidence of infection: the risk of infection decreased by 20% for each increase of 10 percentage points in the knowledge score (P<0.001). Attitude was also a significant predictor of the incidence of infection: the risk of infection decreased by 10% for each increase of 10 percentage points in the attitude score (P=0.005). We did not observe a significant association between attitude and self-
reported behavior or between self-reported behavior and the incidence of infection — findings that may be due to measurement error in self-reports.

**CHANGES IN OBSERVED HAND-WASHING**

Changes in hand-washing practice are shown in Table 3. At baseline, 54.0% of students in the control group and 46.0% of those in the intervention group washed their hands after they used the toilet (P=0.61). The rate of hand-washing increased to 98.9% in the intervention group at the follow-up assessment but remained nearly the same as the baseline rate in the control group (54.2%) (P=0.005).

**MONITORING OF POTENTIAL CONFOUNDING**

The oral questionnaire administered in March 2011 showed that in 14 of the 19 intervention schools, the head of the school did not mention the project to teachers in other schools. Four schools exchanged project-related information either with other intervention schools or with schools that were not participating in the study; only one intervention school interacted with a control school.

**ADVERSE EVENTS**

No adverse events were observed immediately (within 15 minutes) after the administration of albendazole according to the WHO protocol. However, in the follow-up questionnaire, some adverse events were reported (Table S3 in the Supplementary Appendix), all of which could have been attributable to any childhood illness.

**DISCUSSION**

The educational package in our study resulted in 50% efficacy in preventing infection with soil-transmitted helminths among Chinese schoolchildren. The reduction in the rate of infection was associated with an increase in knowledge and improved hygiene practice and establishes proof of principle that the health-education intervention increases students’ knowledge about transmission of the infection and changes their behavior, with the new behavior resulting in fewer infections. A clear correlation between scores on the KAP questionnaire and the incidence of infection with soil-transmitted helminths was evident, since across the entire study population, uninfected students scored 10 percentage points higher on the KAP questionnaire than did infected students. Knowledge was the major factor influencing hygiene practice. A correlation was also observed between scores on the KAP questionnaire and observed behavior in both the intervention and control groups.

Baseline scores on the KAP questionnaire were slightly higher among students in the intervention schools than among students in the control schools. This finding may be attributable to the sharing of information with students in the intervention schools after their teachers attended the teacher-training workshop, which was held before commencement of the trial. After adjustment for the baseline score, the difference in the adjusted knowledge scores between the two student groups at the follow-up assessment remained significant. Monitoring of potential confounding resulting from the sharing of information between intervention and control schools suggested that no relevant exchange had occurred between teachers and children in the intervention schools and those in the control schools.

Children are at major risk for infection with soil-transmitted helminths, and programs at schools are a cost-effective means of delivering interventions, a feature that was recognized by the WHO through the launch of the Global School Health Initiative. Video-based interventions targeting schoolchildren have been shown to have a positive effect on knowledge and attitudes, but few studies have evaluated their effect on the incidence of disease or have quantified their efficacy as an independent control tool. This randomized, controlled trial provides data on the effect of a health-education package, incorporating a cartoon, in changing behavior and lowering the risk of infection with soil-transmitted helminths. Critical in the development of the package was the early community involvement of health and education officials, health workers, teachers, parents, and students and our thorough assessment of the risk factors, knowledge, attitudes, and practices regarding soil-transmitted helminths — all of which enabled us to develop a culturally tailored, informative, and engaging package. This package shows that improving hygiene practice is in the hands of the target group and can result in a positive health outcome.
Mass drug administration is effective for the control of infection with soil-transmitted helminths, but once the treatment is terminated, the prevalence of the worms returns to pretreatment levels within 6 to 18 months.\textsuperscript{2,28,29} The WHO advocates mass drug administration in all preschool and school-age children, women of child-bearing age, and adults who are at high risk, but health education is not part of the WHO roadmap for the control of these neglected tropical diseases.\textsuperscript{30} Extensive coverage has been achieved with the help of generous drug donations by pharmaceutical companies and the successful incorporation of deworming programs in school health initiatives in low-income countries.\textsuperscript{31}

There is considerable debate about the ability to sustain control of helminth infection solely by means of mass drug administration.\textsuperscript{2,28,29,32-36} Furthermore, there is concern about the development of drug-resistant parasites as a result of continued treatment pressure.\textsuperscript{37} It is considered inevitable that drug resistance will develop in nematodes that infect humans, given the number of species infecting livestock that are now resistant to anti-helminth agents owing to continuous and extensive drug use.\textsuperscript{38-40} Indeed, this may already have happened in the case of some hookworm infections that have not responded to albendazole therapy.\textsuperscript{41} Efforts to reduce the overall incidence of infection with soil-transmitted helminths require an integrated approach consisting of pharmacologic treatment to reduce morbidity and the prevalence of the infection and other interventions (e.g., improvements in hygiene achieved through health education) to prevent reinfection. This approach will limit the number of treatment cycles required, reduce treatment pressure, and result in a more sustainable long-term approach to control.

The effective health-education package that we have developed for use in schools complements the current approach to control of infection with soil-transmitted helminths advocated by the WHO. It can readily be incorporated into future deworming programs, as well as ongoing programs, such as those in sub-Saharan Africa\textsuperscript{42} and the Chinese national program for the control of soil-transmitted helminths. Future programs could involve the integration of chemotherapy and health education in combination with efforts to ensure clean water, good sanitation, and improved personal hygiene.\textsuperscript{5}

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Appendix B: Research documents preliminary assessments

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Appendix B.1 Household questionnaire

B.1 Household questionnaire

家庭问卷（Household questionnaire）

To be filled in by research team:

日期 Date __________________________年/月/日 (yyyy/mm/dd)

调查者 Interviewer _______________________

ID:

行政村 Administration village
自然村 Natural village
个人门牌号码 House

个人信息 (Personal Information)

姓名 Name ___________________________

性别 Sex (1) 男 (Male) (2) 女 (Female)

Date of birth _______ _______ _______ _______ yyyy/mm/dd

School

Stool Student ID

GPS co-ordinates 定位: longitude N __________ latitude E ____________

Background & Village

1. 你在本村居住多久了 (How long have you been living in this village)?
   (1) < 1 年 (year) (2) < 5 年 (years) (3) > 5 年 (years)
   (4) > 10 年 (years) (5) 自出生一直居住在此 (all my life)

1a. Do you spend all your time in this village? 你大部分时间都在村子里吗?
   (1) yes 是 (2) no 不是

If No, how much time do you spend in this village?

____ number of days/week 每天/周时间

____ number of weeks/month 每周/月时间

____ number of months/year 每月/年时间
2. 你的家庭在本村居住多久了？（How long has your family been living in this village）？
   (1) < 1年（year） (2) < 5年（years） (3) > 5年（years）
   (4) > 10年（years） (5) 自出生一直居住在此（all my life）

3. 你觉得你们村子存在的最大问题是什么？（According to you, what’s the biggest problem in your village）？
   ……………………………………………………………………………………………

4. 你认为村子里最严重的健康问题是什么？（What’s the most serious health concern in the village）？请在以下15项中选出5个并按严重程度排序（Please rank 5 out of these 15. The biggest problem ranked with 1）
   □ Diarrhoea 腹泻 □ Malnutrition营养不良
   □ Cardio-vascular diseases心血管病 □ Breathing problems呼吸问题
   □ Flu感冒 □ High blood pressure高血压
   □ Dust 灰尘 □ Roundworm蛔虫
   □ Infertility/impotence不孕/阳萎 □ Parasite (specify):其他寄生虫
   ……………………………………………………………………………………………
   □ Short-sightedness近视 □ Intestinal Fluke (F. buski)肠道吸虫
   □ Abdominal pain 肚子痛 □ Hepatitis B乙肝
   □ Tuberculosis肺结核

社会经济状况（Socio-Economic Status）
5. 你的家庭共有多少成员（How many people (including yourself) are there in your household）？
   (1) Just me (2) 2 (3) 3 (4) 4-5 (5) 6-7 (6) >7

6. 你们家里住了几个小孩（How many children live in your household）？
   (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) > 5

7. 你自己有几个小孩（How many children do you have）？
   (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) > 5

8. 你们家有多少人在挣钱（How many people (including yourself) in your immediate family earn an income）？
   (1) 1 (2) 2 (3) 3 (4) 4-5 (5) 6-7 (6) >7

9. 你家经济来源是（Where does most of your family income come from）？
   单选（choose one answer）
   (1) 捕鱼（Fishing） (2) 种田（Farming） (3) 种（Vegetable crop production）
   (4) 养殖（Animal raising） (5) 经商（Business） (6) 其他（Other）：………………………………
10. 有结余么（Can you save some of your earnings）？
   (1) 有（yes）   (2) 没有（no）

11. 有自己的农田么（Do you have any land for your farming）？
   (1) 有（yes）   (2) 没有（no）

12. 如果有，那你的农田是什么类型（If yes, what kind of farmland is it）？
   (1) 旱田（Dry land）   (2) 水田（wet land）   (3) 两者都有（both）

13. 你家中，你或你的直系家属有无（At home, do you or any of your immediate family own）
   a. 家用药品（Medicines at home）？ (1) 有（Yes）   (2) 无（No）
   b. 家用饮用水（Tap water for drinking）？ (1) 有（Yes）   (2) 无（No）
   c. 自压井水（Hand pump for water）？ (1) 有（Yes）   (2) 无（No）
   d. 家用抽水马桶（A flushable toilet at home）？ (1) 有（Yes）   (2) 无（No）
   e. 收音机（A radio）？ (1) 有（Yes）   (2) 无（No）
   f. 电视机（A television）（TV）？ (1) 有（Yes）   (2) 无（No）
   g. DVD播放机（A DVD player）？ (1) 有（Yes）   (2) 无（No）
   h. 卫星天线（A satellite dish）？ (1) 有（Yes）   (2) 无（No）
   i. 肥皂（Soap）？ (1) 有（Yes）   (2) 无（No）
   j. 电脑（A Computer）？ (1) 有（Yes）   (2) 无（No）
   I. 网线（An Internet connection）？ (1) 有（Yes）   (2) 无（No）

14. 你和你的直系亲属有养动物吗（Do people in your household including yourself own any animals）？
   (1) 有（Yes）   (2) 无（No）

14a. 如果有，有多少只（If yes, how many）：
   水牛（Buffaloes）？ □□□□   鸡（Chicken）？ □□□□
   奶牛（Cows）？ □□□□   鸭子（Ducks）？ □□□□
   马（Horses）？ □□□□   鹅（Geese）？ □□□□
   羊（Goats）？ □□□□   狗（Dogs）？ □□□□
   猪（pig）？ □□□□   其他动物（Other）？ □□□□

15. 你家有菜园吗（Is there a vegetable field belonging to your house）？
   (1) 有（Yes）   (2) 无（No）

16. 你们家吃的食物有多少是自己种出来的（How much of the food you consume do you grow yourself）？
   (1) 都是（Everything）   (2) 一半（Half）
   (3) 不到一半（Less than half）   (4) 没有（None）
17. 你每天在自家菜园工作多久 (How many hours a day do you spend working on your vegetable field)?
(1) < 1小时 (2) 1-2小时 (3) 2-5小时 (4) > 5小时

18. 你的孩子每天在菜园工作多久（How many hours a day do your children spend working in your vegetable field）？
第一个孩子（Child 1）: (1) 0小时 (2) < 1小时 (3) 1-2小时 (4) > 2小时
第二个孩子（Child 2）: (1) 0小时 (2) < 1小时 (3) 1-2小时 (4) > 2小时
第三个孩子（Child 3）: (1) 0小时 (2) < 1小时 (3) 1-2小时 (4) > 2小时

19. 你在菜园使用什么样的肥料（What do you use to fertilize your garden）？
（可多选more than one answer possible）
(1) 化肥（Artificial fertilizer） (2) 动物粪便（animal nightsoil）
(3) 人粪（human nightsoil） (4) 腐殖质（plant compost）
(5) 其他（other）：………………………………

