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Knowing the target for neglected tropical disease programs: identifying systematic differences between school-attending and non-school-attending children in Amhara region, Ethiopia

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By

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Bachelor of Arts
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2008

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Abstract

Knowing the target for neglected tropical disease programs: identifying systematic differences between school-attending and non-school-attending children in Amhara region, Ethiopia

By Aisha Elizabeth Pomfret Stewart

Background: School-age children are often targeted by neglected tropical disease (NTD) programs. In areas where school attendance is low, the population of school-age children may not be homogeneous, with differences between school-attending and non-school-attending children. We aimed to identify whether systematic differences between school-attending and non-school-attending children exist in Amhara National Regional State in Ethiopia, where school attendance is approximately 60%.

Methods: We conducted a cross-sectional, cluster random survey of school-age children aged 6-15 years. Potential differences between school and non-school children recorded were: demographics, trachoma clinical signs and intestinal parasitic infections, anthropometric measurements, knowledge and behaviors regarding trachoma control and hygiene activities and household characteristics. Stool specimens were collected.

Principal Findings: 2,711 school-age children were recruited of whom 2,468 (91.0%) from 106 communities in 20 districts provided assent and all data. Reported school attendance was 58.5% (95% confidence interval (CI): 54.5-62.4). School-attending children were older (odds ratio (OR)=1.42, 95% CI: 1.33-1.51), more likely to be female (OR=1.42, 95% CI: 1.15-1.76), live with their birth parents (OR=2.49, 95% CI: 1.30-4.77), present with less trachomatous inflammation-follicular (TF; OR=0.55, 95% CI: 0.37-0.81), have lower body-mass-index-for age (OR=1.86, 95% CI: 1.36-2.55), reside in households with higher socio-economic status (OR=1.94, 95% CI: 1.46-2.56), have heard about trachoma (OR=3.87, 95% CI: 2.70-5.54), report more frequent face washing (OR=2.74, 95% CI: 1.76-4.25), hand washing after defecation (OR=3.49, 95% CI: 2.16-5.64) and latrine use (OR=2.29, 95% CI: 1.80-2.92). Adjusting for age and sex, there were no significant differences in presentation of TF or intestinal parasitic infections between school-attending and non-school-attending children.

Conclusions: Systematic differences exist between school-attending and non-school-attending children. Control strategies for NTDs should include interventions specifically targeted to school-attending and non-school-attending children, as they are different populations and consequently require unique approaches to maximize coverage to each group.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 2 TABLES

CHAPTER 3 TABLES

LIST OF FIGURES

CHAPTER 2 FIGURES

CHAPTER 3 FIGURES

APPENDICES FIGURES

CHAPTER 1: INTRODUCTION

Neglected tropical diseases (NTDs), such as trachoma, soil-transmitted helminths (STH; hookworm, *Ascaris lumbricoides* and *Trichuris trichiura*) and schistosomiasis, disproportionately affect the world's poorest citizens. Among the 2.7 billion people living on less than US$ 2 per day, over one billion are estimated to be infected with at least one NTD (Liese et al., 2010; WHO, 2010). NTDs proliferate in populations living in poor, rural areas with limited access to clean water, improved sanitation and suitable housing conditions. NTDs cause 534,000 deaths annually, which is relatively low compared to mortality caused by the "big three" diseases: HIV/AIDS, malaria and tuberculosis (Hotez et al., 2007). However, NTDs lead to chronic, and potentially irreversible, morbidities and disabilities, such as blindness, anemia, severe stunting and cognitive impairments, as well as social stigmatization. Accounting for disabilities caused by NTDs using the measure of disability-adjusted life years (DALYs), these diseases present a greater public health burden than malaria and tuberculosis. In addition to causing adverse health outcomes, NTDs perpetuate poverty (Liese et al., 2010), as morbidity and disability caused by these diseases decreases the productivity of infected individuals, leading to economic losses for entire households (Conteh et al., 2010).

Despite the high DALYs posed by NTDs, they have historically received low prioritization as a public health issue, possibly due to low number of resulting deaths. However, over the past 20 years NTDs have garnered increasing attention, and targets for control and elimination for many have been set by the World Health Organization (WHO) (WHO, 2012a). This shift has been attributed to the advent of low-cost and effective control strategies (Hotez et al., 2009). Many control strategies for NTDs rely on mass drug administration (MDA) using medicines donated from pharmaceutical companies. However, MDA is neither sufficient nor sustainable. Considering trachoma, the leading cause of preventable blindness worldwide, MDA is the most effective method to reduce infection, but control strategies for the NTD must also include health education and behavior change in order to strive towards meeting the WHO target of global elimination of blinding trachoma by the year 2020 (Emerson & Ngondi, 2009; WHO, 1998).

Progress towards the global elimination target for trachoma, as well as other NTD targets, has been made, demonstrating the success of control strategies. Specifically regarding trachoma, global estimates of the number of people with active trachoma (characterized by trachomatous inflammation-follicular (TF); trachomatous inflammation-intense (TI); or TF and TI) decreased from about 150 million in 1990 to less than 40 million in 2011. Although the prevalence of active trachoma has declined, the number of people with trichiasis, the painful, blinding stage of the disease, has increased from less than 6 million in 1990 to 7 million in 2011. Despite the progress made in reducing active trachoma, there remains a considerable need for implementation of control activities to meet the 2020 target, specifically in the 53 countries where the eye disease is endemic (WHO, 2012b). Focusing on reducing prevalence of active trachoma, which is highest among children under the age of 10 years (Solomon et al., 2004), may decrease the incidence of trichiasis given that repeated bouts of active trachoma during childhood may lead to scarring and trichiasis in adulthood (WHO, 2012b).

In order to reduce the burden of trachoma, as well as other NTDs, surveys must be conducted to generate prevalence estimates in order to determine the control strategies needed. However, surveys to document prevalence require substantial resources and time (Baker et al., 2010). For example, large-scale cluster surveys that screen household members for clinical signs of trachoma are needed to map the disease and generate reliable prevalence estimates (Ngondi et al., 2009b; Solomon et al., 2006). Similarly, stool sample specimens must be collected from school-age children to determine the prevalence of STH infection and schistosomiasis (WHO, 2006c, 2011).

As an alternative to community-based surveys, school-based approaches have increasingly been promoted for NTDs that highly burden school-age children, such as trachoma, STH and schistosomiasis (Baker et al., 2010; Hotez & Kamath, 2009; King et al., 2009; Pelletreau et al., 2011; WHO, 2006a, 2011). Schools serve as a convenient setting to carry out prevalence surveys and control activities, as they allow access to children from multiple communities who are at high-risk for infection (Baker et al., 2010; Partnership for Child Development, 1999; Pelletreau et al., 2011; WHO, 2006a). Current control programs for trachoma, STH and schistosomiasis incorporate school-based approaches. School-attending children are taught health lessons in schools to promote facial cleanliness and environmental improvements to increase awareness and behavior change to control trachoma (WHO, 2006a). Additionally, schools are used as platforms to conduct prevalence surveys for STH and schisotomiasis and to delivery preventive chemotherapy (WHO, 2002, 2006c, 2011).

Not only do schools offer a platform to easily and rapidly assess the burden of disease and to administer control interventions, but they also target the high-risk population of school-age children. School-age children are a vulnerable group, as children under the age of 14 years suffer from almost 70% of deaths and 75% of DALYs due to infectious diseases, including NTDs (WHO, 2006b). Further evidence suggests "school-age children are likely to be the greatest beneficiaries from NTD control programs because they have potential to be protected from ill-health and undernutrition and have some capacity to recover before damage is substantial and permanent. They may also, as productive adults, show the quickest returns from investments in NTD control" (Hall et al., 2012). To reach the ambitious goals for NTD control and elimination programs, targeting the high-risk population of school-age children is critical and effective methods to reach the group must be investigated.

Problem statement

In areas where school attendance is high, school-based programs may provide an optimal platform to conduct prevalence surveys and administer NTD control activities for school-age children. A problem with this approach arises when considering the proportion of children who attend school. School attendance has been shown to vary significantly in countries where NTDs are endemic, with high frequency of attendance in some communities and low frequency in neighboring communities (Fentiman et al., 1999; King et al., at review). Implementing a school-based strategy in areas where school attendance is low is likely to exclude non-school-attending children from crucial disease prevalence surveys and control interventions (Montresor et al., 2001a; Talaat et al., 1999). If disease status, as well as individual and household characteristics, varies between school-attending and non-school-attending children, then prevalence surveys conducted at schools are unlikely to produce accurate estimates (Baker et al., 2010; Pelletreau et al., 2011). Additionally, limiting interventions to school-attending children may fail to control disease at the community level, leaving non-school-attending children without coverage and likely to continue to transmit infection (Anderson et al., 2013).

Much is suspected about the differences between school-attending and non-school-attending children, making it difficult to discern the implications of using school-based programs for disease prevalence surveys and control activities. Often, studies consider the population of school-age children to be homogeneous and do not differentiate between school-attending and non-school-attending children. Evidence suggests school attendance may be linked to household socio-economic status (SES), the child's health and perceived readiness to attend school, as well as the need for the child to assist at home. Therefore, it follows that school-attending children may be systematically different from non-school-attending children (Fentiman et al., 1999, 2001; Montresor et al., 2001b). Identifying these differences is critical to informing modifications to NTD control activities to maximize coverage for both school-attending and non-school-attending children and ultimately reduce prevalence among the high-risk group of school-age children, whether or not they are in school.

Purpose statement

This study seeks to address a knowledge gap by identifying whether systematic differences exist between school-attending and non-school-attending children in the context of a trachoma control program in the North Gondar and West Gojam zones in Amhara region, Ethiopia. This information is vital to inform modifications to regional trachoma control programs, as well as other NTD programs, to ensure that full coverage of interventions extend to school-attending and non-school-attending children.

Research questions

To achieve the study purpose, this investigation aims to answer two research questions:

1. What differences exist between school-attending and non-school-attending children related to demographics, disease status of trachoma, infection with STH, *Schistosoma mansoni* and protozoan parasites, growth status, knowledge and behaviors related to trachoma control interventions and household factors?
2. Are school-attending and non-school-attending children systematically different?

Statement of study significance

Given the high burden of NTDs among school-age children, effective strategies to determine disease prevalence and delivery of control activities are critical to reduce prevalence and promote long-term economic growth and development in endemic areas. While schools provide a centralized point to access a large number of children who are at high-risk for disease, they exclude non-school-attending children. In areas where school attendance is low, school-based intervention approaches may not cover all school-age children. Critically, if the entire population of school-age children is the target of NTD programs and only a portion are reached through school-based approaches, the programs are effectively missing the target. Exploring factors associated with school attendance through the context of a trachoma control program will provide essential information to fill this knowledge gap, and allow for evidence-based program modifications to appropriately and effectively target intervention activities to school-attending and non-school-attending children.

<u>List of acronyms and terms</u>

CI	Confidence interval
CO	Corneal opacity
DALY	Disability-adjusted life year
GET2020	Alliance for the Global Elimination of Blinding Trachoma by 2020
HEW	Health extension worker
MDA	Mass drug administration
NTD	Neglected tropical disease
OR	Odds ratio
SAFE	Control strategy for trachoma endorsed by the World Health Organization: Surgery, Antibiotics, Facial cleanliness and Environmental improvements
SES	Socioeconomic status
STH	Soil-transmitted helminths (hookworm, *Ascaris lumbricoides* and *Trichuris trichiura)*
TF	Trachomatous inflammation–follicular
TI	Trachomatous inflammation–intense
TS	Trachomatous scarring
TT	Trachomatous trichiasis
WHO	World Health Organization
Active trachoma	Initial stages of trachoma characterized by the presence of trachomatous inflammation-follicular (TF) and/or trachomatous inflammation-intense (TI), as defined by the World Health Organization simplified grading system
Non-school-attending child	Child aged 6 to 15 years who reports not to regularly attend school
School-age child	Child aged 6 to 15 years
School-attending child	Child aged 6 to 15 years who reports regularly attending school

CHAPTER 2: LITERATURE REVIEW

Trachoma burden, prevalence and control strategies

Trachoma, caused by ocular infection with *Chlamydia trachomatis*, is the leading cause of infectious and preventable blindness worldwide. Repeated infections with *C. trachomatis* during childhood cause active trachoma, which, if left untreated may lead to permanent scarring and blindness, typically seen in adulthood. Today, the eye disease is known to be endemic in 53 countries, primarily in Africa and Asia (Figure 1). About 325 million people live in endemic areas and are at risk of low vision and blindness from trachoma (WHO, 2012b). Despite the geographic distribution of trachoma, 48.5% of the global burden of active trachoma is concentrated in five countries including Ethiopia, India, Nigeria, Sudan and Guinea, and 50% of trichiasis cases are found in China, Ethiopia and Sudan (Mariotti et al., 2009).

Figure 1. Global distribution of endemic trachoma based on known 2010 estimates (WHO, 2012b).

To measure the burden of trachoma, trachoma control programmers typically use the WHO simplified grading system to screen individuals for clinical signs of the eye disease when conducting surveys. Figure 2 shows the WHO simplified grading system classification, which categorizes clinical signs of trachoma into five stages: 1**)** trachomatous inflammation-follicular (TF), 2) trachomatous inflammation-intense (TI), 3) trachomatous scarring (TS), 4) trachomatous trichiasis (TT) and 5) corneal opacity (CO) (Thylefors et al., 1987).

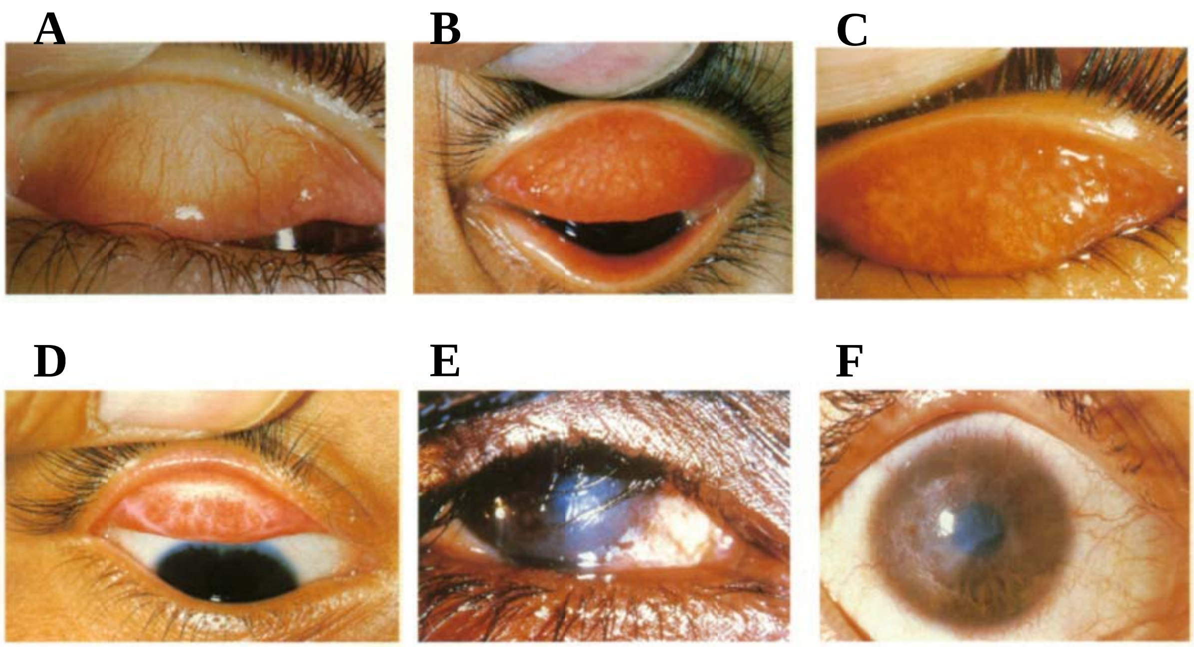


Figure 2. The WHO simplified grading system (adapted from Thylefors et al., 1987). **A**: normal conjunctiva, **B**: trachomatous inflammation – follicular (TF), **C**: trachomatous inflammation – intense (TI), **D**: trachomatous scarring (TS), **E**: trachomatous trichiasis (TT) and **F**: corneal opacity (CO).

Prevalence estimates of clinical signs of trachoma are necessary to determine control strategies. To control disease, the WHO promotes the SAFE strategy. SAFE stands for: Surgery for trichiasis, Antibiotics to treat trachoma infection, Facial cleanliness and Environmental improvements (Table 1). The WHO recommends implementation of the full SAFE strategy in communities where prevalence of active trachoma in children aged 1 to 9 years exceeds 10% or where prevalence of trichiasis among people aged 15 years or older exceeds 1% (Solomon et al., 2006). The WHO has promoted the SAFE strategy since 1997, when it established the Alliance for the Global Elimination of Blinding Trachoma by the year 2020 (GET2020) (WHO, 1998). Ultimately, GET2020 aims to reduce the prevalence of trichiasis to one case per 1,000 total population and the prevalence of TF in children aged 1 to 9 years to less than 5% (Solomon et al., 2006).

Table 1. Overview of the SAFE strategy (adapted from WHO, 1997).

SAFE Component	**Description**
S – surgery for trichiasis	Surgery redirects eyelashes that rub against the cornea (trichiasis) to reduce the onset of corneal opacity and resulting blindness.
A – antibiotics to treat *C. trachomatis*	A dose of 1% tetracycline ointment applied twice daily for six weeks or a single dose of azithromycin required to treat infection. The WHO recommends annual mass distribution of antibiotics for at least 3 years to entire districts if the prevalence of TF in children aged 1 to 9 years is equal to or exceeds 10%. If prevalence of TF is 5-10%, then targeted distribution to communities is warranted. Antibiotic distribution is not recommended in communities where TF prevalence is below 5%.
F – facial cleanliness	Promote facial cleanliness and hygiene.
E – environmental improvements	Promote proper disposal of excreta, primarily through the construction and use of pit latrines.

The A, F and E components of SAFE have been carried out using MDA and health education to promote behavior change to interrupt transmission of trachoma. MDA is conducted during annual, community-based campaigns, but health education is primarily carried out at schools (WHO, 2006a). Annual MDA significantly reduces the prevalence of trachoma infection in endemic communities (West et al., 2005), and is the most effective method to reduce trachoma infection. However, it is neither sufficient nor sustainable. When MDA is combined with implementation of the F and E factors, the effects are additive, with increased independent effects of each component. Control strategies must integrate health education and behavior change, as well as MDA to control the eye-disease (Emerson & Ngondi, 2009; Ngondi et al., 2008b).

To achieve the GET2020 goals, trachoma control strategies must target populations in areas of high endemicity, such as Ethiopia (Mariotti et al., 2009). In 2006, the Federal Ministry of Health in Ethiopia conducted the National Survey on Blindness, Low Vision and Trachoma. Results from the survey confirmed trachoma as the second leading cause of blindness nationally, accounting for 11.5% of blindness. Nine million children aged 1 to 9 years, representing 40.1% of the age group, presented with clinical signs of active trachoma (Berhane et al., 2006). The Ethiopian national trachoma prevalence far exceeded estimates from other known endemic countries based on 2008 estimates (Mariotti et al., 2009).

The national survey highlighted the non-uniform distribution of active trachoma across regions. Amhara region harbored the highest prevalence of active disease (62.6%), followed by the regions of Oromia (41.3%), Southern Nations, Nationalities and Peoples' (33.2%), Tigray (26.5%), Somali (22.6%) and Gambella (19.1%). Similarly, the highest prevalence of trichiasis, 5.2%, was found in Amhara region, which exceeds the national estimate of 3.1% (Berhane et al., 2006).

Given the high burden of disease in Amhara region, trachoma control interventions using the SAFE strategy began in select zones in 2001, with coverage extending to all zones in the region by 2007. Surgery campaigns are offered on a regular basis, MDA occurs annually, and health extension workers (HEWs) have been trained to implement school-based health education to promote the F and E components of SAFE. Impact assessments of SAFE activities are conducted every three to five years. The assessments indicate a reduction in prevalence of active trachoma compared to baseline, and uptake of the A, F and E components (Ngondi et al., 2009a).

Trachoma risk factors

The SAFE strategy aims to interrupt pathways of trachoma infection transmission. Trachoma is spread from person-to-person directly and indirectly. Pathways of transmission include eye-to-eye contact through playing and sleeping and spread of infected ocular or nasal discharge with fingers, flies or fomites (Hu et al., 2010). A number of well-documented risk factors increase the likelihood of infection, and the primary risk factors found in Ethiopia are presented and critiqued.

Age

The highest prevalence of active trachoma is found in pre-school age children, with a decline in prevalence seen after the age of 10 years (Solomon et al., 2003; West et al., 1991). Young age predisposes children to infection because they are increasingly exposed to trachoma transmission pathways by playing with peers and exploring the environment. Compared to children, bacterial loads of trachoma infection in adults are lower and the duration of infection tends to be shorter (Bailey et al., 1991; Solomon et al., 2003).

Biological sex

Several studies have documented the disproportionately high burden of trichiasis among women. Cromwell et al. (2009) conducted a meta-analysis of literature reporting higher rates of trichiasis in women and determined that women had 1.82 (95% confidence interval (CI) 1.61-2.07) the odds of having trichiasis compared to men. The increased odds of trichiasis among women are routinely explained by the role of women as caretakers for children who are known to carry the highest bacterial load of trachoma infection (Cromwell et al., 2009). However, evidence does not suggest a relationship between sex and trachoma for girls under the age of 15 years. Alene and Abebe (2000) carried out a cross-sectional survey among 414 households in the North Gondar zone of Amhara, Ethiopia and did not find a significant difference in the prevalence of trachoma between boys and girls under the age of 15 years. The investigators suggested both boys and girls were equally exposed to risk factors. However, the statistical analysis did not stratify risk factors by sex, and there may be sex-specific activities that boys and girls engage in that pose varying risk (Alene & Abebe, 2000).

Undernutrition

Nutrition influences acquisition of and susceptibility to infection. It operates bi-directionally, meaning nutritional status can make hosts more susceptible to disease and disease can compromise nutritional status. Nutritional status and disease may also act synergistically to generate adverse health outcomes. It has been suggested that good nutrition provides protection to hosts from small infectious loads so that disease may not develop. Undernutrition has further implications for recovery from infection after treatment with MDA. Although MDA has the potential to kill infectious agents, impaired nutritional status renders hosts more susceptible to re-infection (Hall et al., 2012).

Smith et al. (2007) examined the growth status of 257 children aged 6 to 59 months in Wolayta district in Ethiopia. Their findings showed that stunted children were almost twice as likely to have active trachoma compared to non-stunted children (Odds ratio (OR)=1.96, 95% CI: 1.12-3.43). However, this study selected participants from households where at least one family member had trichiasis (Smith et al., 2007), which may not allow for generalizability of the results to all households in the area.