20. 你孩子一般在哪些地点帮忙（Where do your children help with work）？
（可多选more than one answer possible）
(1) 厨房（in the kitchen） (2) 花园（in the vegetable field）
(3) 农田（on the field） (4) 不帮忙（nowhere）
(5) 其他（other）：………………………………

21. 你的孩子一周帮忙多长时间（How many hours a week do children help with work above）？
第一个孩子（Child 1）: (1) 0小时 (2) 1-2小时 (3) 3-5小时 (4) 6-10小时 (5) >10小时
第二个孩子（Child 2）: (1) 0小时 (2) 1-2小时 (3) 3-5小时 (4) 6-10小时 (5) >10小时
第三个孩子（Child 3）: (1) 0小时 (2) 1-2小时 (3) 3-5小时 (4) 6-10小时 (5) >10小时

22. 孩子们会跟你讲学校里学习内容吗（Do children sometimes tell you what they learn at school）？
(1) 会（yes） (2) 不会（no） (3) 不知道（Don’t know）

23. 你的孩子们最喜欢的娱乐方式是什么（What are your children’s favourite leisure activities）？
第一个孩子（Child1）: …………………………………………………………………
第二个孩子（Child2）: …………………………………………………………………
第三个孩子（Child3）: …………………………………………………………………

24. 你在家穿鞋吗（Do you wear shoes at home）？
(1) 总是穿（Always） (2) 经常穿（Sometimes） (3) 从不穿（Never）
25. 你在菜园里穿鞋吗（Do you wear shoes in the garden）？
   (1) 总是穿（Always） (2) 经常穿（Sometimes） (3) 从不穿（Never）

26. 你在地里走路时会穿鞋吗（Do you wear shoes when you are working in the field）？
   (1) 总是穿（Always） (2) 经常穿（Sometimes） (3) 从不穿（Never）

27. 别人一般在哪里大便（Where do other people usually defecate）？（单选choose one answer）
   (1) 家厕（Home Latrine） (2) 公厕（Public Latrine）
   (3) 田地（Field） (4) 小河（River） (5) 其他（Other）：………………………………

28. 你家人一般在哪里大便（Where does your family usually defecate）？
   (1) 家厕（Home Latrine） (2) 公厕（Public Latrine） (3) 田地（Field）
   (4) 小河（River） (5) 其他（Other）：……………………………………………………

29. 你一般在哪里大便（Where do you usually defecate）？（可多选more than one answer possible）
   (1) 家厕（Home Latrine） (2) 公厕（Public Latrine）
   (3) 田地（Field） (4) 小河（River） (5) 其他（Other）：……………………………………………………

30. 你便后洗手吗（Do you wash your hands after going to toilet）？
   (1) 总是洗（Always） (2) 经常洗（Sometimes） (3) 从不洗（Never）

31. 饭前洗手吗（Do you wash your hands before eating）？
   (1) 总是洗（Always） (2) 经常洗（Sometimes） (3) 从不洗（Never）

31a. 用肥皂吗（With soap）？
   (1) 总是洗（Always） (2) 经常洗（Sometimes） (3) 从不洗（Never）

32. 你洗手后用什么擦干（How do you dry your hand after washing）？
   (1) 毛巾（Towel） (2) 在衣服上（On my clothes）
   (2) 我不擦手（I don’t dry my hand）
   (4) 其他（Other）：…………………………………………

33. 如果是用毛巾，你多久洗一次毛巾（If on a towel, how often do you wash that towel）？
   (1) 每天（every day） (2) 每周（every week）
   (3) 每两周（every 2 weeks） (4) 从不洗（never）
Appendix B.1 Household questionnaire

34. Do you wash fruit and vegetables before eating them IF RAW?
   (1) Always  (2) Sometimes  (3) Never

Knowledge Intestinal Worms

35. What do you know about intestinal worms (Roundworm, Whipworm, Hookworm)?
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ………………………………………………………………………………………….

36. Have you heard about Roundworms?
   (1) Yes  (2) No  (3) Don’t know

37. Have you heard about Whipworms?
   (1) Yes  (2) No  (3) Don’t know

38. Have you heard about Hookworms?
   (1) Yes  (2) No  (3) Don’t know

39. If you have heard about intestinal worms, where have you heard of it?
   (1) Friend  (2) Poster  (3) TV  (4) Radio  (5) Textbook  (6) Brochure  (7) School  (8) Other: …………………………..

40. Where do you think do most children get infected with intestinal worms?
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

41. What can children do to avoid STH infections?
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

42. What should a health education program at school include?
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

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Appendix B.1 Household questionnaire

43. 你感染肠道蠕虫病后会怎样(What will happen if you are infected with intestinal worms)? 可多选(more than 1 answer possible)

44. 你认为肠道蠕虫病能治疗吗 (Do you think an intestinal worm infection can be treated)?
   (1) 能(Yes)    (2) 不能(No)    (3) 不知道(Don’t know)

45. 如果能,要去什么地方治疗 (If yes, where can I go for treatment)? (可多选more than 1 answer possible)

46. 如果你已经感染了肠道蠕虫病,你会选择什么地方去治疗,按先后顺序 (If you have already had intestinal worms, where did you go for treatment and in which order)?

47. 你认为吃药能治愈肠道蠕虫病吗 (Can taking medicine cure intestinal worms)? (可多选more than 1 answer possible)
   (1) 能(Yes)    (2) 不能(No)    (3) 不知道(Don’t know)

47. 以下哪种药可以治疗肠道蠕虫病 (The medicine for the treatment of soil-transmitted helminths is): (more than 1 answer possible)
   (1) 阿司匹林(Aspirin)    (2) 肠虫清(Albendazole)
   (3) 泻立停(Xieliting)    (4) 不知道(don’t know)    (5) 其他(Other): ………

48. 你对参加孩子学校里的DVD健康教育感兴趣吗 (Would you be interested to attend a DVD based health education session at your child’s school)
   每次放映一个小时 (once 1 hour)?
   (1) 感兴趣(Yes)    (2) 不感兴趣(No)    (3) 不知道(Don’t know)

多谢您完成此问卷! (THANK YOU FOR ANSWERING THE QUESTIONS)!
# B.2 Household observation

**Households: Infrastructure & Behaviour**

*To be filled in by research team:*

Date ______________________ (yyyy/mm/dd)

<table>
<thead>
<tr>
<th>ID:</th>
<th>Administration village</th>
<th>Natural village</th>
<th>House</th>
<th>Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GPS co-ordinates: longitude N __________ latitude E __________

<table>
<thead>
<tr>
<th>School</th>
<th>Stool</th>
<th>Student ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **What is the floor made of?**
   (1) Dirt floor/mud  (2) Wood  (3) Cement  (4) Tiles  (5) other

2. **What material are the house walls made of?**
   (1) Brick (large/easily destroyed in rain)  (2) Brick (small/stronger)  (3) Wood
   (4) thatched reeds

3. **What material is the house roof made of?**
   (1) Brick (large/easily destroyed in rain)  (2) Brick (small/stronger)  (3) Wood
   (4) thatched reeds  (5) Other: ________________________________

4. **Overall impression house:**

**Kitchen Infrastructure**

5. **Kitchen floor made of:**
   (1) Dirt floor/mud  (2) Wood  (3) Cement  (4) Tiles

6. **Location water facilities:**
   (1) Inside kitchen  (2) Outside kitchen

7. **Type of water facilities:**
   (1) Tap water  (2) Hand pump  (3) Well  (4) Bucket  (5) None

8. **Soap available:**
   (1) Yes  (2) No

9. **Fridge available:**
   (1) Yes  (2) No
10. Food covered: (1) Yes (2) No

11. Number of Flies (1) < 5 (2) < 20 (3) > 20

12. Other insects observed:

13. General Cleanliness? (1) Reasonable (2) medium (3) dirty

14. Why? Remarks:

**Lavatory Infrastructure**

15. What is the floor made of? (1) Dirt floor/mud (2) Wood (3) Cement (4) Tiles (5) Other: ..........................

16. Hand washing facilities: (1) < 5m from lavatory (2) >5m from lavatory

17. Type of hand washing facilities: (1) Tap water (2) Hand pump (3) Bucket (4) None

18. Soap available? (1) Yes (2) No

19. The lavatory is: (1) Attached to house (2) Freestanding/outside

20. Type of lavatory: (1) Flush toilet (2) Latrine (3) Manure pit (4) Other: .................

21. How many lavatories are there? (1) 0 (2) 1 (3) 2 (4) > 2

22. Where does the wastewater go to? (1) Pipe (2) Underground septic tank (3) Above ground septic tank (4) River (5) manure pit

23. Number of Flies (1) < 5 (2) < 20 (3) > 20

24. Other insects observed:

25. Overall impression Lavatory:
Garden Infrastructure

26. What is grown in the garden?

27. How is the garden fertilized?
   (1) Human nightsoil   (2) Animal nightsoil   (3) Chemical fertilizer
   (4) Other:………………………………

28. Is there a fish pond? If yes, how are the fish fed?
   (1) Animal waste   (2) Human waste   (3) Kitchen rests
   (3) Other:………………………………
Appendix B.3: Preliminary questionnaire for schoolchildren

B.3 Preliminary questionnaire for schoolchildren

Preliminary questionnaire for schoolchildren in year 4

To be filled in by research team:

Date______________________(yyyy/mm/dd)       Teacher_______________________

ID:
Administration village Natural village House Individual
|__|__|__|__|   |__|__|__|__|  |__|__|__|    |__|__|__|

GPS co-ordinates: longitude N__________________ latitude E__________________

School
[ ] [ ]

To be filled in by children:

Please fill in this questionnaire truthfully with the help of your teacher. All responses will be kept confidential and will not be used against you in any way. The information will be used for research purposes only.

Personal Information

Name_________________________________________

Sex  (1) Male  (2) Female

Date of birth |__|__|__|__|__/|__|__|__|__| yyyy/mm/dd

Knowledge

Please write down what you have heard and what you know about worms that make you sick. You may also write down: “I don’t know.”

1. What do you know about intestinal worms (Roundworm/ Whipworm/Hookworm)?
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………

2. Have you heard about Roundworms?
   (1) Yes  (2) No  (3) Don’t know
3. Have you heard about Whipworms?
   (1) Yes   (2) No   (3) Don’t know

4. Have you heard about Hookworms?
   (1) Yes   (2) No   (3) Don’t know

5. If you have not heard about intestinal worms, please go to question 7. If you have heard of it, where? (You can chose more than one answer)
   (1) Friend   (2) Poster   (3) TV   (4) Radio   (5) Book
   (6) Brochure   (7) school   (8) parents/family
   (9) Others (please specify): .................................................................

**Transmission, Symptoms & Treatment**
The following questions ask about how you can get, what will happen and what you can do when you have intestinal worms.

6. How and where can you get infected with intestinal worms?
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………

7. Do you think intestinal worms can cause serious disease?
   (1) Yes   (2) No   (3) Don’t know

8. What happens if people are infected with intestinal worms? (you can chose more than one answer)
   (1) Feeling tired
   (2) Blindness
   (3) Can’t go to toilet
   (4) Diarrhea
   (5) Overweight
   (6) Slow growth
   (7) Can’t concentrate at school
   (8) Poor appetite
   (9) Belly ache
   (10) Coughing
   (11) Other (please describe): ……………………………………………………………..
   (12) Don’t know
Appendix B.3: Preliminary questionnaire for schoolchildren

9. Do you think an intestinal worm infection can be treated?
   (1) Yes      (2) No      (3) Don’t know

10. If yes, where can I go for treatment? (more than one answer possible)

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

11. Can taking medicine cure intestinal worms?
   (1) Yes      (2) No      (3) Don’t know

Attitude
In the next few questions please tell us how you feel about intestinal worms.

12. I believe that I am at risk of getting intestinal worms
   (1) Yes      (2) No

12a. Why yes or why no?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

13. I would be anxious if I got intestinal worms
   (1) Yes      (2) No

13a. Why yes or why no?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Health Education
In the next paragraph you will be asked what you have learned about intestinal worms at school and how you would like to learn more.

14. The teacher has already told us about intestinal worms
   (1) Yes      (2) No      (3) Don’t know

15. We have read a textbook on intestinal worms
   (1) Yes      (2) No      (3) Don’t know

16. We have watched a film on intestinal worms
   (1) Yes      (2) No      (3) Don’t know
17. Have you ever done an assignment on intestinal worms (e.g. write an essay)?
   (1) Yes    (2) No    (3) Don’t know

18. I told my parents, sisters & brothers about intestinal worms
   (1) Yes    (2) No    (3) Don’t know

19. How would you like (prefer) to learn about intestinal worms? (choose one answer)
   (1) By reading a book    (2) By reading comics    (3) By watching TV
   (4) Other (specify): ...........................................................

20. What do you prefer? (choose one answer)
   (1) TV Cartoons    (2) Films (with actors)    (3) Other
   (specify): ...........................................................

21. What’s your favourite Cartoon on TV?
   Name of Cartoon:
   .................................................................

22. Why do you like your favourite Cartoon so much?
   .................................................................

23. What’s your favourite Comic book?
   Name of Comic:
   .................................................................

24. Why do you like your favourite Comic so much?
   .................................................................

Behaviour
The next few questions will ask you about your family, your activities and habits. Please circle the most suitable answer.

25. Are your parents farmers?
   (1) Yes    (2) No (go to question 30)

26. Do you help your parents farm? If yes, how often do you have to help in the fields?
   (1) Once a week    (2) 2-3 times a week    (3) Every day    (4) Never

27. If you help your parents, where do you work:
   (1) On a wet field    (2) Close to the river    (3) On a dry field
   (4) Don’t know    (5) Other place (please specify): ...........................................................

28. Do you wear shoes when you help your parents?
   (1) Always    (2) Usually    (3) Rarely    (4) Never

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29. Do you wear shoes at school?  
   (1) Always  (2) Sometimes  (3) Never

30. Do you wear shoes at home?  
   (1) Always  (2) Sometimes  (3) Never

31. Do you wear shoes when you are playing with other children?  
   (1) Always  (2) Sometimes  (3) Never

32. Where do your friends usually defecate? (choose one answer)  
   (1) Home Latrine  (2) School Latrine  (3) Field  (4) River  (5) Other place: ……………………………………………………

33. Where does your family usually defecate? (choose one answer)  
   (1) Home Latrine  (2) Public Latrine  (3) Field  (4) River  (5) Other place: ……………………………………………………

34. Where do you usually defecate? (choose one answer)  
   (1) Home Latrine  (2) School Latrine  (3) Field  (4) River  (5) Other place: ……………………………………………………

35. Do you wash your hands after going to the toilet?  
   (1) Always  (2) Sometimes  (3) Never
35a. With soap?  (1) Always  (2) Sometimes  (3) Never

36. Do you wash your hands before eating?  
   (1) Always  (2) Sometimes  (3) Never
36a. With soap?  (1) Always  (2) Sometimes  (3) Never

37. Do you wash fruit and vegetables before eating them IF RAW?  
   (1) Always  (2) Sometimes  (3) Never

38. What is the floor in your house made of? (choose one answer)  
   (1) Dirt floor/mud  (2) Wood  (3) Cement  (4) Porcelain  (5) other

39. What is the floor in your toilet made of? (choose one answer)  
   (1) Dirt floor/mud  (2) Wood  (3) Cement  (4) Porcelain  (5) other

THANK YOU FOR COMPLETING THE QUESTIONNAIRE!
# Appendix B.4: ‘Draw & Write’ assessment

## B.4 ‘Draw & Write’ assessment

Drawing assessment with schoolchildren: one by one interview

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<th>To be filled in by research team:</th>
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<tr>
<td>Date_____________________(yyyy/mm/dd)       Teacher_______________________</td>
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<tr>
<td>Name of student:___________________________________________</td>
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<td>ID:</td>
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<tr>
<td>School</td>
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|        |)

**Task: (please choose A or B)**

**A.** Draw the scene where you saw intestinal worms or somebody (maybe yourself) infected with intestinal worms. Please include in your drawing:
   a. The worms.
   b. The people having the worms
   c. The place where you saw the worms or the sick people.

**B.** If you have never seen intestinal worms or somebody having intestinal worms, please draw:
   a. The place where you think you can get worms & how the place looks like.
   b. How you think the worms can enter your body
   c. The time/ season when you can get the worms
   d. How you can protect yourself from worms
Appendix B.4: ‘Draw & Write’ assessment

**Question guide:**

**Drawing**

1. Can you explain us what we can see on your drawing?

2. What do you know about these worms?

3. Where do you know that from?

**Knowledge Worms**

4. Have you heard of Roundworm?

5. Have you heard of Whipworm?

6. Have you heard of Hookworm?

7. Where have you heard of it?

8. What happened to the person who had the worms?

9. Was that person seriously ill? Are people with worms ill?
Appendix B.4: ‘Draw & Write’ assessment

**Cartoon & Comic**

10. What’s your favourite Cartoon on TV?

11. Why do you like your favourite Cartoon so much?

12. What’s your favourite Comic book?

13. Why do you like your favourite Comic so much?
## B.5.1 Key-informant interview: health staff

### Key-informant interview: health staff

| Date __________________ (yyyy/mm/dd)       Interviewer ___________________________ |
|---------------------------------------------|-----------------------------------------------|
| ID:                                         |                                               |
| Administration village | Natural village | House | Individual |
| _________________________ | _________________________ | ______ | ______ |
| GPS co-ordinates: longitude N________________ latitude E________________ |
| Hospital _________________________ |                                               |

### Personal Information:

- Name________________________
- Position___________________________ since _______________
- Working experience in health sector (years) _______________________________
- Educational background________________________________________________

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<tr>
<th>Sex</th>
<th>(1) Male   (2) Female</th>
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</table>

### Date of birth | | | | yyyy/mm/dd

### Hospital information

- Name of hospital______________________________
- Address_____________________________________
- Area covered________________________________
- Number of patients per year _________ (in-patients) _________ (out-patients)
- Number of ambulant patients:___________ per day _________ per week
- 3 illnesses most frequently treated in this hospital__________________________________________
Question Guide

Knowledge on Intestinal Worms

1. What’s the most significant health problem in the region?
2. Are you familiar with intestinal worms?
3. If yes, with which species?
4. Do you think intestinal worms are a major health problem in this region?
5. How are intestinal worms called in the local language?
6. How do you diagnose intestinal worms?
7. How many STH infections do you diagnose a week?
8. Are STH infections preventable? If yes, how?
9. Which medication do you use to treat intestinal worms?
10. List the actions people take when they are infected with intestinal worms. List actions taken first on top of the list.
11. Do people take the right actions when infected with STH? Why yes, why no?
12. Where can people go for STH treatment?
13. Has there ever a STH control program been carried out in the area?
14. If yes, when, where and what did it include?

Infection Risk

15. According to you, where do children mostly get infected with intestinal worms?
16. According to you, due to which activity /risk behaviour do children mostly get infected?
17. If children knew that .................................................., we could prevent most STH infections.
18. If children didn’t .................................................. (activity), we could prevent most STH infections.
19. If parents .................................................., we could prevent most STH infections.

Health Education for STH

20. According to you, what’s the most important measure to be taken in order to fight intestinal worms?
21. What can children do to sustainably avoid STH infections?

22. Health education at schools for STH.
   a. Who should be in charge?
   b. Important contacts to make it part of school curriculum?
   c. What should it include?
   d. Target age?
   e. Methods?
   f. How long?
   g. How often?
   h. How many repetitions?

23. What do you think about using a DVD for STH health education at schools?

24. How should that DVD look like? What should it include? How long should it be?

25. With which other methods would you combine it?

*Thank you for answering the questions!*
# Appendix B.5.2: Key informant interview: education bureau

## B.5.2 Key-informant interview: officer education bureau

**Key-informant interview: officer education bureau**

<table>
<thead>
<tr>
<th>Date_____________________(yyyy/mm/dd)</th>
<th>interviewer ________________________</th>
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<tr>
<td><strong>Administration village</strong></td>
<td><strong>Natural village</strong></td>
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</table>

**Education Bureau**

| [ ] [ ] [ ] |

**Personal Information:**

- **Name**________________________
- **Position**___________________________ since ____________________________
- **Working Experience in this position (years)** ________________________________
- **Educational background**_______________________________________________

**Sex** [ ] (1) Male (2) Female

**Date of birth** [ ] [ ] [ ] / [ ] [ ] [ ] yyyy/mm/dd

**Education bureau information**

- **Name/ location education bureau**__________________________________________
- **Address**______________________________________________________________
- **Area covered**___________________________________________________________
Appendix B.5.2: Key informant interview: education bureau

**Question Guide**

**Knowledge on Intestinal Worms**

1. What’s the most significant health problem in the region?
2. Are you familiar with intestinal worms?
3. If yes, with which species?
4. Do you think intestinal worms are a major health problem in this region?
5. How are intestinal worms called in the local language?
6. How can you tell if somebody is infected with STH?
7. Which medication is used to treat intestinal worms?
8. Has a STH control program been carried out in the area?
9. If yes, when, where and what did it include?

**Infection Risk**

10. According to you, where do children mostly get infected with intestinal worms?
11. According to you, due to which activity/risk behaviour do children mostly get infected?
12. If children knew that .............................................................., we could prevent most STH infections.
13. If children didn’t ............................................................... (activity), we could prevent most STH infections.
14. If parents ................................................................., we could prevent most STH infections.

**Health Education for STH**

15. According to you, what’s the most important measure to be taken in order to fight intestinal worms?
16. What can children do to sustainably avoid STH infections?
17. Health education at schools for STH.
   a. Who should be in charge?
   b. Important contacts to make it part of school curriculum?
Appendix B.5.2: Key informant interview: education bureau

c. What should it include?
d. Target age?
e. Methods?
f. How long?
g. How often?
h. How many repetitions?

18. What do you think about using a DVD for STH health education at schools?
19. How should that DVD look like? What should it include? How long should it be?
20. With which other methods would you combine it?
21. What’s the children’s favourite cartoon?
22. What’s the children’s favourite comic?

Thank you for answering the questions!
Appendix B.5.3: Key informant interview: health bureau

B.5.3: Key-informant interview: health officer

Key-informant interview: health officer

Date_____________________(yyyy/mm/dd)       Interviewer _______________________

**ID:**
Administration village   Natural village   House   Individual
|   |   |   |   |   |   |   |

GPS co-ordinates: longitude N__________________ latitude E__________________

Health Bureau
|   |   |

**Personal Information:**
Name________________________
Position___________________________ since _______________
Working experience in this position (years) _________________________________
Educational background_________________________________________________

Sex |   (1) Male  (2) Female

**Date of birth** |   |   |   |   |   |   | yyyy/mm/dd

**Health bureau information**
Name/ location of health bureau ______________________________________
Address______________________________________________________________
Area covered _______________________________________________________
Question Guide

Knowledge on Intestinal Worms

1. What’s the most significant health problem in the region?
2. Are you familiar with intestinal worms? With which species?
3. How are intestinal worms called in the local language?
4. Do you think intestinal worms are a major health problem in this region?
5. How are STH infections diagnosed?
6. Which medication is used to treat intestinal worms?
7. Has there ever a STH control program been carried out in the area?
8. If yes, when, where and what did it include?
9. Where can people go for STH treatment?

Infection Risk

10. According to you, where do children mostly get infected with intestinal worms?
11. According to you, due to which activity/risk behaviour do children mostly get infected?
12. If children knew that ................................................................., we could prevent most STH infections.
13. If children didn’t ................................................................. (activity), we could prevent most STH infections.
14. If parents ................................................................., we could prevent most STH infections.

Health Education for STH

15. What can people contribute/do to make intestinal worms disappear in their village?
16. What can children do to sustainably avoid STH infections?
17. Health education at schools for STH.
   a. Who should be in charge?
   b. Important contacts to make it part of school curriculum?
   c. What should it include?
d. Target age?

e. Methods?

f. How long?

g. How often?

h. How many repetitions?