Water access, quantity and use

Numerous studies have explored the relationship between trachoma and water, yet the results are inconsistent. As reviewed in Emerson et al. (2000), several studies detected an association between reductions in active trachoma and shorter distance to a water source, while others showed no effect (Emerson et al., 2000a). Distance to water may be a proxy for the quantity of water brought into a household. If household members travel a short distance to collect water, they may make more frequent trips and more water may be available for use in the household. Several studies have explored this hypothesis, but, again, the results are conflicting (Bailey et al., 1991; Polack et al., 2006; West et al., 1989). A salient finding from a case-control study conducted in The Gambia was that households with fewer cases of active trachoma allocated more water for washing children compared to those with higher prevalence of active trachoma (Bailey et al., 1991). Cross-sectional studies have demonstrated the impact of using water from protected sources on reducing active trachoma. Cumberland et al. (2005) reported a 42% (OR= 0.58; 95% CI: 0.32 -1.05) reduction in active trachoma when Ethiopian households used a protected water source compared to an open source. However, the association did not achieve statistical significance (Cumberland et al., 2005). Ngondi et al. (2008) found a significant association between use of water from a safe source and reductions in active trachoma in a large-scale prevalence survey carried out in Ethiopia. However, it remains unclear how use of water from an improved water source impacts trachoma, and, in fact, it may be a proxy for quantity of or use of water in a household (Emerson et al., 2000a; Ngondi et al., 2008a).

Facial cleanliness and hygiene

Strong evidence from a community-randomized trial suggested the importance of maintaining a clean face to reduce trachoma transmission. The trial enrolled 1,417 children, aged 1 to 7 years, living in Tanzania and found that those allocated to the intensive face-washing arm who had a clean face during at least two follow-up times had significantly reduced odds of presenting with trachoma (OR=0.58, 95% CI: 0.47-0.72) (West et al., 1995). Several reviews noted that a number of studies investigated the role of facial cleanliness in reducing active trachoma, but the results are mixed, as some studies reported protective effects between face washing and trachoma and others showed no effect (Emerson et al., 2000a; Hu et al., 2010; Pruss & Mariotti, 2000). Conflicting results regarding the association between face washing and trachoma raise critical concerns regarding the validity of measuring frequency of face washing. Measures that are self-reported are likely to be biased because respondents may provide the most desirable answer rather than the true answer. Such practices make it exceedingly difficult to measure frequency of face washing in trachoma impact assessments, and results should be interpreted with caution.

Eye-seeking flies, latrines and cattle

The presence of flies has been linked to the presence of trachoma, as *M. sorbens* flies are vectors for the eye disease (Emerson et al., 2000b). Controlling the population of flies in a community has been show to decrease the number of fly-eye contacts and, consequently, the prevalence of trachoma (Emerson et al., 1999). Flies can successfully be controlled using two methods: insecticide spraying and use of pit latrines. *M. sorbens* breed in openly defecated human feces and not in latrines. Therefore, constructing and using latrines to reduce the amount of exposed excreta decreases the population of *M. sorbens* (Emerson et al., 2004). Household members can easily build household latrines, and latrines offer an alternative to insecticide spraying that is costly and time-intensive. Studies have reported decreased risk of active trachoma in households with latrines (Cumberland et al., 2005; Emerson et al., 2000b; Pruss & Mariotti, 2000). However, a cross-sectional study including 2,845 households in Ethiopia did not find a significant association between the presence of a pit latrine in a household and reduction of active trachoma. This may be explained by the fact that the presence of a latrine does not always correspond with use. In areas where latrines are not widely used, their ability to reduce transmission of trachoma will be limited (Ngondi et al., 2008a). Additionally, latrine use at the community level, rather than just the household level, may be necessary to control the fly population and lead to a reduction in active trachoma.

Evidence suggests the existence of an association between close proximity to cattle and increased prevalence of active trachoma. Cumberland et al. (2005) conducted a cross-sectional survey of 915 households in 40 communities in Ethiopia. Their findings suggested close proximity of cattle to households was associated with increased feces around the house and, consequently, increased the population of *M. sorbens*, resulting in higher prevalence of active trachoma (Cumberland et al., 2005). However, surveys conducted in South Sudan in 2005 showed that proximity of cattle to households was not significantly associated with active disease (Ngondi et al., 2008b). What has not been documented in the literature is the association between daily activities, such as cattle herding, and presentation of active trachoma. Particularly in settings where school-age children are responsible for tending to livestock, this activity may expose them to higher risk of trachoma infection.

Poverty

Knowledge of the association between trachoma and poverty dates to the early 20th century (Mecaskey et al., 2003). Trachoma disproportionately burdens the poorest, disadvantaged groups (Emerson et al., 2000a). However, this relationship can be difficult to measure in areas where many household members do not have a stable income and rely on subsistence farming and temporary employment. Using a cross-sectional survey of 5,427 children aged 1 to 9 years, Ngondi et al. (2008) found active trachoma in Amhara, Ethiopia to be significantly associated with households that had a thatched roof and no electricity. These variables were considered proxy indicators for low socio-economic status (SES) (Ngondi et al., 2008a).

The multitude of studies assessing risk factors for trachoma largely present consistent findings that provide guidance for trachoma control interventions. However, while many risk factors are well known, no identified, published studies have considered how risk of disease is distributed across the two groups of school-age children: school-attending and non-school-attending children. To investigate differences between school-attending and non-school-attending children, literature on the topic is presented and critiqued. Considering the evidence on differences between school-attending and non-school-attending children in concert with trachoma risk factors serves as the foundation of this analysis.

School-attending and non-school-attending children

While some studies have described health characteristics of school-attending children (Hall et al., 2008; Standley et al., 2009), few have identified differences between school-attending and non-school-attending children. Differences are likely to exist between school-attending and non-school-attending children, particularly in areas where school attendance is low or variable.

Fentiman et al. (1999) investigated school enrollment patterns in Ghana using a mixed-methods approach that included census data and focus group discussions from three regions (N=19,932). A school-age child was defined as a child between 6 to 15 years of age. The study showed enrollment varied substantially by region and concluded that age of enrollment is highly variable, with children often enrolling later than is recommended. The authors noted that the health of the child was a reason for late or non-enrollment. Non-enrolled children were more likely to be stunted and thin compared to enrolled children. Based on qualitative findings, the study determined that families who did not enroll all school-age children did so because they often needed the child to assist with household chores or work (Fentiman et al., 1999). The mixed-methods approach used by this study and the large sample size make its findings worthy of note.

A subsequent mixed-methods study by Fentiman et al. (2001) carried out in Ghana included 4,708 school-age children. A school-age children was defined as a child between the ages of 6 to

15 years. Quantitative findings indicated non-enrolled primary school children aged 6 to 7 years had significantly higher prevalence of stunting compared to their enrolled peers (51% of non-enrolled stunted vs. 19% of enrolled, $p<0.001$). Results from focus group discussions, revealed that a child's height and perceived lack of cognitive abilities were factors for late or non-enrollment. Additionally, non-enrolled boys were significantly more likely to be infected with *Schistosoma haematobium* and be anemic compared to enrolled boys. Of particular note, qualitative findings suggested that the primary livelihood activity practiced by the household, educational status of the child's caretakers and ownership of material items (e.g. proxies for wealth) influenced school enrollment (Fentiman et al., 2001). Similar to previous results found among school-age children in Ghana, this study provides further evidence of differences between school-attending and non-school-attending children, particularly related to health status and SES.

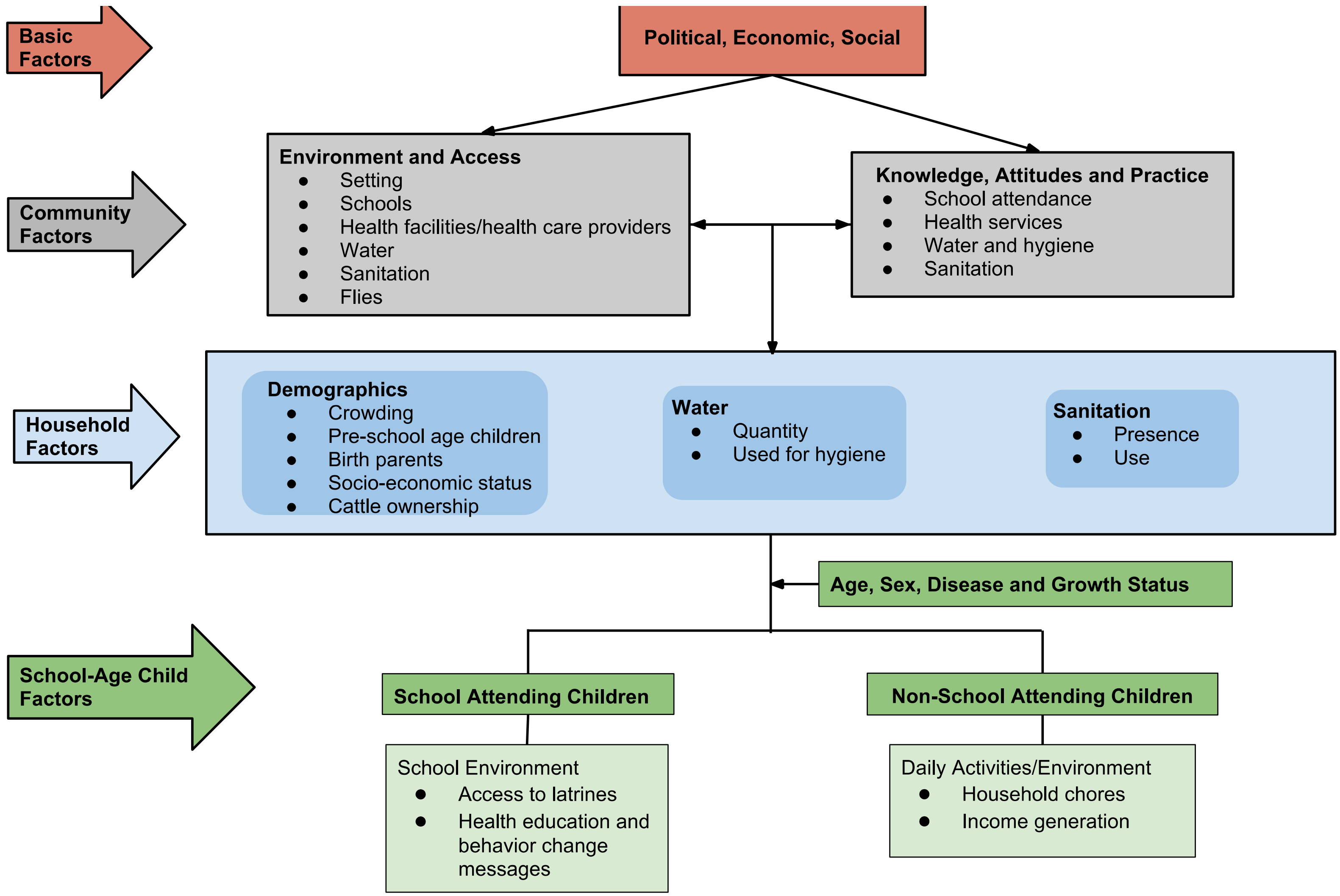
Montresor et al. (2001) conducted a cross-sectional survey in Tanzania to examine patterns of enrollment and presence of STH infection among 1,056 school-age children. A school-age child was defined as a child between the ages of 7 to 14 years. It is important to note that this study was carried out after the implementation of a National Helminth Control Program that provided school children with mebendazole 500 mg three times annually. Stool samples were collected from 517 enrolled and non-enrolled children residing in different households. The results demonstrated that non-enrolled children had two-times the proportion of heavy intensity infections of STH compared to enrolled children, which indicated the school-based national control program had been effective in reducing prevalence of infection among enrolled school children. Additional results showed that neither higher SES nor education of the mother was associated with higher rates of school enrollment. Interestingly, 65% of non-enrolled children had at least one enrolled sibling, which suggested that enrolled children could share educational health messages with non-enrolled siblings (Montresor et al., 2001b).

A study conducted in Egypt examined schistosomiasis infection and knowledge and practices related to disease transmission among children enrolled and not enrolled in school. A school-based national schistosomiasis control program has been implemented in Egypt. This study used a mixed-methods approach, and included a sample of 58 enrolled children, aged 12 to 13 years, and 41 non-enrolled children of the same age. The study was intentionally conducted in an area where school enrollment was known to be low, about 38%. Knowledge of schistosomiasis transmission was high for both groups (91.4% for enrolled and 100% of non-enrolled), but enrolled students were significantly more likely to be aware of complications due to schistosomiasis. School-enrolled children also believed acquisition of infection could be personally controlled, while non-enrolled children were more likely to believe infection was beyond their control. No differences in infection of *S. mansoni* were detected between the two groups. The study observed non-enrolled children were more likely to have illiterate mothers ($p<0.05$) (Mekheimar & Talaat, 2005). While this study used a small sample size derived from one community, its findings align with previous studies that investigated school-attending and non-school-attending children, and provide further evidence of differences between the two groups.

Results from trachoma assessments conducted in Ethiopia and Mali reported the prevalence of TF among school-attending children to be less than half of that compared to their non-school-attending peers, adjusting for age, sex and clustering (OR=0.64, 95% CI: 0.56-0.73; OR=0.67, 95% CI: 0.56-0.80, respectively), even after implementation of the full SAFE strategies in both study areas (King et al., at review). These results provide evidence of differing trachoma prevalence between school-attending and non-school-attending children, and resonate with evidence from previous studies that showed non-school-attending children to have higher prevalence of infection.

Given the ways in which trachoma is transmitted, it follows that school-attending and non-school-attending children in Ethiopia are likely to differ in regards to trachoma risk factors. A summary of trachoma risk factors, the levels at which they operate and how they may influence school-age children is presented in a conceptual framework below (Figure 3). An analysis focusing on the individual characteristics and household factors among school-attending and non-school-attending children situated within the context of a trachoma control program follows.

Figure 3. Conceptual framework of trachoma risk factors and manifestations for school-age children.



CHAPTER 3: MANUSCRIPT

Knowing the Target for NTD Programs: Identifying Systematic Differences between School-Attending and Non-School-Attending Children in Amhara Region, Ethiopia

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Short title: Systematic Differences between School-Age Children

Contribution of student

I was involved in the development of the questionnaire for the school-age child study. I traveled to Amhara, Ethiopia prior to the beginning of the survey to assist in the training of field workers and formatting the study tools. Specifically, I designed and carried out training on collecting anthropometric measurements for eight laboratory technicians. During the training period, I also assisted in formatting all survey tools for electronic data collection using Android tablets and helped to supervise pilot-testing of the survey protocol. During the data collection process, I supervised field teams and collaborated with field supervisors to download data from the tablets and review the data for entry errors. After completion of the survey, I analyzed the results with guidance from Jonathan King. I drafted the manuscript, including the figures and tables, which all co-authors edited.

Abstract

Background: School-age children are often targeted by neglected tropical disease (NTD) programs. In areas where school attendance is low, the population of school-age children may not be homogeneous, with differences between school-attending and non-school-attending children. We aimed to identify whether systematic differences between school-attending and non-school-attending children exist in Amhara National Regional State in Ethiopia, where school attendance is approximately 60%.

Methods: We conducted a cross-sectional, cluster random survey of school-age children aged 6-15 years. Potential differences between school and non-school children recorded were: demographics, trachoma clinical signs and intestinal parasitic infections, anthropometric measurements, knowledge and behaviors regarding trachoma control and hygiene activities and household characteristics. Stool specimens were collected.

Principal Findings: 2,711 school-age children were recruited of whom 2,468 (91.0%) from 106 communities in 20 districts provided assent and all data. Reported school attendance was 58.5% (95% confidence interval (CI): 54.5-62.4). School-attending children were older (odds ratio (OR)=1.42, 95% CI: 1.33-1.51), more likely to be female (OR=1.42, 95% CI: 1.15-1.76), live with their birth parents (OR=2.49, 95% CI: 1.30-4.77), present with less trachomatous inflammation-follicular (TF; OR=0.55, 95% CI: 0.37-0.81), have lower body-mass-index-for age (OR=1.86, 95% CI: 1.36-2.55), reside in households with higher socio-economic status (OR=1.94, 95% CI: 1.46-2.56), have heard about trachoma (OR=3.87, 95% CI: 2.70-5.54), report more frequent face washing (OR=2.74, 95% CI: 1.76-4.25), hand washing after defecation (OR=3.49, 95% CI: 2.16-5.64) and latrine use (OR=2.29, 95% CI: 1.80-2.92). Adjusting for age and sex, there were no significant differences in presentation of TF or intestinal parasitic infections between school-attending and non-school-attending children.

Conclusions: Systematic differences exist between school-attending and non-school-attending children. Control strategies for NTDs should include interventions specifically targeted to school-attending and non-school-attending children, as they are different populations and consequently require unique approaches to maximize coverage to each group.

Introduction

Surveys and control strategies for several neglected tropical diseases (NTDs) often target the population of school-age children [1-4]. School-age children, aged 6 to 15 years, bear a high prevalence of disease and have the potential to recover from NTDs, such as active trachoma (characterized by trachomatous inflammation-follicular [TF]; trachomatous inflammation-intense [TI]; or TF and TI), soil-transmitted helminths (STH; hookworm, *Ascaris lumbricoides* and *Trichuris trichiura*) and schistosomiasis, before developing chronic and irreversible disabilities [5-7]. While school-age children represent a well-defined target, the group is composed of both school-attending and non-school-attending children, and may not be homogeneous or assembled in schools. Evidence suggests school-attending children may be systematically different from non-school-attending children, meaning they may have unique underlying characteristics that differ from their non-school-attending peers [8-10]. Consequently, school-attending and non-school-attending children may require different NTD control activities in order to maximize coverage of interventions to the population of school-age children [11].

While several studies have investigated the health of school-attending children [12,13], few published studies have examined differences between school-attending and non-school-attending children. A study of school-enrolled and non-enrolled children in Zanzibar found that non-enrolled children had twice the proportion of heavy intensity infections of STH compared to enrolled children after implementation of a national school-based deworming program. Further findings revealed that enrollment was not associated with socio-economic status (SES) [8]. Similarly, evidence from Ghana showed that non-enrolled children had higher prevalence of stunting and infection with *Schistosoma haematobium* compared to enrolled children, and that they were more likely to reside in poorer households [9,10]. Studies conducted in Ethiopia and Mali observed the prevalence of TF among school-attending children was significantly less than that for their non-school-attending peers, after adjusting for age, sex and clustering (odds ratio (OR) = 0.64, 95% confidence interval (CI): 0.56-0.73; OR=0.67, 95% CI: 0.56-0.80, respectively) [14].

Differences between school-attending and non-school-attending children have implications for NTD control strategies that require multi-pronged approaches. For example, where trachoma is endemic, the World Health Organization (WHO) endorses the SAFE strategy to control disease, which includes: Surgery for trichiasis, Antibiotic distribution to treat infection, Facial cleanliness and Environmental improvements to reduce transmission [15]. Community-based mass drug administration (MDA) and school-based health education to promote behavior change have been utilized to implement the A, F and E components of SAFE. Annual MDA reduces prevalence of trachoma infection in endemic communities [16], but, when combined with implementation of the F and E factors, the effects are additive, with increased independent effects of each component [17]. Increasingly, school-based strategies have been promoted to specifically target school-age children for NTD control and elimination programs. Schools offer a convenient, established platform that allow access to children from multiple communities and offer perceived cost savings for intervention programs [1,2,4,18].

For trachoma control, schools offer the potential to integrate the F and E factors of the SAFE strategy into school-health curricula to promote awareness and behaviors that interrupt disease transmission [4]. However, such school-based approaches may not extend coverage to non-school-attending children who may be at increased risk of disease [11,19,20]. In the absence of robust community-based health education programs that reach all community members, non-school-attending children may be unable to access control activities, particularly those related to the F and E factors of SAFE.

This cross-sectional study aimed to identify systematic differences between school-attending and non-school-attending children in 20 districts of two zones in the Amhara National Regional State of Ethiopia after five years of implementation of the full SAFE strategy, including five rounds of MDA. School-age child factors related to demographics, disease status of TF and intestinal parasitic infections, including STH, *Schistosomiasis mansoni*, cestodes, *Giardia lamblia* and *Entamoeba histolytica/dispar*, growth status, knowledge and behaviors related to the A, F and E components of SAFE and household characteristics were examined. Such findings are critical to inform program modifications in order to maximize coverage of NTD control programs for both school-attending and non-school-attending children to reduce the prevalence of disease in endemic areas.

Methods

Study area and sampling

The study was nested in an integrated trachoma control impact assessment that was conducted in the zones of North Gondar and West Gojam in the Amhara region in May-July 2012 (school was in session until the beginning of July when the rainy season began). The assessment aimed to estimate the district-level prevalence of trachoma clinical signs and the uptake of SAFE interventions. A total of 209 clusters were surveyed for the integrated trachoma impact assessment of which 106 were selected for the additional school-age child study. The surveys were targeted to *woredas* (districts) that had received at least five years of SAFE interventions, including five rounds of MDA with azithromycin.

The sample size was calculated to determine the prevalence of intestinal parasitic infections among school-age children. At the 0.05 significance level, we assumed a prevalence of 25% STH infection and a design effect of 4.0. We estimated a sample size of 1,181 children per zone was needed.

Multi-stage cluster random sampling was used. In the first stage, clusters, defined by a single *gott* (administrative unit comparable to a village) were selected from a geographically ordered list of all *gotts* using probability proportional to population size. The number of *gotts* selected per *woreda* was proportional to the population size of the *woreda*. In the second stage, defined segments of approximately 40 households per *gott* were randomly selected by the field team upon arrival in the *gott* with the assistance of a *gott* leader or representative. To select the segment, field teams enumerated a list of equally sized segments and blindly picked the name of a segment from a hat [21]. In the final stage, one child, aged 6 to 15 years, was randomly selected from each household. The child was selected by the electronic data collection tool, a Samsung Galaxy tablet using the platform Swift Insights (Swift Insights, The Carter Center, Atlanta, GA, USA), which was programmed to randomly select a child aged 6 to 15 years from a list of all household members that was entered into the tablet at each household. If the selected child was not present, then the field team notified the household members to inform the child upon his/her return that he/she had been selected to participate in the survey and to find the field team in the *gott* if the child wished to participate in the survey.

Study tools and data collection

Questionnaires were translated into Amharic and formatted for electronic data collection in Amharic using Swift Insights. Data recorders received eight days of training to learn to use the tablets and to administer questionnaires following a standardized protocol. Data recorders pilot-tested questionnaires and tablets in non-survey clusters to ensure quality and standardization of interviews and translation, as well as the functionality and usability of individual tablets.

Trachoma graders were trained for one week, and were required to pass a written exam identifying trachoma clinical signs on a set of 50 slides and to also pass a field-reliability exam. For the field-exam, inter-observer reliability was assessed using an ophthalmologist as the gold standard grader. Graders achieving at least 84% agreement with TF and a κ of 0.7 were eligible to participate in a survey team. Graders used 2.5x binocular magnification loops and appropriate light for screening. Individuals presenting signs of active trachoma (TF and/or TI) were offered treatment with 1% tetracycline eye ointment.

An interview with a household representative over the age of 15 years was conducted at each selected household to gather information on SES, access to and use of water and sanitation, as well as hygiene practices. Latrine presence and use, roof material construction and whether cattle were kept near the house were verified by observation by the data recorders. Trained trachoma graders screened all present household members for clinical signs of trachoma using the WHO simplified trachoma grading system [22].

Selected school-age children were interviewed and data were recorded on: age, sex, living with birth parents, whether they attended school regularly, caring for younger siblings, trachoma knowledge, hygiene practices and location where last defecated. The data recorder observed whether the respondent was wearing shoes and, if applicable, whether they were closed or open.