18. What do you think about using a DVD for STH health education at schools?

19. How should that DVD look like? What should it include? How long should it be?

20. With which other methods would you combine it?

Thank you for answering the questions!
B.5.4 Key-informant interview: head of school

Key-informant interview: head of school

Date_____________________(yyyy/mm/dd)       interviewer _______________________

ID:

Administration village   Natural village  House  Individual
|___|___|___|___|   |___|___|___|___|  |___|___|___|

GPS co-ordinates: longitude N__________________ latitude E__________________

School
|___|

Personal Information:

Name________________________

Position___________________________ since _______________

Teaching experience (years) _______________________________

Educational background___________________________________

Sex |___| (1) Male   (2) Female

Date of birth |___|___|___|/|___|___|/|___|___ yyyy/mm/dd

Question Guide

Health Education at School

1. Is health education part of the curriculum?
2. How important is health education at your school?
3. How important is health education in your personal opinion?
4. Is basic hygiene education part of curriculum?
5. How important is hygiene education at your school?
Appendix B.5.4: Key informant interview: head of school

6. How important is hygiene education in your personal opinion?
7. Does health education/ hygiene education material exist?
8. If yes, may we have a look at it?

**Knowledge on Intestinal Worms**

9. What’s the most significant health problem in the region?
10. Are you familiar with intestinal worms?
11. If yes, with which species?
12. Do you think intestinal worms are a major health problem in this region?
13. How are intestinal worms called in the local language?
14. Do you know the diagnostic method for intestinal worms, if yes, what are they?
15. How can you tell a child is infected with intestinal worms?
16. Do you know the medication for treating intestinal worms? If yes, give the names
17. Is there any curriculum for intestinal? How many hours per week/year?
18. Has there ever been treatment for intestinal worms at your school? If yes, when?
19. If yes, what did the treatment include?

**Infection Risk**

20. Do you think children are at risk of getting infected at school?
21. Do you think the school’s sanitary installations meet with basic hygiene standards?
22. How many children do you think are infected with intestinal worms at your school (estimation)?
   (1) 0-10% (2) 10-20% (3) 20-30% (4) more than 30%
23. According to you, where do children mostly get infected with intestinal worms?
24. According to you, due to which activity/risk behaviour do children mostly get infected?
25. If the children knew that .............................................................., we could prevent most STH infections.
26. If children didn’t ................................................................. (activity), we could prevent most STH infections.
27. If parents ………………………………………………………., we could prevent most STH infections.
28. What’s the percentage of parents who work outside in another city and don’t live in the same household as the children?

Health Education for STH
29. According to you, what’s the most important measure to be taken in order to fight intestinal worms?
30. What can children do to sustainably avoid STH infections?
31. Health education at schools for STH.
   a. Who should be in charge?
   b. Important contacts to make it part of school curriculum?
   c. What should it include?
   d. Target age?
   e. Methods?
   f. How long?
   g. How often?
   h. How many repetitions?
32. What do you think about using a DVD for STH health education at schools?
33. How should that DVD look like? What should it include? How long should it be?
34. With which other methods would you combine it?
35. Have you used video/DVD in your lesson?
36. If yes, please tell us about your experience.
37. What’s the children’s favourite cartoon?
38. What's the children’s favourite comic?

Thank you for answering the questions!
Appendix B.5.5: Key informant interview: health education teacher

B.5.5 Key-informant interview: health education teacher

| Date____________________(yyyy/mm/dd)       Interviewer ______________________ |
| ID: Administration village | Natural village | House | Individual |
| GPS co-ordinates: longitude N__________________ latitude E__________________ |
| School |
| Personal Information: |
| Name________________________ |
| Position___________________________ since _______________ |
| Teaching experience (years)______________________________ |
| Educational background___________________________________ |
| Sex | (1) Male (2) Female |
| Date of birth | yyyy/mm/dd |

Question Guide

Health Education at School

1. Is health education part of the curriculum?
2. How important is health education in your lessons?
3. How important is health education in your personal opinion?
4. What does the health education curriculum include? How many hours per week/year?
5. Is basic hygiene education part of curriculum?
6. How important is hygiene education in your lessons?
Appendix B.5.5: Key informant interview: health education teacher

7. How important is hygiene education in your personal opinion?
8. What does the hygiene education curriculum include?
9. What does your class know about basic hygiene?
10. What’s the teaching method used for hygiene education?
11. Does health education/hygiene education material exist?
12. If yes, may we have a look at it?

Knowledge on Intestinal Worms

13. What’s the most significant health problem in the region?
14. Are you familiar with intestinal worms?
15. If yes, with which species?
16. How are intestinal worms called in the local language?
17. Do you think intestinal worms are a major health problem in this region?
18. Do you know the diagnostic method for intestinal worms, if yes, what are they?
19. Do you know the medication for treating intestinal worms? If yes, give the names
20. Is there any curriculum on intestinal worm infections? How many hours per week/year?
21. Is there any existing health education material for intestinal worms?
22. If yes, may we have a look at it?
23. What does your class know about intestinal worms?
24. How do you teach transmission of intestinal worms?
25. How can you tell a child is infected with intestinal worms?
26. Has there ever been treatment for intestinal worms at your school? If yes, when?
27. If yes, what did the treatment include?

Infection Risk

28. Do you think children are at risk of getting infected at school?
29. Do you think the school’s sanitary installations meet with basic hygiene standards?
30. How many children do you think are infected with intestinal worms at your school (estimation)?
   (1) 0-10% (2) 10-20% (3) 20-30% (4) more than 30%
31. According to you, where do children mostly get infected with intestinal worms?
Appendix B.5.5: Key informant interview: health education teacher

32. According to you, due to which activity/risk behaviour do children mostly get infected?
33. If children knew that ............................................................., we could prevent most STH infections.
34. If children didn’t ................................................................. (activity), we could prevent most STH infections.
35. If parents ................................................................., we could prevent most STH infections.
36. What’s the percentage of parents who work outside in another city and don’t live in the same household as the children?

Health Education for STH

37. According to you, what’s the most important measure to be taken in order to fight intestinal worms?
38. Health education at schools for STH.
   a. Who should be in charge?
   b. Important contacts to make it part of school curriculum?
   c. What should it include?
   d. Target age?
   e. Methods?
   f. How long?
   g. How often?
   h. How many repetitions?

39. What do you think about using a DVD for STH health education at schools?
40. How should that DVD look like? What should it include? How long should it be?
41. With which other methods would you combine it?
42. Have you used video/DVD in your lessons?
43. If yes, please tell us about your experience.
44. What’s the children’s favourite cartoon?
45. What’s the children’s favourite comic?

Thank you for answering the questions!
Appendix B.6: Video pilot test: Questions for schoolchildren

Video pilot test: Questions for schoolchildren卡通片观后问卷调查

To be answered by schoolchildren while watching the Cartoon a second time.
第二次观看卡通片后填写

Name:        School:

1. What can the hero see when he wears the magic glasses?
   英雄戴上魔术眼睛后看到了什么？

2. How can you get infected with worms? Name 3 possible ways.
   怎样感染上蠕虫病？请指明三种途径

3. How can you avoid a worm infection? Please name 3:
   如何避免感染蠕虫病？请指明三种办法

4. What happens to you when you are infected? Name 3 signs for worm infection.
   感染蠕虫病后会有什么后果？请指明三种后果

5. What can you do when you are infected?
   感染蠕虫病后该怎么办？

6. If you take medicine against worms, can you get sick again?
   a) Yes                    b) No
Appendix C: Research documents for intervention trial

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# Appendix C.1: Stool collection and examination form

## C.1 Stool collection & examination form

<table>
<thead>
<tr>
<th>姓名 (Name)</th>
<th>行政村 (Admi ID)</th>
<th>学校年级 (School ID)</th>
<th>学生编号 (Student ID)</th>
<th>无粪便原因 (Reason for no stool)</th>
<th>收集日期 (Collection Date)</th>
<th>分析日期 (Analysis Date)</th>
<th>玻片编码 (Slide Code) (A - C)</th>
<th>粪检结果 (Result of stool)</th>
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无粪样原因 (Reason for no stool): 1 = 不在absent; 2 = 拒绝refusal; 3 = 生病sick; 4 = 其他other; 999 = 缺失missing

观察者 (Investigator (sign)): 日期 (Date):
Appendix C.2: Infrastructure & behaviour observation form

C.2: Infrastructure & behaviour observation form

学校基础设施与行为观察
(School: Infrastructure & Behaviour)

日期 (Date) ___________________ (年/月/日) 观察者(Observer): ________________
编号:
行政村(Admin village) 学校 (School)
□□□□

[Max total score: 20]

1. 该校在校学生总计多少人 (How many children)? Categories:

2. 该校有多少个年级 (How many school classes)?

3. 该校有多少个教室 (How many classrooms)?

3a. 该校用水从哪里来 (Where do you take the water from in your school)? [max 4]

   (1) 校内自来水 (tap water in school) [4]   (2) 校外自来水 (tap water outside) [1]
   (3) 水井 (well) [2]                         (4) 压把井 (hand pump) [3]
   (5) 其他 ,请描述 (Other, specify) ………… [to be defined]
   (6) 没有 (None) [0]
4. 学校概况 (Overall impression school):

卫生间基础设施 (Lavatory Infrastructure)

5. 厕所类型 (Type of lavatory): [max 3]
   (1) 冲水厕所 (Flush toilet) [3]    (2) 公厕 (Latrine ) [2]
   (3) 蹲坑式厕所 (Manure pit) [1]    (4) 其他 ,请描述 (Other, specify) [to be defined]

6. 地板由什么建成 (What is the floor made of)? [max 3]
   (1) 脏泥地 (Dirt floor/mud) [0]    (2) 木地板 (Wood) [1]
   (3) 水泥地 (Cement) [2]    (4) 瓷砖 (Tiles) [3]
   (5) 其他 ,请描述 (Other, specify) ……..[to be defined]

7. 该校厕所有多少蹲位 (How many manure pits are there in the toilet)?
   (1) 0    (2) 1-5    (3) 6-10    (4) 11-15    (5) > 15

8. 废水流向哪里 (Where does the wastewater go to)?  [max 3]
   (1) 粪坑 (Manure pit) [1]    (2) 地下管道 (Pipe) [3]
   (3) 沼气池 (septic tank) [2]    (4) 小河 (River) [0]

9. 洗手设施 (安装的水桶除外):
   Hand washing facilities (other than installed bucket): [max 2]
   (1) 离厕所5米以内 (<5m from lavatory) [2]
   (2) 离厕所5米以外 (>5m from lavatory) [1]
   (3) 没有 (None) [0]
10. 洗手设施类型 (安装的水桶除外) (Type of hand washing facilities (other than installed bucket)): [max 4]
(1) 自来水 (Tap water) [4]  (2) 压把井 (hand pump) [3]  (3) 水桶 (bucket) [1]
(4) 水井 (Well) [2]  (5) 没有 (None) [0]

11. 有无可用的肥皂 (Soap available)? [max 1]  (1) 有 (Yes) [1]  (2) 无 (No) [0]

12. 厕所概况 (Overall impression Lavatory):
Appendix C.2: Infrastructure & behaviour observation form

洗手观察1：课间10分钟 (Hand washing Observation 1: 10min break)
开始时间 (Start Time):  
结束时间 (End Time):  

观察者 (Observer): 

13. 学生便后洗手吗 (wash hands AFTER TOILET)? 留意佩戴标志的学生 (Study children to be identified by tag)

<table>
<thead>
<tr>
<th></th>
<th>实验组学生 (Study children)</th>
<th>其他学生 (Others)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>洗手 (Yes)</td>
<td>不洗手 (No)</td>
</tr>
<tr>
<td></td>
<td>男(M)</td>
<td>女(F)</td>
</tr>
<tr>
<td>记录 (Count)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>合计 (Total)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. 学生在其他时间洗手吗 (wash hands on other occasions)?

<table>
<thead>
<tr>
<th></th>
<th>记录 (实验组学生) Count (study children)</th>
<th>合计 Count (others)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>男 (Male)</td>
<td>女 (Female)</td>
</tr>
<tr>
<td>(1) 吃东西前 (before eating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1a) 吃东西后 (after eating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) 玩耍后 (after playing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) 玩水 (play with water)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) 清洗水果 (fruit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) 饮水前后 (drink water)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 清洗污垢 (wash off dirt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) 洗脸 (wash the face)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) 漱口 (rinse the mouth)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9) 其他 (举例说明) Other (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>合计 (Total)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
洗手观察2: 午餐休息时间 (Hand washing Observation 2: lunch break, 30min)

开始时间 (Start Time): 

结束时间 (End Time): 

观察者 (Observer):

<table>
<thead>
<tr>
<th>15. 学生便后洗手吗 (wash hands AFTER TOILET)? 留意佩戴标志的学生 (Study children to be identified by tag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>目标人群 (Study children)</td>
</tr>
<tr>
<td>洗手 (Yes)</td>
</tr>
<tr>
<td>男(M)</td>
</tr>
<tr>
<td>记录 (Count)</td>
</tr>
<tr>
<td>合计 (Total)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>16. 学生在其他时间洗手吗 (wash hands on other occasions)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>记录 (实验组学生)</td>
</tr>
<tr>
<td>Count (study children)</td>
</tr>
<tr>
<td>男 (Male)</td>
</tr>
<tr>
<td>(1) 吃东西前 (before eating)</td>
</tr>
<tr>
<td>(1a) 吃东西后 (after eating)</td>
</tr>
<tr>
<td>(2) 玩耍后 (after playing)</td>
</tr>
<tr>
<td>(3) 玩水 (play with water)</td>
</tr>
<tr>
<td>(4) 清洗水果 (fruit)</td>
</tr>
<tr>
<td>(5) 饮水前后 (drink water)</td>
</tr>
<tr>
<td>(6) 清洗污垢 (wash off dirt)</td>
</tr>
<tr>
<td>(7) 洗脸 (wash the face)</td>
</tr>
<tr>
<td>(8) 漱口 (rinse the mouth)</td>
</tr>
<tr>
<td>(9) 其他 (举例说明)</td>
</tr>
<tr>
<td>Other (specify)</td>
</tr>
<tr>
<td>合计 (Total)</td>
</tr>
</tbody>
</table>
Appendix C.3: Baseline KAP questionnaire

C.3: Baseline questionnaire for schoolchildren in year 4 and 5

Baseline questionnaire for schoolchildren in year 4 and 5

(modified; includes scores for analysis)

To be filled in by research team:

Date_____________________(yyyy/mm/dd)

ID:
Administration village School Class Student
|__|__|    |__|__|   |__|__|  |__|__|

To be filled in by children:
Please fill in this questionnaire truthfully with the help of your teacher. All responses will be kept confidential and will not be used against you in any way. The information will be used for research purposes only.

Personal Information
Name

Grade at school: (1) 4 (2) 5
Sex (1) Male (2) Female

Date of birth |__|__|__|__|/|__|__|/|__|__| yyyy/mm/dd

Knowledge [3 points]
Please write down what you have heard and what you know about worms (Roundworm/Whipworm/Hookworm) that make you sick. You may also write down: "I don’t know."

1. Have you heard about Roundworms?
   (1) Yes (2) No (3) Don’t know

2. Have you heard about Whipworms?
   (1) Yes (2) No (3) Don’t know

3. Have you heard about Hookworms?
   (1) Yes (2) No (3) Don’t know [3 points]
Appendix C.3: Baseline KAP questionnaire

4. If you have not heard about worms (Roundworm/Whipworm/Hookworm), please go to question 5. If you have heard of it, where? (You can chose more than one answer)
   (1) Friend (2) Poster (3) TV (4) Radio (5) Book
   (6) Brochure (7) school (8) parents/family
   (9) Others (please specify): ................................................................. [no score]

5. Have you ever had worms (Roundworm/Whipworm/Hookworm) yourself?
   (1) Yes (2) No (3) Don’t know [no score]

6. Has somebody you know already had worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes (2) No (3) Don’t know [no score]

Transmitton, Symptoms & Treatment [25 points]
The following questions ask about how you can get, what will happen and what you can do when you have worms.

7. How can you get infected with worms (Roundworm/Whipworm/Hookworm)? Name all the possibilities you know.
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   [1 point for each correct answer] [5]

8. Do you think intestinal worms can cause serious disease?
   (1) Yes (2) No (3) Don’t know [1]

9. What happens if people are infected with intestinal worms? (you can chose more than one answer)
   (1) Feeling tired
   (2) Blindness
   (3) High blood pressure
   (4) Diarrhoea
   (5) Overweight
   (6) Slow growth
   (7) Can’t concentrate at school
   (8) Fever
   (9) Poor appetite
   (10) Belly ache
   (11) Other (please describe):
       ……………………………………………………………………………………

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Appendix C.3: Baseline KAP questionnaire

10. **How can you prevent/avoid a worm infection? (choose all correct answers)**
   (1) Washing fruit and vegetables if eating them raw.
   (2) Sleeping under a mosquito net
   (3) Not playing in the dirt
   (4) Eating too much
   (5) Cover food
   (6) Using the latrine.
   (7) Washing hands after toilet
   (8) Brushing my teeth
   (9) Not playing in vegetable garden
   (10) Washing hands before eating
   (11) Always wear shoes or sandals.
   (12) Doing enough exercise
   (13) Keeping up personal hygiene
   (14) Other (please describe):
       ………………………………………………………………………
   (15) Don’t know
       [1 point for each correct answer] [6]

11. **Do you think an intestinal worm infection can be treated?**
   (1) Yes  (2) No  (3) Don’t know [1]

12. **If yes, where can I go for treatment? (more than one answer possible)**
   (1) School  (2) Local Clinic [1]  (3) Hospital [1]  (4) My parents
   (5) Village doctor  (6) don’t know [2]

13. **If you take medicine for intestinal worms, will you be cured forever?**
   (1) Yes  (2) No  (3) Don’t know [1]

**Attitude** [2]
*In the next few questions please tell us how you feel about worms.*

14. **I believe that I am at risk of getting worms (Roundworm/Whipworm/Hookworm)**
   (1) Yes  (2) No  (3) Don’t know [1]

14a. **Why yes or why no?**
Appendix C.3: Baseline KAP questionnaire

15. I would be anxious if I got worms (Roundworm/Whipworm/Hookworm)
   (1) Yes  (2) No  (3) Don’t know [1]

15a. Why yes or why no?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………

Health Education [4]
In the next paragraph you will be asked what you have learned about worms (Roundworm/Whipworm/Hookworm) at school.

16. Has the teacher already told you about intestinal worms?
   (1) Yes  (2) No  (3) Don’t know [1]

17. Have you watched a DVD on worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know [1]

18. Have you ever done an assignment on worms (Roundworm/Whipworm/Hookworm) (e.g. write an essay)?
   (1) Yes  (2) No  (3) Don’t know [1]

19. Have you told your parents, sisters & brothers about worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know [1]

Behaviour [9]
The next few questions will ask you about your family, your activities and habits. Please circle the most suitable answer.

20. Do you wear shoes on a hot summer day, when you are playing with other children?
   (1) Always [1]  (2) Usually [0.5]  (3) Rarely  (4) Never [1]

21. Do you wear shoes at home?
   (1) Always [1]  (2) Usually [0.5]  (3) Rarely  (4) Never [1]

22. Do you wear shoes at school?
   (1) Always [1]  (2) Usually [0.5]  (3) Rarely  (4) Never [1]
23. Where do farmers usually defecate? (choose one answer)
   (1) Home Latrine     (2) Public Latrine     (3) Field     (4) River
   (5) Other place: …………………………………………………… [no score]

24. Where does your family usually defecate? (choose one answer)
   (1) Home Latrine     (2) Public Latrine     (3) Field     (4) River
   (5) Other place: …………………………………………………… [no score]

25. Where do you usually defecate? (choose one answer)
   (1) Home Latrine  [1] (2) School Latrine [1] (3) Field     (4) River
   (5) Other place: ……………………………………………………  [1]

26. Sometimes it can be difficult to find water and soap. Do you wash your hands after going to the toilet?
   (1) Always [1] (2) Usually [0.5] (3) Rarely (4) Never [1]

   26a. With soap?   (1) Always [1](2) Usually [0.5]    (3) Rarely (4) Never [1]

27. Do you wash your hands before eating?
   (1) Always [1] (2) Usually [0.5] (3) Rarely (4) Never [1]

   27a. With soap?   (1) Always [1](2) Usually [0.5] (3) Rarely (4) Never [1]

28. Do you wash fruit and vegetables before eating them IF RAW?
   (1) Always [1] (2) Usually [0.5] (3) Rarely (4) Never [1]

Total points          [ 4 3 ]

THANK YOU FOR COMPLETING THE QUESTIONNAIRE!
### C.4 Baseline treatment form

<table>
<thead>
<tr>
<th>基线治疗表 Baseline treatment form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>姓名</strong></td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**未治疗原因** *Reason for no treatment:*
1 = 不在*absent; 2 = 拒绝*refusal; 3 = 生病*sick; 4 = 其他*other; 999 = 缺失*missing

**观察者** *Investigator (签名 sign):**

**日期** *Date:*
C.5: Student questions for video viewing

Student questions for video viewing

To be answered while watching the video a second time.

<table>
<thead>
<tr>
<th>ID:</th>
<th>Administration village</th>
<th>School</th>
<th>Individual</th>
</tr>
</thead>
</table>

1. What can the hero see when he wears the magic glasses?

2. How can you get infected with worms? Name 3 possible ways.

3. How can you avoid a worm infection? Please name 3:

4. What happens to you when you are infected? Name 3 signs for worm infection.

5. What can you do when you are infected?

6. Reinfection: if you take medicine against worms, can you get sick again?

   Yes No
C.6: Drawing competition: instructions for teachers

Information for teachers:

Competition to be started week of 11-15 October 2010.

- Main idea: children repeat key messages with help of comic book and apply them to their own environment by drawing warning signs for infection sites such as toilet, playground at school or vegetable garden at home.

- For example:
  - For toilet: Wash hands.
  - For vegetable garden: don’t play in vegetable garden

  ➤ Refer to comic book for more ideas.

- Make 1-2 examples for children to make them understand their task. Allow them to ask questions. Then let the children think themselves and come up with their own ideas.

- Children’s homework for next day: identify infection places at home and/or at school. Write them down.

- Next day: teacher gives approval or disapproval for the children’s idea. The children’s idea that has been approved before they can start drawing.

  ➤ Note: Not everybody can choose toilet. Creative ideas are awarded. Best 3 warning signs win a prize.

- Teacher assigns warning signs to each child until all dangerous places in schools, at home are covered.

- Allow the next 4 art classes for the kids to design the warning signs.

- The best 3 warning signs will win a prize and are hung-up on the targeted location at school/home.

Give the following instruction for children:

1. Do you remember the Cartoon: “The Magic Glasses”? What was the story about? What did it tell you?

2. Homework for tomorrow:

   a) identify places where you can get worms in the schools, at home. Choos one.
b) think about how you would have to warn people about worms in this place

c) how could you design a warning sign to warn other people: the message, the image?

d) next day: tell the teacher about your idea.

3. In art class: Design warning sign with text and drawing. Get approval for your idea from the teacher.

4. Use the next 4 art classes to work on your warning sign.
C.7: Essay competition: instructions for teachers

Essay competition: students write essays about their actions against worms

Information for teachers:

Competition to be started first two weeks after Chinese New Year Holiday (February 2011).

- Main idea: children repeat key messages with help of comic book and take action to spread the knowledge on how to fight worm infections. For example:
  - Friend doesn’t wash hands after toilet, tell a friend to wash hands after the toilet and make sure water and soap are available to wash hands.
  - For kitchen: tell parents to cover food, wash raw vegetables

  ➔ Refer to comic book for more ideas.

- Make 1-2 examples for children to make them understand their task. Allow them to ask questions. Then let the children think themselves and come up with their own ideas.

- Children’s homework for next week: identify people who are at risk of infection. Tell them how they can avoid worms. Write down what they did.