The height, weight and mid-upper arm circumference (MUAC) of each child were measured by trained laboratory technicians in accordance with WHO methods [23,24]. Children were measured barefoot and with light clothing at their household. Standing height was collected to the nearest 0.1cm using Seca 213 portable stadiometers (Seca GmbH & Co. KG, Hamburg, Germany). Weight was measured to the nearest 0.1kg using Seca 803 or Seca 869 electronic scales placed on a flat surface. MUAC was measured to 0.1cm precision using non-stretch MUAC tapes.

Each child was asked to provide a stool sample specimen and offered a single oral dose of 400mg albendazole regardless of whether a stool sample was provided. Stool specimens of approximately 1.0g were collected and preserved in 10mL sodium acetate-acetic acid-formalin. The stool specimen was labeled with a barcode, which was scanned using Swift Insights and linked with the child’s questionnaire. Stool specimens were processed using a standardized concentration technique at the Bahir Dar Regional Laboratory in the West Gojam zone of

Amhara region. Specimens were assessed for the presence and quantity of eggs (up to 100 eggs per gram of feces) for STH, *S. mansoni* and protozoan cysts [25,26].

Quality control and statistical analysis

Data were stored on tablets and downloaded to password-protected computers by field supervisors every two to five days. Data on individual school-age children were linked to the child's household interview and household census using the child's unique identifier and household serial number that were automatically generated by Swift Insights. Where a unique identifier was missing or had been duplicated in the school-age child interview data due to a data entry error, the child's name, age and sex were matched to records in the household census from which the unique identifier could be ascertained. If it was not possible to match the child's name, age and sex to identify the unique identifier, the child was excluded from the analysis.

Statistical analysis was conducted using multiple software programs. A household SES index was created using STATA version 12.0 (STATA Corporation, College Station, TX, USA). To calculate the index, a factor analysis was performed, which included nine characteristics from the household and school-age child interviews: ownership of a radio, television, mobile phone, electricity, cattle, a roof made of stick and mud or corrugated metal, any household member with a college education, private piped water into the yard of the household and the school-age child wearing close-toed shoes. The index generated a weighted sum of the variables and distributed them into categories of SES [27]. SUDAAN version 10.0 (Research Triangle Institute, Research Triangle Park, NC, USA) was used to conduct univariate analysis with logistic regression to evaluate unadjusted associations between school attendance and characteristics related to demographics, disease status, growth status, knowledge and behaviors related to the A, F and E components of SAFE and household factors. SUDAAN was used to account for variation between clusters due to the sampling design. Separate logistic regression models for TF, hookworm, *A. lumbricoides*, *T. trichiura*, *S. mansoni*, *G. lamblia* and *E. histolytica/dispar* were built, adjusting for age and sex. The WHO Anthro Plus SAS macro (WHO Anthro Plus version 3.2.2, 2011) was used with SAS version 9.3 (Cary, NC, USA) to analyze anthropometric measurements using the WHO Reference 2007 for boys and girls aged 5 to 19 years. Reported age in years was converted to months, and height-for-age and body-mass-index (BMI)-for-age Z-scores were calculated. Children with height-for-age or BMI-for-age Z-score values less than -2 standard deviations were defined as stunted or thin, respectively.

Ethics statement

This study was approved by the Institutional Review Board of Emory University (Protocol #079-2006) and by the Amhara National Regional State Health Bureau Ethical Review Committee. Permission to obtain verbal informed consent and verbal assent was granted by the review boards due to the high rate of illiteracy among the study population. Confirmation of verbal consent and assent was recorded using Swift Insights. Verbal informed consent to conduct the study in the selected *gotts* was obtained from zonal and *woreda* health officers, as well as *gott* leaders or designated representatives. Verbal informed consent was obtained from household members who were interviewed and all household members who were screened for trachoma. Both verbal informed consent from parents/caregivers and verbal assent from school-age children were obtained before conducting interviews and collecting anthropometric measurements and stool sample specimens.

Results

In total, 2,711 school-age children from 106 communities were selected to participate in the study (Figure 1). Among those selected, 2,585 provided assent to participate. However, 117 (4.5% of those selected) assenting children were excluded from the analysis as they had incomplete data identifiers and we were unable to link them to their corresponding household data. A total of 2,468 (91.0% of those selected) school-age children were included in the analysis.

School attendance

Overall, 58.5% (95% CI: 54.5-62.4) of surveyed children reported to attend school (Figure 2). Reported school attendance ranged from 13.3% to 100% in selected *gotts*. School attendance varied significantly by age. Children 6 years of age had the lowest reported school attendance of 6.9% (95% CI: 4.0-11.6). Reported school attendance peaked among children aged 11 and 12 years, with both groups reporting attendance of 81.4% (95% CI: 71.1-88.3 and 74.6-86.7, respectively).

Demographics

Individual school-age child characteristics varied by school attendance (Table 1). Those who reported attending school had a mean age of 10.8 years (95% CI: 10.6-11.0) and were significantly older than children who did not attend school (OR=1.42, 95% CI 1.33-1.51). More girls attended school than boys (OR=1.42, 95% CI: 1.15-1.76). Compared to non-school-attending children, school attendees were significantly more likely to live with their birth parents (OR=2.49, 95% CI: 1.30-4.77). Further differences were found between the two groups regarding younger siblings. School-attending children were 32% (OR=0.68, 95% CI: 0.53-0.87) less likely to have younger siblings aged 0 to 5 years compared with their non-school-attending peers.

Prevalence of TF

Our investigation found a significant difference in the prevalence of TF between school-attending and non-school-attending children (Table 1). Children who reported attending school were 45% less likely to present with TF compared to non-school-attending children (OR=0.55, 95% CI: 0.37-0.81). Prevalence of TF varied by age (Figure 3). Among children under the age of 10 years, 8.9% (95% CI: 6.2-12.7) of school attendees presented with TF compared to 12.0% (95% CI: 9.1-15.8) of non-school attendees. The prevalence of TF decreased with age among both school-attending and non-school-attending children aged 10-15 years. Prevalence of TF in the older age group of school-age children was 3.0% (95% CI: 2.0-4.6) among school attendees and 1.9% (95% CI: 0.9-4.0) among non-school attendees.

Prevalence of intestinal parasitic infections

No significant differences were observed in the prevalence of intestinal parasitic infections between school-attending and non-school-attending children, as shown in Figure 4 (Table 1). Overall, 54.2% (95% CI: 49.5-58.8) of school-age children had at least one STH. Among STH infections, the prevalence of hookworm was highest, infecting 37.0% (95% CI: 32.2-42.1) of the study population. Overall prevalence of *A. lumbricoides* was 24.1% (95% CI: 19.0-29.9), and *T. trichiura* was 1.8% (95% CI: 1.1-2.9). About 11.0% (95% CI: 7.0-16.9) of school-age children had *S. mansoni*, and 15.4% (95% CI: 13.7-17.2) and 10.8% (95% CI: 8.7-13.3) had *G. lamblia* and *E. histolytica/dispar*, respectively.

Growth status

Growth status, as measured by height-for-age and BMI-for-age Z-scores, MUAC and prevalence of stunting and thinness (low BMI-for-age) are shown in Figure 5 (Table 1). School-attending and non-school-attending children had similar mean height-for-age Z-scores of -1.53 (95% CI: -1.66, -1.40) and -1.52 (95% CI: -1.65, -1.40), respectively. Consequently, school-attending and non-school-attending children had the same rate of stunting of 37.7% (95% CI: 34.0-41.6 and 34.1-41.3, respectively). However, school-attending children had a significantly lower mean BMI-for-age Z-scores compared to non-school-attending children (OR=0.85, 95% CI: 0.77-0.95), and school-attending children were significantly more likely to be thin compared to their non-school-attending peers (OR=1.86, 95% CI: 1.36-2.55). School-attending children had a significantly greater MUAC compared to non-school-attending children (OR=1.28, 95% CI: 1.09-1.50).

Knowledge and behaviors related to the A, F and E factors of SAFE

Analysis of the A, F and E components of the SAFE strategy revealed further differences between school-attending and non-school-attending children (Table 2). Among school-attending children, 57.7% (95% CI: 50.0-65.0) reported that they had heard of trachoma compared to only 26.0% (95% CI: 19.8-33.4) of non-school-attending children (OR=3.87, 95% CI: 2.70-5.54). Among those who had heard of trachoma, 76.3% (95% CI: 68.8-82.5) of school-attending children reported they had heard about the disease at school, while 19.7% (95% CI: 11.6-31.3) of non-school-attending children had heard about it from school (OR=13.13, 95% CI: 6.52-26.41). Overall, few children had heard about trachoma from a school child, a health extension worker or the mass media (26.1%, 95% CI: 19.4-34.0; 7.3%, 95% CI: 5.2-10.0; 18.4%, 95% CI: 12.3-26.6, respectively). Significantly more school-attending children reported hearing about trachoma from mass media compared to non-school-attending children (OR=5.02, 95% CI: 2.23-11.30), but significant differences between the two groups were not observed among those reporting to have heard about trachoma from a school child or a health extension worker.

School-attending children were also significantly more likely to report knowing at least one A, F or E component of the SAFE strategy (OR=3.79, 95% CI: 2.67-5.38; Table 2). Among school-age children who knew at least one A, F or E factor, 62.3% (95% CI: 55.7-68.4) reported knowing about the A component. Overall, 24.8% (95% CI: 18.5-32.4) of school-age children knew using pit latrines could prevent trachoma, but there was no significant difference in the proportion of school-attending and non-school-attending children who knew of the practice. However, school-attending children were significantly more likely to know that face washing and keeping a clean environment could prevent trachoma (OR=2.41, 95% CI: 1.64-3.54; OR=2.09, 95% CI: 1.27-3.42, respectively).

The data on behaviors related to the A, F and E factors (Table 2) indicate that school-attending children were more likely to report taking azithromycin during at least four out of five rounds of MDA (OR=1.38, 95% CI: 1.05-1.81). School-attending children were significantly more likely to report washing their faces at least once per day (OR=2.74, 95% CI: 1.76-4.25) and to report washing their hands with water or with water and soap after their last defecation (OR=3.49, 95%

CI: 2.16-5.64). For the E component of SAFE, 47.8% (95% CI: 40.1-55.5) of school-attending children reported last defecating in a latrine, while only 28.5% (95% CI: 22.1-35.9) of non-school-attending children reported this behavior (OR=2.29, 95% CI: 1.80-2.92). Restricting the sample to only those school-age children who had a latrine at their household (N=1,059), 90.0% (95% CI: 85.8-93.1) of school-attending children and 67.5% (95% CI: 59.2-74.8) of non-school-attending children reported last defecating in a latrine.

Household characteristics

Nine variables were used to create a household SES index (Table 3). Among the variables used to create the index, school-attending children were significantly more likely to live in a household with a radio, a television, a mobile phone, a non-thatch roof, a college-educated household member, private piped water into the yard and wearing close-toed shoes compared to non-school-attending children. The index classified households as "poor" or "less poor." About 31.7% (95% CI: 26.4-37.5) of school-attending children lived in a "less poor" household compared to 19.3% (95% CI: 15.9-23.3) of non-school-attending children (OR=1.94, 95% CI: 1.46-2.56). Slightly less than one-half of all study households had a latrine, but school-attending children were significantly more likely to live in a house with a latrine compared to non-school-attending children (OR=1.52, 95% CI: 1.16-1.98).

Association between school attendance and disease status adjusted for age and sex

Adjusting for age and sex, there were no significant differences in prevalence of TF between school-attending and non-school-attending children (Table 4). Similarly, there were no significant differences between school-attending and non-school-attending children regarding infection with hookworm, *A. lumbricoides*, *T. trichiura*, *S. mansoni*, *G. lamblia* and *E. histolytica/dispar*, adjusting for age and sex (Table 4).