- Next week: teacher gives approval or disapproval for the children’s action. The children’s who’s action that has been approved can start writing.

  ➔ Note: Not everybody can choose toilet. Creative ideas are awarded. Best 3 warning signs win a prize.

- Allow the next 4 Chinese lessons for the kids to write the essay. The best 3 essays will win a prize and are hung-up in the classroom.

Give the following instruction for children:

1. Do you remember the Cartoon: “The Magic Glasses”? What was the story about? What did it tell you?

2. Homework for next week:

   a) Observe the people around you.

   b) If they carry out a “worm-dangerous” behaviour you warn them about the worms and tell them what to do in order to avoid a worm infection.
c) write down a few words about what you did.

d) next week: tell the teacher about your idea and ask him for approval.

3. In Chinese class: If the teacher approves your idea, write an Essay about your actions as a worm gard. The best 3 essays will win a prize and are hung-up in the classroom.

4. Use the next 4 Chinese classes to work on essay.
### C.8: School monitoring March 2011

School monitoring March 2011

<table>
<thead>
<tr>
<th>行政村 (Admin village)</th>
<th>学校 (School)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Short interview with head of school**

**Name head of school:**

**Cooperation**

1. How is the tap filling in your school organized? DO NOT read answer options, but choose option 1; 2; 3, 4 or 5 according to the teacher’s answer
   - (1) well organized inclusive roster (roster available -> check)
   - (2) one responsible person for tap filling. Name:
   - (3) organized without roster. Ask about details of organization.
   - (4) not organized
   - (5) other:

2. Has anything changed in the school since the anti-worm campaign? If yes, what?
   - (1) Infrastructure change:
   - (2) Teaching/Education:
   - (3) Observed change in children’s behaviour:
   - (4) Other:
Contamination between intervention and control schools

3. Who have you told about the program?

........................................................................................................................................................................

4. What have you told them about the program?

........................................................................................................................................................................

5. Did you talk to someone from another school about the following program?
   (1) Yes   (2) No   (3) Don’t know

6. If yes with whom?
   (1) teachers   (2) parents   (3) students   (4) others:..............

7. Do teachers of your school teach in other schools?
   (1) Yes   (2) No   If yes, where? Name of school:..............

8. Do teachers from other schools teach in your school?
   (1) Yes   (2) No   If yes, from where? Name of school:....

9. Do children from your school mix with children from other schools?
   (1) Yes   (2) No   If yes, where? Name of school(s):..............

To be answered by observer:

10. What’s your own personal impression of the school’s overall cooperation:
    (1) Very poor   (2) poor   (3) satisfactory   (4) good

11. How many children use/have the comic book?
    (1) 80%   (2) 50-80%   (3) 30-50%   (4) < 30%

12. How many parents have seen the video?
C.9: Follow-up questionnaire (intervention group)

Follow-up Questionnaire for Schoolchildren in Year 4 and 5

To be filled in by research team:

Date_____________________(yyyy/mm/dd)

ID:
Administration village | School | Class | Student
|___|___|___|___|

To be filled in by children:

Please fill in this questionnaire truthfully with the help of your teacher. All responses will be kept confidential and will not be used against you in any way. The information will be used for research purposes only.

Personal Information

Name_____________________________________

Grade at school: (1) 4 (2) 5

Sex (1) Male (2) Female

Date of birth __________________________ yyyy/mm/dd

Knowledge

Please write down what you have heard and what you know about worms (Roundworm/Whipworm/Hookworm) that make you sick. You may also write down: ”I don’t know.”

1. Have you heard about Roundworms?
   (1) Yes (2) No (3) Don’t know

2. Have you heard about Whipworms?
   (1) Yes (2) No (3) Don’t know

3. Have you heard about Hookworms?
   (1) Yes (2) No (3) Don’t know
4. If you have not heard about intestinal worms (Roundworm/Whipworm/Hookworm), please go to question 5. If you have heard of it, where? (You can chose more than one answer)
(1) Friend (2) Poster (3) TV (4) Radio (5) Book
(6) Brochure (7) school (8) parents/family
(9) Others (please specify): ...................................................

5. Have you ever had worms (Roundworm/Whipworm/Hookworm) yourself?
(1) Yes (2) No (3) Don’t know

6. Has somebody you know already had worms (Roundworm/Whipworm/Hookworm)?
(1) Yes (2) No (3) Don’t know

Transmission, Symptoms & Treatment
The following questions ask about how you can get worms, what happens to you and what you can do when you have worms.

7. How can you get infected with worms (Roundworm/Whipworm/Hookworm)? Name all the possibilities you know.

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
Do you think intestinal worms can cause serious disease?
(1) Yes (2) No (3) Don’t know

8. What happens if people are infected with intestinal worms? (you can chose more than one answer)
(1) Feeling tired
(2) Blindness
(3) High blood pressure
(4) Diarrhoea
(5) Overweight
(6) Slow growth
(7) Can’t concentrate at school
(8) Fever
(9) Poor appetite
(10) Belly ache
(11) Other (please describe): ...................................................
(12) Don’t know
9. How can you prevent/avoid a worm infection? (choose all correct answers)
(1) Washing fruit and vegetables if eating them raw.
(2) Sleeping under a mosquito net
(3) Not playing in the dirt
(4) Eating too much
(5) Cover food
(6) Using the latrine.
(7) Washing hands after toilet
(8) Brushing my teeth
(9) Not playing in vegetable garden
(10) Washing hands before eating
(11) Always wear shoes or sandals.
(12) Doing enough exercise
(13) Keeping up personal hygiene
(14) Other (please describe): ………………………………………………
(15) Don’t know

10. Do you think a worm infection can be treated?
(1) Yes   (2) No   (3) Don’t know

11. If yes, where can I go for treatment? (more than one answer possible)
(1) School   (2) Local Clinic   (3) Hospital   (4) Floating vendor
(5) Village doctor   (6) don’t know

12. If you take medicine for intestinal worms, will you be cured forever?
(1) Yes   (2) No   (3) Don’t know

Attitude
In the next few questions please tell us how you feel about worms.

13. Do you think you are at risk of getting intestinal worms?
(1) Yes   (2) No   (3) Don’t know
13a. Why yes or why no?
…………………………………………………………………………………………
……………………………………………………………………………………

14. Are you afraid of getting infected with intestinal worms?
(1) Yes   (2) No   (3) Don’t know
14a. Why yes or why no?
…………………………………………………………………………………………
……………………………………………………………………………………

Health Education
In the next paragraph you will be asked what you have learned about worms (Roundworm/Whipworm/Hookworm) at school.

15. Has the teacher already told you about intestinal worms?
(1) Yes   (2) No   (3) Don’t know
16. Have you watched a DVD on worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know

17. Have you ever done an assignment on worms (Roundworm/Whipworm/Hookworm) (e.g. write an essay)?
   (1) Yes  (2) No  (3) Don’t know

18. Have you told your parents, sisters & brothers about worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know

**Behaviour**

The next few questions will ask you about your family, your activities and habits. Please circle the most suitable answer.

19. Do you wear shoes on a hot summer day, when you are playing with other children?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

20. Do you wear shoes at home?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

21. Do you wear shoes at school?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

22. Where do farmers usually/mostly (-> translation) defecate? (choose one answer)
   (1) Home Latrine  (2) Public Latrine  (3) Field  (4) River
   (5) Other place: ..............................................................

23. Where does your family usually/mostly (-> translation) defecate? (choose one answer)
   (1) Home Latrine  (2) Public Latrine  (3) Field  (4) River
   (5) Other place: ..............................................................

24. Where do you usually/mostly (-> translation) defecate? (choose one answer)
   (1) Home Latrine  (2) School Latrine  (3) Field  (4) River
   (5) Other place: ..............................................................
25. Sometimes it can be difficult to find water and soap. Do you wash your hands after going to the toilet?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

26a. With soap?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

26. Do you wash your hands before eating?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

27a. With soap?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

27. Do you wash fruit and vegetables before eating them IF RAW?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

**Feedback on video and treatment**

*The following questions are about the worm treatment and the cartoon(or DVD?) ‘The Magic Glasses’.*

28. When you were treated for worms, did you have difficulties swallowing the pills?
   (1) Yes  (2) No  (3) Don’t know

29. How did you feel after the worm treatment? (more than one answer possible)
   (1) I felt good.
   (2) I felt dizzy.
   (3) I felt sick.
   (4) I had diarrhoea.
   (5) I had to vomit.
   (6) Other (please specify):…………………………

30. Did you enjoy the video?
   (1) Yes  (2) No  (3) Don’t know

31. After seeing the “Magic Glasses”, did you have/do any of the following? (more than one answer possible)
   (1) I told my family about the worms
   (2) I avoided going to the toilet because of the worms
   (3) I was scared of catching worms when playing with other children
   (4) I had bad dreams about worms
   (5) None of the above

**THANK YOU FOR COMPLETING THE QUESTIONNAIRE!**
C.9: Follow-up questionnaire (control group)

Follow-up questionnaire for schoolchildren in year 4 and 5

To be filled in by research team:
Date_____________________(yyyy/mm/dd)

ID:
Administration village    School    Class    Student
|___|___|    |___|___|   |___|___|

To be filled in by children:
Please fill in this questionnaire truthfully with the help of your teacher. All responses will be kept confidential and will not be used against you in any way. The information will be used for research purposes only.

Personal Information

Name_________________________________________

Grade at school:   (1) 4    (2) 5

Sex   (1) Male   (2) Female

Date of birth _____________________________ yyyy/mm/dd

Knowledge
Please write down what you have heard and what you know about worms (Roundworm/Whipworm/Hookworm) that make you sick. You may also write down: ”I don’t know.”

1. Have you heard about Roundworms?
   (1) Yes   (2) No   (3) Don’t know

2. Have you heard about Whipworms?
   (1) Yes   (2) No   (3) Don’t know

3. Have you heard about Hookworms?
   (1) Yes   (2) No   (3) Don’t know
4. **If you have not heard about intestinal worms (Roundworm/Whipworm/Hookworm), please go to question 5. If you have heard of it, where? (You can chose more than one answer)**
   (1) Friend  (2) Poster  (3) TV  (4) Radio  (5) Book
   (6) Brochure  (7) school  (8) parents/family
   (9) Others (please specify): ………………………………………

5. **Have you ever had worms (Roundworm/Whipworm/Hookworm) yourself?**
   (1) Yes  (2) No  (3) Don’t know

6. **Has somebody you know already had worms (Roundworm/Whipworm/Hookworm)?**
   (1) Yes  (2) No  (3) Don’t know

**Transmission, Symptoms & Treatment**

The following questions ask about how you can get worms, what happens to you and what you can do when you have worms.