Discussion

This study identified significant differences between school-attending and non-school-attending children. This suggests the two groups may be systematically different and unique approaches must be applied to effectively reach each group when conducting prevalence surveys for NTDs, as well as implementing control strategies. School attendance varied by cluster, and overall only slightly more than half of our study population reported to regularly attend school. Of critical importance, differences in demographics between school-attending and non-school-attending children were observed, as school-attending children were significantly older, female, reported living with their birth parents and had a lower proportion of siblings under the age of 5 years.

Notably, the likelihood of school-attending children presenting with TF was almost half of that compared to their non-school-attending peers when unadjusted, but this association was not significant after adjusting for age and sex. Still, using schools as a platform to conduct prevalence assessments would under-estimate the community prevalence of TF by almost half. Caution may be required when generalizing estimates of disease, as well as demographics derived from school-based surveys to the entire population of school-age children residing in a community.

Although mass chemotherapy distribution for intestinal parasitic infections occurs periodically in the Amhara region, the prevalence of STH infection was high (54.2%) among our study population. Our estimates were higher than those observed in a national health survey of

Ethiopian school children, which estimated overall infection with hookworm and any STH to be 7.7% and 29.8%, respectively [12]. However, a study conducted in one district in North Gondar zone, Amhara region estimated prevalence of STH and *S. mansoni* similar to that observed in our study population [28]. Our findings suggest that school-age children in North Gondar and West Gojam zones in Amhara region may be disproportionately infected with STH and *S. mansoni* compared to school children nationally. According to the WHO guidelines, mass chemotherapy distribution for intestinal helminth infection is warranted [29].

At 37.7% (95% CI: 34.8-40.7) and 16.8% (95% CI: 14.9-18.9) the prevalence of stunting and thinness among our study population was higher than national estimates for Ethiopian school children [12]. A study conducted among school children in Gondar Town, North Gondar zone (an area included in our study) reported the prevalence of stunting among children aged 6 to 14 years to be 27% [30], which is higher than estimates from the national health survey (22.9%) [12], but lower than results from our study. Of note, our findings showed that school-attending children were more likely to be thin compared to non-school-attending children. This difference may be explained by changes associated with puberty that would primarily affect the older, school-attending children in our study population [12]. Further, our study was conducted during the rainy season at which time most people are engaged in farming and food is relatively scarce. Additionally, determining the prevalence of stunting requires age data, which may be inaccurately reported and cause estimates to be under- or over-estimated.

Overall, school-attending children were more likely to report higher awareness and uptake of the A, F and E components of the SAFE strategy. Less than half of the study population reported taking azithromycin during at least four out of five rounds of MDA. This suggests that children, particularly non-school-attending children may be absent from their homes during community-based MDA campaigns or may not be aware of the timing of the campaigns. However, it is important to note that annual MDA in the Amhara region aims to cover 80% of the population. The probability of a school-age child having taken azithromycin during all five rounds of MDA is about 32.8%. Therefore, our findings indicate high coverage of MDA in both groups of school-age children. This contrasts the finding of knowledge the A component of SAFE, which was 62.3% (95% CI: 55.7-68.4). It is possible that the children genuinely do not associate azithromycin MDA with trachoma control, although the low response may be due to the way in which the question was asked. Still, approaches to ensure both school-attending and non-school-attending children receive annual azithromycin doses are critical to interrupting disease transmission [16].

Our findings suggest efforts to promote the F and E components of SAFE are occurring at schools because school-attending children reported significantly higher awareness and practice of F and E activities compared to non-school-attending children. While overall reported practice of face washing at least once per day was high among school-attending and non-school-attending children, reported hand washing after defecation was low overall, suggesting the need for more effective behavior change strategies to promote the behavior. Regarding the E component of SAFE, reported knowledge of using latrines to prevent trachoma was lowest compared to A and F factors. However, among the school-age children with latrines present at their households, the majority reported to have last defecated in a latrine, suggesting willingness to use latrines if they are available.

Further, our findings showed school-attending children were more likely to live in a household with a higher SES compared to non-school-attending children. Similarly, studies conducted among enrolled and non-enrolled school-age children in Ghana observed that livelihood, education status of parents and ownership of material items (used as proxies for wealth) influenced school enrollment [9,10]. However, this finding was not corroborated in a study conducted in Zanzibar, which concluded that SES was not associated with school enrollment [8]. Discrepancies in this finding between our study and others may be due to the way in which household SES was measured using proxies for wealth, and the relationship between household SES and school attendance may be influenced by the local context.

A primary limitation of this study is the use of self-reported data. The outcome, school attendance, was self-reported, and it was not verified against school enrollment records, although it is plausible that self-reports of whether a child "usually" attended school would be more accurate than enrollment records. Self-reported individual and household characteristics were not verified by observation, with the exception of roof material construction, latrine presence and use, presence of cattle and whether the child was wearing shoes. Self-reported measures may have been under- or over-estimated, especially those that asked respondents about behaviors. In such instances, respondents may have indicated that they practiced a behavior because they understood it was positive, but they may not have actually engaged in the practice. However, recognizing positive hygiene behavior may be an important first step that will lead to practice of the behavior.

Although schools offer a convenient platform to conduct prevalence surveys and control activities, in areas where school attendance is low, they effectively miss a portion of the target of school-age children: the non-school-attending children. School-based surveys have the potential to underestimate the prevalence of diseases such as trachoma, and they should not generalize the characteristics of school-attending children to the broader population of school-age children. School-based control programs appear to be effective in educating students about trachoma and promoting behavior change, but alternative methods to promote health education and trachoma control activities among non-school-attending children are required. This will become more critical as communities reach the goal of <5% TF prevalence in children aged 1 to 9 years and stop MDA [15]. Promotion and practice of the F and E interventions will need to continue in order to prevent an increase in TF after MDA is stopped. Future studies that investigate feasible and effective approaches to reach non-school-attending children in areas where school attendance is low are needed to provide insight into strategic ways to deliver health education messages and promote behavior change around the F and E factors of SAFE to ensure that both school-attending and non-school-attending children learn about and adopt methods to prevent trachoma.

Authors' contributions: AEPS, JDK, PME designed the study. AEPS, JDK, BM, TT, TE, ES, MZ, DG coordinated data collection. AEPS, JDK analyzed the data. AEPS, JDK, CLM, PME interpreted the results. All authors drafted and approved the final manuscript.

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Conflicts of interest: None declared.

Ethical approval: This study was approved by the Institutional Review Board of Emory University (Protocol #079-2006) and by the Amhara National Regional State Health Bureau Ethical Review Committee. Permission to obtain verbal informed consent and verbal assent was granted by the review boards due to the high rate of illiteracy among the study population. Confirmation of verbal consent and assent was recorded using Swift Insights. Verbal informed consent to conduct the study in the selected *gotts* was obtained from zonal and *woreda* health officers, as well as *gott* leaders or designated representatives. Verbal informed consent was obtained from household members who were interviewed and all household members who were screened for trachoma. Both verbal informed consent from parents/caregivers and verbal assent from school-age children were obtained before conducting interviews and collecting anthropometric measurements and stool sample specimens.

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Tables and figures

Table 1. Distribution and Unadjusted Univariate Analysis of Demographics, Disease Status and Growth Status among School-Age Child by School Attendance (N=2,468).

	Overall		School-Attending		Non-School-Attending				
Demographic		**95% CI**		**95% CI**		**95% CI**	**OR**	**95% CI**	**P-value**
Age, years, mean	9.8	9.6-10.0	10.8	10.6-11.0	8.4	8.2-8.7	**1.42**	**1.33 -1.51**	**<0.0001**
Female, %	54.2	51.8-56.5	57.8	54.6-60.9	49.1	45.1-53.1	**1.42**	**1.15-1.76**	**0.001**
Live with birth parents, %	97.6	96.6-98.4	98.5	97.6-99.1	96.4	94.3-97.7	**2.49**	**1.30-4.77**	**0.006**
Siblings aged 0-5 years, %	80.6	78.2-82.7	78.1	75.0-80.9	84.0	81.0-86.7	**0.68**	**0.53-0.87**	**0.002**
Disease Status									
TF* prevalence, %	6.9	5.4-8.6	5.2	3.8-7.2	9.2	6.9-12.0	**0.55**	**0.37-0.81**	**0.003**
Any soil-transmitted helminth, %	54.2	49.5-58.8	55.8	50.4-61.0	52.0	46.2-57.7	1.17	0.92-1.48	0.20
Hookworm, %	37.0	32.2-42.1	37.9	32.1-44.0	35.8	30.3-41.7	1.09	0.84-1.43	0.51
Ascaris lumbricoides, %	24.1	19.0-29.9	25.5	19.9-32.0	22.1	16.8-28.4	1.21	0.91-1.60	0.20
Trichuris trichiura, %	1.8	1.1-2.9	2.1	1.1-3.7	1.4	0.7-2.7	1.47	0.64-3.33	0.36
Schistosoma mansoni, %	11.0	7.0-16.9	10.8	6.5-17.5	11.3	7.3-17.1	0.95	0.66-1.35	0.76
Giardia lamblia, %	15.4	13.7-17.2	15.2	12.8-18.0	15.6	13.3-18.2	0.97	0.74-1.29	0.86
Entamoeba histolytica/dispar, %	10.8	8.7-13.3	10.8	8.4-13.8	10.7	8.1-14.0	1.01	0.73-1.40	0.95
Growth Status									
Height-for-age Z score, mean	-1.5	-1.63, -1.42	-1.5	-1.66, -1.40	-1.5	-1.65, -1.40	1.00	0.94-1.06	0.94
BMI^-for-age Z score, mean	-1.0	-1.05, -1.86	-1.1	-1.17, -0.93	-0.8	-0.94, -0.70	**0.85**	**0.77-0.95**	**0.004**
MUAC,[§] cm, mean	16.2	16.0-16.4	16.6	16.4-16.8	15.5	15.2-15.8	**1.28**	**1.09-1.50**	**0.003**
Stunting, %	37.7	34.8-40.7	37.7	34.0-41.6	37.7	34.1-41.3	1.00	0.82-1.22	0.99
Thin (low-BMI-for-age), %	16.8	14.9-18.9	20.3	17.5-23.3	12.0	9.5-15.0	**1.86**	**1.36-2.55**	**0.0002**

*Trachomatous inflammation-follicular
^Body-mass-index
§Mid-upper arm circumference

Table 2. Distribution and Unadjusted Univariate Analysis of Knowledge and Behaviors Related to the A, F and E Components of the SAFE Strategy among School-Age Children by School Attendance (N=2,468).