7. **How can you get infected with worms (Roundworm/Whipworm/Hookworm)? Name all the possibilities you know.**
   ………………………………………………………………………
   ………………………………………………………………………
   ………………………………………………………………………
   ………………………………………………………………………
   ………………………………………………………………………

8. **Do you think intestinal worms can cause serious disease?**
   (1) Yes  (2) No  (3) Don’t know

9. **What happens if people are infected with intestinal worms? (you can chose more than one answer)**
   (1) Feeling tired
   (2) Blindness
   (3) High blood pressure
   (4) Diarrhoea
   (5) Overweight
   (6) Slow growth
   (7) Can’t concentrate at school
   (8) Fever
   (9) Poor appetite
   (10) Belly ache
   (11) Other (please describe): ………………………………………
   (12) Don’t know
10. How can you prevent/avoid a worm infection? (choose all correct answers)
   (1) Washing fruit and vegetables if eating them raw.
   (2) Sleeping under a mosquito net
   (3) Not playing in the dirt
   (4) Eating too much
   (5) Cover food
   (6) Using the latrine.
   (7) Washing hands after toilet
   (8) Brushing my teeth
   (9) Not playing in vegetable garden
   (10) Washing hands before eating
   (11) Always wear shoes or sandals.
   (12) Doing enough exercise
   (13) Keeping up personal hygiene
   (14) Other (please describe): …………………………………………………
   (15) Don’t know

11. Do you think a worm infection can be treated?
    (1) Yes  (2) No  (3) Don’t know

12. If yes, where can I go for treatment? (more than one answer possible)
    (1) School  (2) Local Clinic  (3) Hospital  (4) Floating vendor
    (5) Village doctor  (6) don’t know

13. If you take medicine for intestinal worms, will you be cured forever?
    (1) Yes  (2) No  (3) Don’t know

**Attitude**

*In the next few questions please tell us how you feel about worms.*

14. Do you think you are at risk of getting intestinal worms?
    (1) Yes  (2) No  (3) Don’t know

14a. Why yes or why no?
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………

15. Are you afraid of getting infected with intestinal worms?
    (1) Yes  (2) No  (3) Don’t know

15a. Why yes or why no?
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………

**Health Education**

*In the next paragraph you will be asked what you have learned about worms (Roundworm/Whipworm/Hookworm) at school.*

16. Has the teacher already told you about intestinal worms?
    (1) Yes  (2) No  (3) Don’t know
Appendix C.9: Follow-up questionnaire (intervention group)

17. Have you watched a DVD on worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know

18. Have you ever done an assignment on worms (Roundworm/Whipworm/Hookworm) (e.g. write an essay)?
   (1) Yes  (2) No  (3) Don’t know

19. Have you told your parents, sisters & brothers about worms (Roundworm/Whipworm/Hookworm)?
   (1) Yes  (2) No  (3) Don’t know

**Behaviour**

*The next few questions will ask you about your family, your activities and habits. Please circle the most suitable answer.*

20. Do you wear shoes on a hot summer day, when you are playing with other children?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

21. Do you wear shoes at home?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

22. Do you wear shoes at school?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

23. Where do farmers usually/mostly (- translation) defecate? (choose one answer)
   (1) Home Latrine  (2) Public Latrine  (3) Field  (4) River
   (5) Other place: .................................................................

24. Where does your family usually/mostly (- translation) defecate? (choose one answer)
   (1) Home Latrine  (2) Public Latrine  (3) Field  (4) River
   (5) Other place: .................................................................

25. Where do you usually/mostly (- translation) defecate? (choose one answer)
   (1) Home Latrine  (2) School Latrine  (3) Field  (4) River
   (5) Other place: .................................................................
26. Sometimes it can be difficult to find water and soap. Do you wash your hands after going to the toilet?
   (1) Always  (2) Usually  (3) Rarely  (4) Never
   26a. With soap?  (1) Always  (2) Usually  (3) Rarely  (4) Never

27. Do you wash your hands before eating?
   (1) Always  (2) Usually  (3) Rarely  (4) Never
   27a. With soap?  (1) Always  (2) Usually  (3) Rarely  (4) Never

28. Do you wash fruit and vegetables before eating them IF RAW?
   (1) Always  (2) Usually  (3) Rarely  (4) Never

Worm treatment
The following questions are about the treatment you received against worms in September last year.

29. When you were treated for worms, did you have difficulties swallowing the pills?
   (1) Yes  (2) No  (3) Don’t know

30. How did you feel after the worm treatment? (more than one answer possible)
   (1) I felt good.
   (2) I felt dizzy.
   (3) I felt sick.
   (4) I had diarrhoea.
   (5) I had to vomit.
   (6) Other (please specify):………………………………
Appendix D: Project information letter and consent form

D.1 Information letter and consent form for parents........................................234

D.2 Information letter and consent form for head of school..............................237
D.1: Information sheet and consent form (parents)

INFORMATION SHEET FOR CONSENT LETTER (Translated into Chinese)

For parents

Names of Principle Investigators  
Yuesheng Li, MD, PhD  
Director, Hunan Institute of Parasitic Diseases,  
Yueyang, Hunan Province, China.

Don McManus, PhD, DSc  
Laboratory Head, Queensland Institute of Medical Research Brisbane, Australia

Franziska Bieri, MSc  
Ph.D. Scholar, Queensland Institute of Medical Research  
Brisbane, Australia

Name of Organization  
Hunan Institute of Parasitic Diseases, Yueyang,  
Hunan Province, China

Queensland Institute of Medical Research  
Brisbane, Australia

Name of Sponsor  
UBS Optimus Foundation, Switzerland

TITLE

Impact of educational DVD on soil transmitted helminth (STH) infection risk behaviour of schoolchildren in China

Invitation to participate in a research project

The study is a one-year intervention study on intestinal worm infections (Roundworm, Whipworm, Hookworm), targeting schoolchildren within certain villages in Hunan Province. The aim of the research project is to develop and test an educational DVD on intestinal worms. 2000 schoolchildren in Grade 4 and 5 within Linxiang County will participate in the study. In September 2010 and June 2011, the children will be asked to submit a stool sample, which will be analysed for worm eggs. The schoolchildren are administered a questionnaire to test their knowledge attitude and practice on STH. In selected schools, the children’s behaviour in terms of hand washing will be observed. All the
Appendix D: Information sheet and consent form (parents)

children will receive free anthelminthic treatment in the form of a pill (400mg Albendazole) in September 2010 and June 2011.

**Procedures**

The information collected with this research project will be used to test the effectiveness of an educational DVD on intestinal worms (Roundworm, Whipworm, Hookworm), that can be shown at schools and changes their infection risk behaviour, resulting in less intestinal worm infections.

**Risks and Discomforts**

Participating in this research project does not involve any risk for the children. The drug Albendazole is safe and the children will be monitored for side-effects.

**Incentives**

You will not be provided any incentive to take part in the research.

**Economic considerations**

There are no charges to you for participating in this study.

**Confidentiality**

The information that we collect from this research project will be kept confidential and will be stored in a file which will not have the children’s name on it, but a number assigned to it. Which number belongs to which name will be kept under lock and key, and will not be divulged to anyone except the scientists and representatives of the Hunan Institute of Parasitic Disease (HIPD).

**Right to refuse or withdraw**

The children or their parents/guardians are free to choose not to participate in this study. They may stop participating in the research at any time that they wish to, without losing any of their rights as a patient. If they withdraw, it will not adversely affect their relationship with the teachers, doctors, nurses, or other health professionals.

**Questions and Who to contact**

Please feel free to ask about anything you do not understand and require reading this consent text carefully - as long as you need - before or after you make a decision. If you have any questions about the research and your right as a research participant, you can ask local
responsible doctors of the study team authorised by the Institute of Parasitic Diseases, Yueyang, Hunan, China.

This proposal has been reviewed and approved by HIPD ethical committee which is the committee whose task is to make sure that research participants are protected from harm. If you wish to find out more about the project and have any questions, please feel free to contact Professor Li Yuesheng, Hunan Institute of Parasitic Diseases, Yueyang, Hunan province, China. Tel: 86-730-8615009.
CONSENT FORM:

For parents

Dear Dr Li and Ms Bieri

I agree that my child takes part in the research project on “Impact of educational DVD on soil transmitted helminth (STH) infection risk behaviour of schoolchildren in China”. I have been informed about the purpose of this research project. The research project is to determine whether educational DVD and cartoon increases the schoolchildren’s knowledge on intestinal worms (Roundworm, Whipworm, Hookworm) and changes their infection risk behaviour, resulting in less intestinal worm infections. In September 2010 and June 2011, my child will be asked to submit a stool sample, fill in a questionnaire about his/her knowledge on intestinal worms. In selected schools children will be observed regarding their hygiene behaviour.

I have read the foregoing information, or it has been read to me. I understand that I have the opportunity to ask any questions about this study. I consent voluntarily that my child participates as a subject in this study and understand that we have the right to withdraw from the study at any time without in any way affecting our further medical care.

School: ___________________________  Class: ___________________________

To be signed by participants parent or legal guardian:

Child’s name: ___________________________

Signed by: ___________________________

Date ___________________________

Place ___________________________

If illiterate, signed by an independent literate representative (where possible, this person should be selected by the participant)

Child’s name: ___________________________

Signed by: ___________________________

Date ___________________________

Place ___________________________
D.2: Information sheet and consent form (school)

INFORMATION SHEET FOR CONSENT LETTER (Translated into Chinese)

For Head of School

Names of Principle Investigators

Yuesheng Li, MD, PhD
Director, Hunan Institute of Parasitic Diseases, Yueyang, Hunan Province, China.

Don McManus, PhD, DSc
Laboratory Head, Queensland Institute of Medical Research Brisbane, Australia

Franziska Bieri, MSc
Ph.D. Scholar, Queensland Institute of Medical Research Brisbane, Australia

Name of Organization

Hunan Institute of Parasitic Diseases, Yueyang, Hunan Province, China

Queensland Institute of Medical Research Brisbane, Australia

Name of Sponsor

UBS Optimus Foundation, Switzerland

TITLE

Impact of educational DVD on soil transmitted helminth (STH) infection risk behaviour of schoolchildren in China

Invitation to participate in a research project

The study is a one-year intervention study on intestinal worm infections (Roundworm, Whipworm, Hookworm), targeting schoolchildren within certain villages in Hunan Province. The aim of the research project is to develop and test an educational DVD on intestinal worms. 2000 schoolchildren in Grade 4 and 5 within Linxiang County will participate in the study. In September 2010 and June 2011, the children will be asked to submit a stool sample, which will be analysed for worm eggs. The schoolchildren are administered a questionnaire to test their knowledge attitude and practice on STH. In selected schools, the children’s behaviour in terms of hand washing will be observed. All the
Appendix D: Information sheet and consent form (school)

children will receive free anthelminthic treatment in the form of a pill (400mg Albendazole) in September 2010 and June 2011.

**Procedures**

The information collected with this research project will be used to test the effectiveness of an educational DVD on intestinal worms (Roundworm, Whipworm, Hookworm), that can be shown at schools and changes their infection risk behaviour, resulting in less intestinal worm infections.

**Risks and Discomforts**

Participating in this research project does not involve any risk for the children. The drug Albendazole is safe and the children will be monitored for side-effects.

**Incentives**

You will not be provided any incentive to take part in the research.

**Economic considerations**

There are no charges to you for participating in this study.

**Confidentiality**

The information that we collect from this research project will be kept confidential and will be stored in a file which will not have the children’s name on it, but a number assigned to it. Which number belongs to which name will be kept under lock and key, and will not be divulged to anyone except the scientists and representatives of the Hunan Institute of Parasitic Disease (HIPD).

**Right to refuse or withdraw**

The children or their parents/guardians are free to choose not to participate in this study. They may stop participating in the research at any time that they wish to, without losing any of their rights as a patient. If they withdraw, it will not adversely affect their relationship with the teachers, doctors, nurses, or other health professionals.

**Questions and Who to contact**

Please feel free to ask about anything you do not understand and require reading this consent text carefully - as long as you need - before or after you make a decision. If you have any questions about the research and your right as a research participant, you can ask local
responsible doctors of the study team authorised by the Institute of Parasitic Diseases, Yueyang, Hunan, China.

This proposal has been reviewed and approved by HIPD ethical committee which is the committee whose task is to make sure that research participants are protected from harm. If you wish to find about more about the project and have any questions, please feel free to contact Professor Li Yuesheng, Hunan Institute of Parasitic Diseases, Yueyang, Hunan province, China. Tel: 86-730-8615009.
CONSENT FORM:

For Head of School

Dear Dr Li and Ms Bieri,

I agree that my school takes part in the research project on “Impact of educational DVD on soil transmitted helminth (STH) infection risk behaviour of schoolchildren in China”. I have been informed about the purpose of this research project. The research project is to determine whether educational DVD and cartoon increases the schoolchildren’s knowledge on intestinal worms (Roundworm, Whipworm, Hookworm) and changes their infection risk behaviour, resulting in less intestinal worm infections. In September 2010 and June 2011, the children will be asked to submit a stool sample, fill in a questionnaire about their knowledge on intestinal worms. In selected schools children will be observed regarding their hygiene behaviour.

I have read the foregoing information. I understand that I have the opportunity to ask any questions about this study. I consent voluntarily that my school participates in this study and understand that we have the right to withdraw from the study at anytime.

I will inform the teachers about this project and will undertake the necessary steps to ask the schoolchildren’s parents for written consent. Therefore I can use the information sheet and consent letter attached.

To be signed by the head of the school:

Signed by: _______________________________

Date____________________________________

School: _________________________________

Place ___________________________________
Appendix E: Video cover and pamphlet with the key messages

A comic accompanying the educational cartoon

Magic Glasses

A joint initiative between:
Queensland Institute of Medical Research, Brisbane, Australia
Human Institute of Parasitic Diseases, New Haven, USA
School of Population Health, University of Queensland, Brisbane, Australia
Funded by: UBS Optimus Foundation, Switzerland

Andrew Bedford
3rd World Media Production, Brisbane, Australia

Always play in clean places

Always use a toilet

Always wash your hands after the toilet and before eating

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Appendix E: Video cover and pamphlet with key messages

Figure A1: Video cover and pamphlet with the key messages
Appendix F: Photographs project workshops and fieldwork

Figure A2: Teacher training workshop, Linxiang Centre for Disease Control, September 2010

Figure A3: Teacher training workshop, Linxiang Centre for Disease Control, September 2010
Figure A4: Local authorities Linxiang City District, Dissemination workshop, Linxiang Centre for Disease Control, April 2012. From left: Ma Rong (mayor Linxiang City), Yu Hao (director Health Department), Linxiang City District, Sun Weibo (Director Linxiang CDC) and health, Luo Yawen (teacher)

Figure A5: Video handover to Director Yu Hao, Health Department, Linxiang City District, April 2012.
Figure A6: Field team November 2010. From left: Ma Minxia (Linxiang CDC), Yin Wenqing (Linxiang CDC), Li Lingmin (Linxiang CDC), Guo Fengying (HIPD, Yueyang), Franziska Bieri (QIMR, Brisbane), He Yongkang (HIPD, Yueyang), Li Shengming (HIPD, Yueyang), Long Huan (HIPD, Yueyang)

Figure A7: School visit, Linxiang City District, Hunan Province, China (September 2010). From left: teacher, Don McManus (QIMR, Australia), Darren Gray (University of Queensland, QIMR, Australia), Franziska Bieri (QIMR, University of Queensland, Australia)
Appendix F: Photographs workshops and fieldwork

Figure A8: Children watching the educational video ‘The Magic Glasses’, Linxiang City District, Hunan Province, China (June 2010)

Figure A9: Winners of drawing competition Linxiang City District, Hunan Province, China (March 2010)
Figure A10: Field observations, preliminary assessment October 2009, Linxiang City District, Hunan Province, China

Figure A11: Vegetable garden study area, Linxiang City District, Hunan Province, China (October 2009)
Figure A12: Village in study area, Linxiang City District, Hunan Province, China (October 2009)

Figure A13: Project school, Linxiang City District, Hunan Province, China (September 2010)
Appendix F: Photographs workshops and fieldwork

Figure A14: School toilet, Linxiang City District, Hunan Province, China (October 2009)

Figure A15: School kitchen, Linxiang City District, Hunan Province, China (October 2009)
Appendix G: GIS maps with main results on school level

Figure A14. Map of study area with infection status on school level
Figure A15. Map of study area knowledge scores on school level
Appendix H: Media releases

H.1: Media releases - overview

Queensland scientists use a cartoon to reduce worm infections in China. The Roast, ABC2, April 26, 2013.

Queensland researchers' cartoon fights off parasitic worms. ABC NEWS, April 25, 2013.


*There’s no worm in there*- Using cartoons and fun to counter an insidious disease. In: UBS Optimus World Magazine, September 2011. (Appendix G2)

‘The Magic Glasses’ – an educational cartoon to prevent soil-transmitted helminth in Chinese schoolchildren. Video on display at the Integrated Pathology Learning Centre, Medical School, University of Queensland, Brisbane, Australia. March 2011 to present.


H.2: UBS Optimus Foundation World Magazine, September 2011
From hookworms to bookworms
How success at school is connected with health

China
Using cartoons and fun to counter an insidious disease

Doing good has many facets
The social significance of philanthropy
A shared commitment

We are a charitable grant-making foundation established by UBS in 1999. We are dedicated to the well-being of children in need around the world through education, protection and health.

These three elements are the critical factors in a child’s life. They give children the chance to lead an independent adult life and to become active members of society who can help to positively influence future generations. We offer UBS clients a broad range of ways to get involved in charitable, humanitarian projects. Our funding strategy ensures the optimum use of donations to support sustainable, positive change.

Because UBS bears all administrative and labor costs related to the UBS Optimus Foundation, 100 percent of your donation goes straight into the projects.

Over the past ten years we have supported 230 projects in 65 countries with contributions from over 10,500 donors totaling around 100 million Swiss francs.
One of the best investments we can make is to ensure that children across the world are given the opportunity to positively contribute to society. Several factors – such as health, education and protection – are critical in optimizing a child’s development.

As illustrated in the article by Anthony Costello and Audrey Prost (p 7), it is increasingly recognized that these factors are interwoven: poor health and nutrition affect children’s cognitive functioning and therefore their ability to benefit from education.

Similarly, researchers have found that children who received intensive education interventions starting in infancy have had significantly better health and health behaviors as young adults.

Schools are an excellent place to reach children in order to deliver important health interventions and information, as discussed in the article on a disease prevention program in China (p 10), where researchers are testing a novel educational video that teaches children how to avoid parasite reinfection after providing them the standard medical treatment to remove the parasites.

This project looks to improve upon current treatment by identifying a solution that could allow for long-term prevention and cost saving. Researching and evaluating the effect and long-term impact of such innovative approaches is a funding interest of the UBS Optimus Foundation.

Another priority of ours is sharing our partners’ efforts with a wider community, in order to offer a greater insight and understanding of the complexity and interdisciplinarity of the pressing issues related to sustainable development.

Therefore, in this issue, we’ve asked renowned scientists and experts in their respective fields to share their knowledge and experiences.

We’re excited to share their contributions with you, and thank them for taking time to report from the front lines. We look forward to continuing to share the progress of the foundation and our partners as we move forward together in improving the lives of children in need.

In order to remain updated about the foundation’s activities, please register your information at www.ubs.com/optimus.
There’s no worm in there

Using cartoons and fun to counter an insidious disease.
The young mother cannot hold back her tears as she speaks about her son. She is really worried because her son is much smaller than his classmates of the same age. He no longer has any appetite and is getting thinner and thinner. He is not able to concentrate in school; his performance has dropped off dramatically.

The mother knows that this must have to do with the parasites that infect her son over and over again. And this despite the fact that she has him treated on a regular basis. Other mothers observe similar symptoms in their children, but do not know what the reason could be. “Many people are not aware of this problem – often parents and teachers mistake the typical symptoms for those of the flu or food poisoning,” explains Franziska Bieri, project manager of the prevention project in Hunan, China.

A burden for two billion people
This lack of knowledge is exacerbated by the fact that worldwide more than two billion people are affected by worm infections. This also applies to China where the rate – according to national surveys – is said to have dropped from 923 million affected in 1990 to 154 million in 2004. Nonetheless, particularly in rural regions where there is little development, at times more than fifty percent of the population is infected with the insidious disease.

The usual countermeasure is the distribution of medication. However, this does not provide any sustainable improvement if the people do not learn at the same time how they can avoid new infections. This is of major significance for children in particular. They romp around outside where the soil might be contaminated, they walk outside without shoes where worms can penetrate their skin, and they eat contaminated food and forget to wash their hands regularly. All of these are forms of behavior that dramatically increase the risk of another worm infection.

“This is why we searched for a way to motivate children to change their behavior in such a way that the risk of another infection is reduced,” explains Franziska Bieri.

From knowledge to action – a long journey
However, bringing about a change in behavior is easier said than done. Knowledge has to be communicated, understood, remembered and applied. Today we know that learning content is best stored in the memory when it is linked with positive feelings during communication. For this reason, a trend is forming increasingly in health education to not only point out the risks of health-damaging behavior, but rather to shape content into entertaining forms that make observers laugh and positively reinforce it. Moving images appeal to children particularly well – they grab their attention and generate an entertainment value.

The idea came about to develop an animated video suitable for children that fascinates young people through its...
funny story and at the same time educates them about health-promoting forms of behavior.

The following instructions are the focus:

– Play only where it’s clean
– Use a toilet that’s as clean as possible and wash your hands afterwards
– Also wash your hands before eating
– Cover food standing around with a fly screen
– Wash raw fruits and vegetables well, cook food all the way through
– Wear shoes or sandals
– Go to the doctor if you feel sick

If this behavior is observed, the risk of a new infection is reduced greatly. The video will be shown at schools where what’s learned is also discussed with the teachers and integrated into daily life. Many of the participants are enthusiastic: Xiao Yan-Hua, father of nine-year-old Xiao Qiang explains: “Ever since my daughter saw the film she’s been paying much more attention to hygiene and has not been infected again since last September. That’s why this year she has not had to undergo any more treatment.” The teachers have also been positively impressed by the project, and they even observe that the children are absent less and are more attentive in school. Initial experiences have been extremely positive, but this does not mean the goals of the project have been attained.

“We didn’t know much about worms before we saw the video. Now we regularly wash our hands before eating.”

Liu Xuan (11) and Peng Liantian (10)
(picture on the right)
In conversation with Franziska Bieri, project manager

What was your motivation in launching this project?
I am convinced that experts from various disciplines should work together to address mankind’s most pressing problems. Worm diseases affect two thirds of the world’s population and thus represent a major problem. And yet they are hardly discussed, which is why we also call these infections the “quiet epidemic.” In this specific project that is aiming for fewer infections in children through changes in behavior, experts from the natural and educational sciences are working together with artists from the entertainment industry. If we can scientifically prove that this will lower the infection rate, we can make a contribution that will be more sustainable than merely mass treatment with medication.

Are local groups involved in the project?
The involvement of local teachers, parents, health staff and individuals from the health and education office at the provincial level was very important to us. We have involved not only the beneficiaries – the children – but also teachers, parents and local authorities in the project planning and the development of the video from the very beginning. We would also like to attract national representatives from the health and education ministries for the later distribution of the film.

Profile
Franziska Bieri did her Master’s in Geography and Biology at the University of Bern in 2005. After attaining her teacher’s diploma for high schools at the Teaching Training College in Bern in 2007, she worked as a high school teacher. Later she worked as a delegate for the Swiss Caritas in Indonesia until she took up her doctoral studies in August 2009 at the University of Queensland in Brisbane, Australia, in order to work on this research project in Hunan province in China.

Promoting an integrative approach
The most successful way to control infectious diseases, such as worm infections, is an integrative approach which equally focuses on an environment that promotes health (sanitation/hygiene), accurate diagnosis, effective treatment and health education. At the same time, worm infections must be understood in the context of other diseases, since people in areas affected by poverty often have multiple infections. Under such circumstances, for example, an instrument that would allow for several diseases to be diagnosed with just one test would be ideal.

Wherever possible, the Foundation thus supports projects that pursue an integrative approach or are active in one of the specific areas of the four levels which can also be used elsewhere. At present, the Foundation supports nine worm infection projects in Africa, Asia, and Latin America with a total of 2.87 million Swiss francs.
Scientific proof of impact

More importantly, it has to be scientifically ascertained whether the development of knowledge and behavior is actually being changed in the long term by this video, which in turn should result in a demonstrably lower infection rate. If the proof can be provided that the procedure is successful, the video will be broadly distributed and made freely available. “It would be great if we could convince the education ministry to include the video in the curriculum in areas where infections occur most frequently,” emphasizes Franziska Bieri.

Initial investigations in Hunan province clearly showed that the children like the film and understand the core messages well. Surveys among teachers indicated that the behavior of children has clearly changed.

Nonetheless there are still many challenges ahead if worm infections are to be brought under control on a permanent basis: as with many of the neglected diseases, it is very difficult to raise awareness of these infectious diseases and to find funds for control measures. And cases of worm diseases are considered especially revolting – no one likes to talk about them, and that makes it difficult to find potential donors for this subject. Those who suffer are the ones impacted. They remain caught in the familiar vicious cycle of poverty.