	Overall		**School-Attending**		**Non-School-Attending**				
Knowledge	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**OR**	**95% CI**	**P-value**
Heard about trachoma	44.5	38.4-50.8	57.7	50.0-65.0	26.0	19.8-33.4	**3.87**	**2.70-5.54**	**<0.0001**
Heard about trachoma at school (N=1,148)	62.6	54.6-70.0	76.3	68.8-82.5	19.7	11.6-31.3	**13.13**	**6.52-26.41**	**<0.0001**
Heard about trachoma from school child (N=1,148)	26.1	19.4-34.0	26.5	19.0-35.8	24.6	17.4-33.6	1.11	0.67-1.82	0.68
Heard about trachoma from health extension worker (N=1,148)	7.3	5.2-10.0	7.4	5.2-10.6	6.7	3.3-13.3	1.11	0.49-2.53	0.79
Heard about trachoma from mass media (N=1,148)	18.4	12.3-26.6	22.5	15.3-31.8	5.5	2.4-12.1	**5.02**	**2.23-11.30**	**0.0001**
Know at least one AFE* factor	44.5	37.9-51.2	57.4	49.3-65.1	26.2	20.0-33.5	**3.79**	**2.67-5.38**	**<0.0001**
Know face washing prevents trachoma (N=1,153)	80.4	72.2-86.6	84.2	76.6-89.6	68.8	57.4-78.3	**2.41**	**1.64-3.54**	**<0.0001**
Know antibiotics prevent trachoma (N=1,153)	62.3	55.7-68.4	63.3	56.1-70.0	59.0	49.5-67.8	1.20	0.81-1.79	0.36
Know clean environment prevents trachoma (N=1,153)	36.6	30.9-42.7	40.5	34.3-46.9	24.6	16.2-35.4	**2.09**	**1.27-3.42**	**0.004**
Know using latrines prevents trachoma (N=1,153)	24.8	18.5-32.4	26.6	20.5-33.7	19.1	10.7-31.7	1.53	0.93-2.51	0.09
Reported Behavior									
Took azithromycin ≥ 4 times^	49.6	40.6-58.5	52.9	43.4-62.1	44.9	35.4-54.7	**1.38**	**1.05-1.81**	**0.02**
Wash face									
< 1 time/day	8.9	6.0-13.0	5.5	3.5-8.5	13.7	9.1-20.2	1.00		
≥ 1 time/day	91.9	87.0-94.0	94.5	91.5-96.5	86.3	79.8-91.0	**2.74**	**1.76-4.25**	**<0.0001**
Wash hands after defecation	17.1	12.1-23.4	23.5	16.7-31.9	8.1	4.9-13.0	**3.49**	**2.16-5.64**	**<0.0001**
Last defecated in latrine	39.8	33.0-47.0	47.8	40.1-55.5	28.5	22.1-35.9	**2.29**	**1.80-2.92**	**<0.0001**

* AFE factors refer to components of SAFE (Surgery, Antibiotics, Facial cleanliness, Environmental improvements) strategy.
^Out of 5 possible rounds of mass azithromycin distribution.

Table 3. Household Characteristics and Household Socio-Economic Status Index among School-Age Children by School Attendance (N=2,468).

	Overall		School-Attending		Non-School-Attending				
Characteristic	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**OR**	**95% CI**	**P-value**
Radio ownership	13.0	10.7-15.7	14.5	11.9-17.5	10.8	8.1-14.4	**1.40**	**1.02-1.91**	**0.04**
Television ownership	1.0	0.4-2.7	1.6	0.6-4.3	0.2	0.0-1.2	**10.33**	**1.54-69.40**	**0.02**
Mobile phone ownership	6.4	4.1-9.8	8.7	5.3-14.0	3.1	1.9-5.0	**2.95**	**1.63-5.34**	**0.0005**
Cattle ownership	96.8	91.9-98.8	96.0	87.6-98.8	98.0	96.4-98.9	0.48	0.17-1.32	0.15
Electricity	3.9	1.5-9.6	4.8	1.6-13.6	2.6	1.0-6.6	1.88	0.60-5.88	0.27
Non-thatch roof*	83.2	77.6-87.6	86.3	80.9-90.3	78.9	71.4-84.8	**1.68**	**1.21-2.34**	**0.002**
College-educated HH member^	2.6	1.6-4.1	4.1	2.6-6.6	0.4	0.2-0.9	**10.38**	**4.22-25.56**	**<0.0001**
Piped water into yard	2.1	0.5-8.5	3.0	0.6-12.9	0.7	0.2-3.3	**4.08**	**1.09-15.26**	**0.04**
Child wearing close-toed shoes	10.3	7.6-13.7	13.9	10.2-18.6	5.2	3.3-7.9	**2.95**	**1.91-4.57**	**<0.0001**
Latrine present§	46.5	39.6-53.5	50.8	43.2-58.3	40.5	33.1-48.3	**1.52**	**1.16-1.98**	**0.003**
Household Socio-Economic Status Index									
Less Poor	26.6	22.5-31.0	31.7	26.4-37.5	19.3	15.9-23.3	**1.94**	**1.46-2.56**	**<0.0001**
Poor	73.5	69.0-77.5	68.3	62.5-73.6	80.7	76.8-84.1	1.00		

*Roof made of stick and mud or corrugated metal
^Any household member with college/university education
§Characteristic not included in household socio-economic status index

Table 4. Association between School Attendance and Disease Status Separately, Adjusted for Age and Sex (N=2,468).

Disease	Adjusted OR	95% CI	P-value
TF*	0.96	0.64-1.43	0.83
Hookworm	1.01	0.75-1.36	0.93
Ascaris lumbricoides	1.15	0.83-1.61	0.40
Trichuris trichiura	1.56	0.75-3.25	0.23
Schistosoma mansoni	0.82	0.55-1.21	0.31
Giardia lamblia	1.11	0.84-1.47	0.38
Entamoeba histolytica/dispar	1.06	0.76-1.47	0.74

*Trachomatous inflammation-follicular

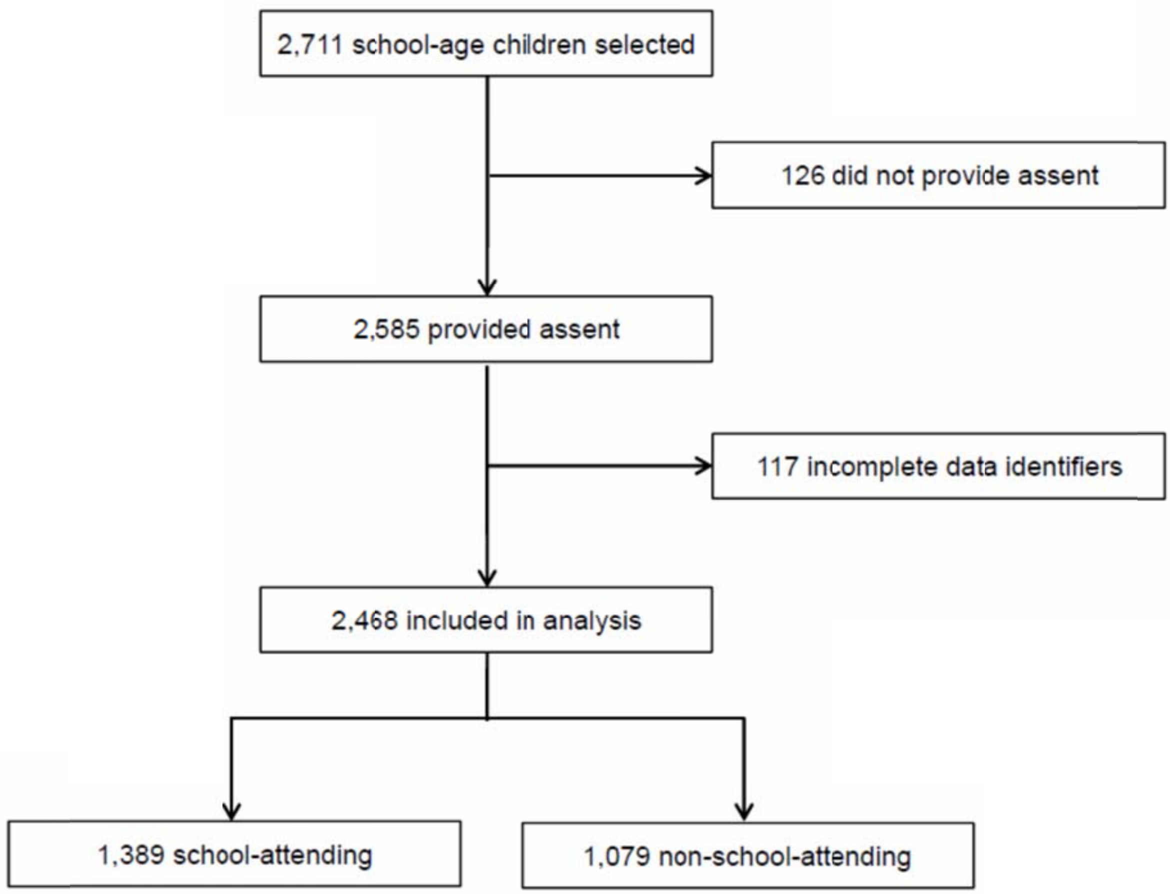

Figure 1. The Study Population, Amhara Region, Ethiopia.

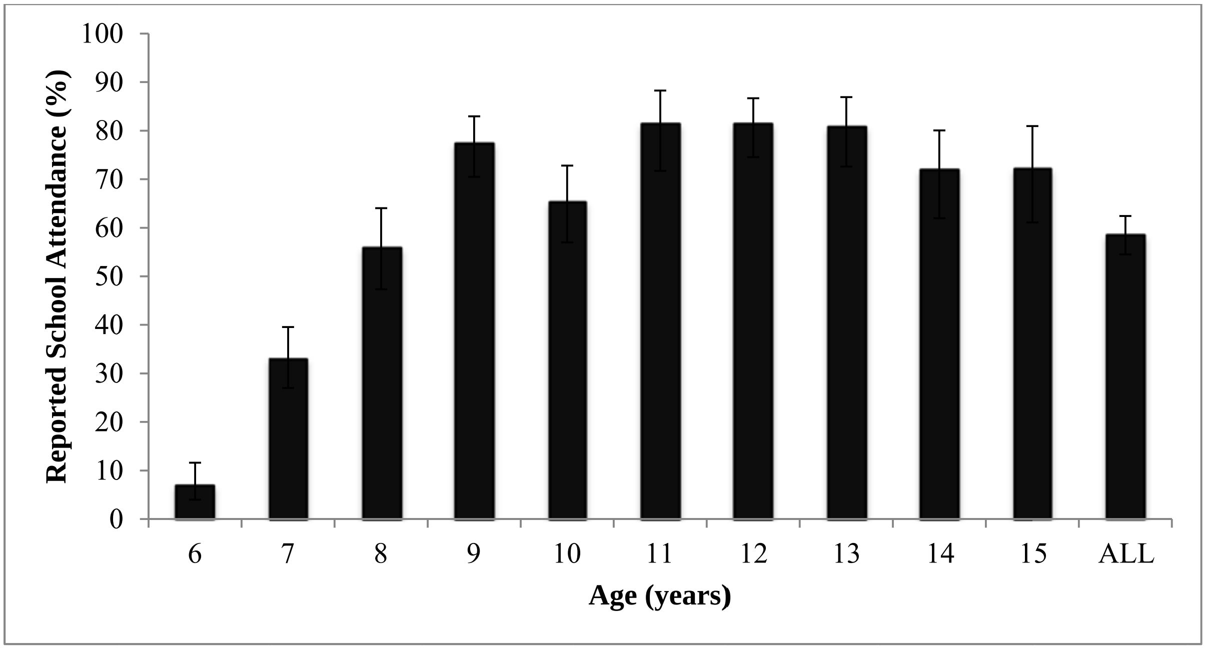

Figure 2. Reported School Attendance by Age among School-Age Children (N=2,468). Frequencies of reported school attendance weighted to account for the sampling design. Error bars represent 95% confidence intervals.

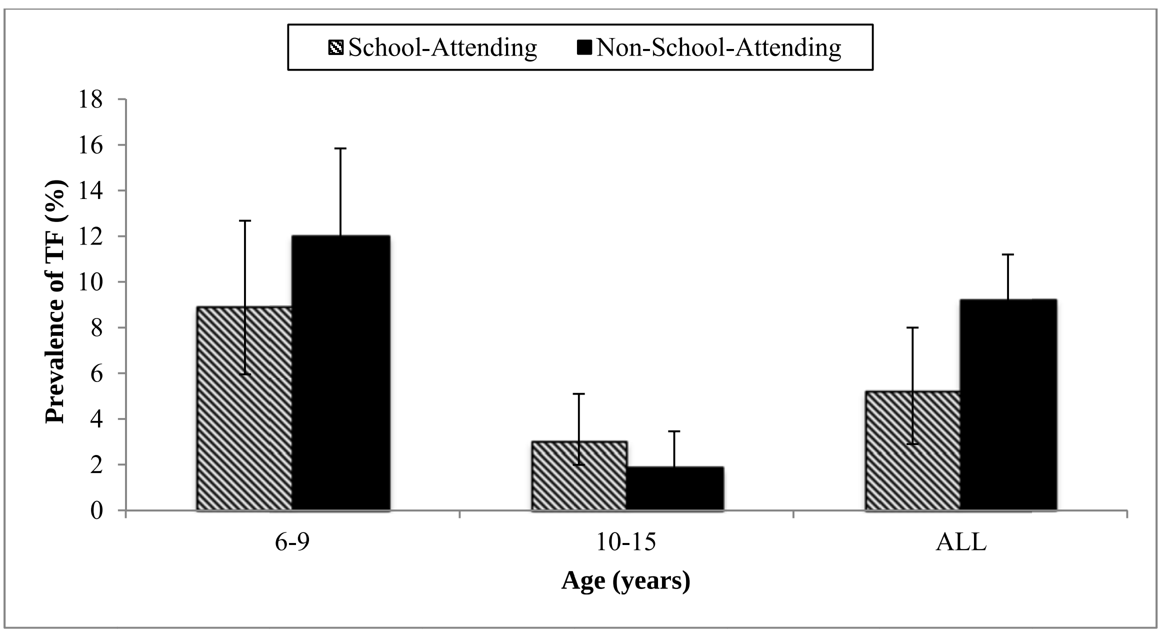

Figure 3. Prevalence of Trachomatous Inflammation-Follicular (TF) by Age Group among School-Age Children (N=2,468). Prevalence estimates presented are weighted to account for sampling design. Error bars represent 95% confidence intervals.

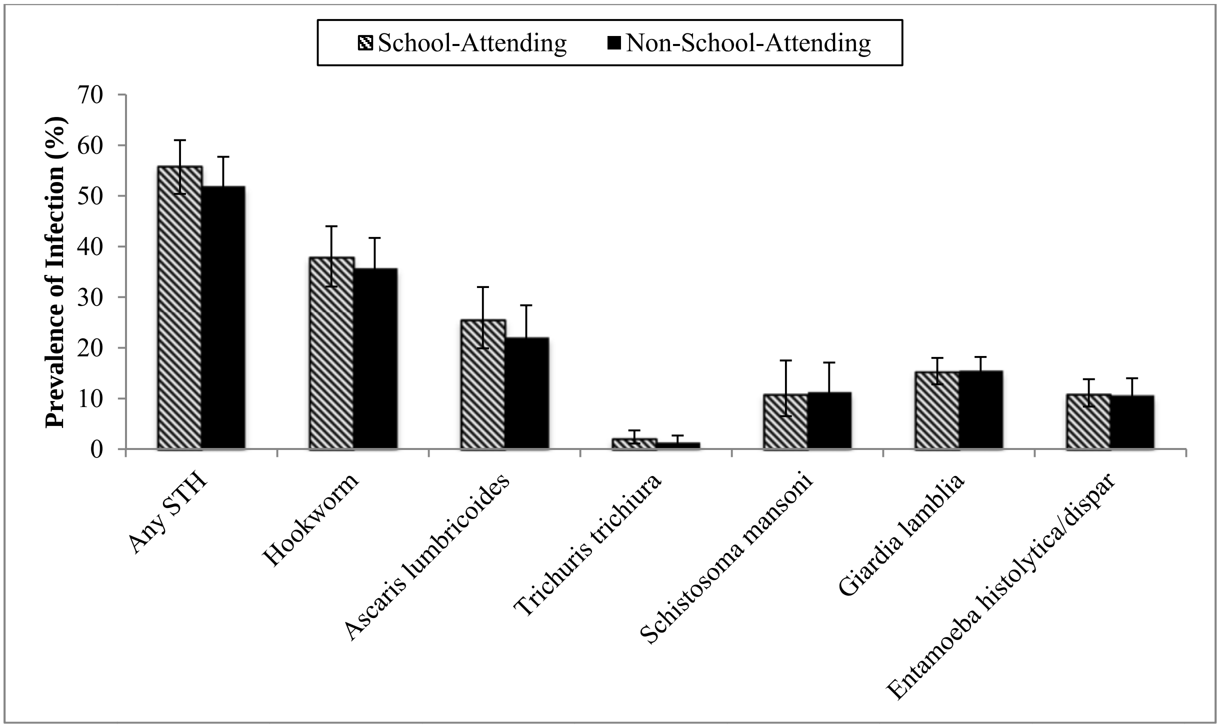

Figure 4. Prevalence of Intestinal Parasitic Infections in School-Age Children (N=2,400). Any STH refers to a child having at least one soil-transmitted helminth. Prevalence is weighted to account for sampling design. Error bars represent 95% confidence intervals

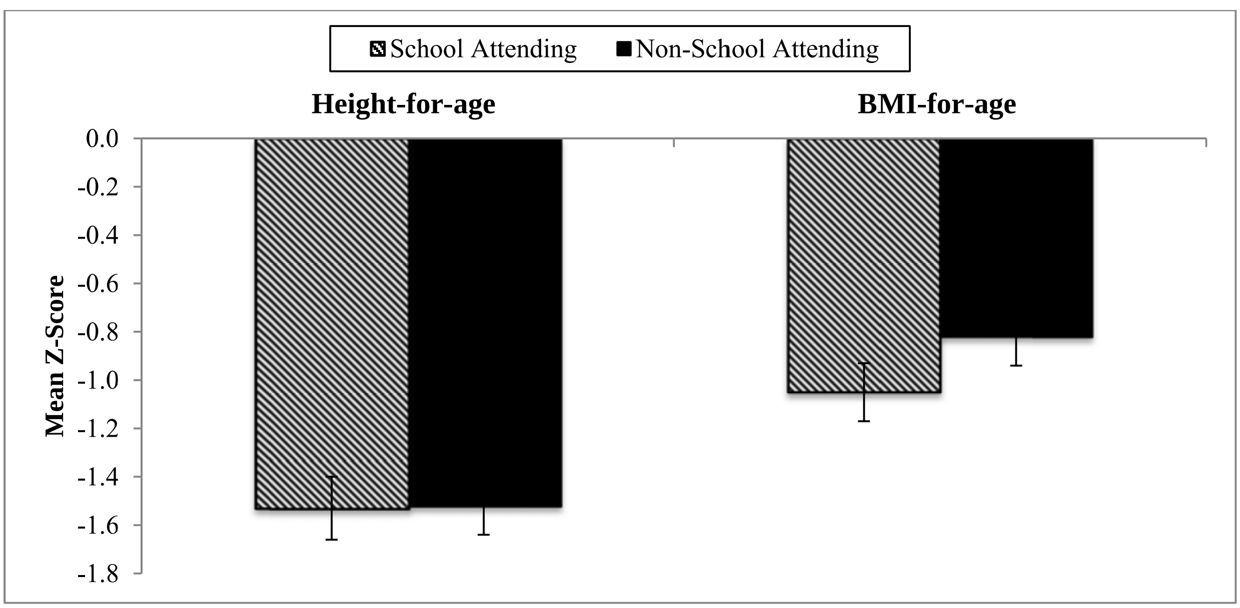

Figure 5. Mean Height-for-Age and Body-Mass-Index (BMI)-for-Age Z-score among School-Age Children (N=2,468). Mean Z-scores calculated using World Health Organization Reference 2007 for boys and girls aged 5 to 19 years. Mean values weighted to account for sampling design. Error bars represent 95% confidence intervals.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

Conclusion

This study provides an important contribution to the field of trachoma, and more broadly NTD control and elimination programs that specifically target school-age children. Understanding the differences between school-attending and non-school-attending children is critical for designing effective interventions that specifically target each group. Although schools offer a convenient platform to conduct prevalence surveys and control activities, particularly in areas where school attendance is low or variable, they miss a portion of the target population school-age children, notably the non-school-attending children. Thus, school-based surveys have the potential to underestimate the prevalence of disease among school-age children if prevalence is lower for school-attendees. School-based surveys also can not extend estimates of individual and household characteristics, such as knowledge and behaviors related to the A, F and E components of SAFE, to the general school-age child population. School-based control programs appear to be effective in educating students about trachoma and promoting behavior change, but alternative methods to promote health education and trachoma control activities for non-school-attending children are required to maximize coverage to both groups.

Ensuring both groups of school-age children are reached with the full SAFE strategy will become critical as prevalence of TF among children aged 1 to 9 years decreases below 5% and MDA is stopped (in accordance with WHO guidelines). In these settings, continuation of the F and E interventions will be imperative to control the prevalence of TF and prevent reinfection. Future studies that investigate feasible and effective approaches to reach non-school-attending children would provide insight into strategic ways to deliver health education and behavior change to ensure that both school-attending and non-school-attending children have the opportunity to receive health education and promotion to adopt behavior changes to prevent transmission and acquisition of trachoma, as well as other NTDs.

Recommendations

Based upon this analysis, recommendations for future studies, intervention modifications and public health implications emerge.

1. Caution about using schools as a platform to conduct prevalence surveys.

This study revealed the presence of differences between school-attending and non-school-attending children. The individual and household characteristics of school-age children are not homogeneous, and school-attending and non-school-attending children are significantly different in several respects. Although schools provide an easily accessible platform to conduct prevalence surveys, it is not appropriate to generalize the estimates to the broader school-age child population. In communities where school attendance is low or variable, school-based surveys will not provide information on non-school-attending children who are a high-risk group. If the goal of a NTD program is to investigate the characteristics of the entire school-age child population, community-based surveys are needed to obtain reliable estimates, and information about non-school-attending children must be collected in order to determine the type of interventions needed to control disease in this group.

2. Further examine relationships between school attendance and trachoma risk factors.

- **Age and caring for young siblings**. In Ethiopia, school-age children, particularly older children, are likely to be responsible for caring for younger siblings. Since children over the age of 10 years had the highest frequency of school attendance, health education messages delivered in schools should encourage older children to help provide good hygiene for their younger siblings. As pre-school age children have the highest bacterial load of *C. trachomatis* infection, improving their facial cleanliness and hygiene is likely to result in decreased prevalence of trachoma.
- **Biological sex**. This analysis revealed that school-attending children were more likely to be female. If male school-age children are less likely to attend school, they may not be exposed to critical health messages about the prevention of trachoma infection. Investigation into the daily activities of male children is warranted to identify effective methods to reach them with SAFE activities.
- **Knowledge of trachoma-related prevention methods and practiced behaviors**. This study relied upon self-reported data to measure knowledge and frequency of hygiene practices. While significant differences were detected in knowledge and reported behaviors between school-attending and non-school-attending children, further investigation, ideally using objective measures to verify behavior, is needed to understand uptake of the A, F and E components of the SAFE strategy.

3. Determine best practices in school-based trachoma control programs.

Investigation of the current practices of school teachers and HEWs who teach health education at schools would provide information on the way in which school-attending children learn about trachoma, as well as other NTDs. Among those who had heard about trachoma, the majority had heard about the eye-disease at school. However, when considering knowledge of the A, F and E components, few school-age children reported knowing of the E component, or use of pit latrines, as a method to control trachoma. Identifying best practices in health education would provide a model framework on which to prescribe trachoma-health education activities to ensure school-attending children learn about the importance of each SAFE factor.

4. Identify approaches to deliver health education and behavior change messages to non-school-attending children.

This study revealed significant differences in reported awareness and uptake of the A, F and E components of the SAFE strategy between school-attending and non-school-attending children. Based on this analysis, school-based education and health promotion appeared to be effective given school-attending children reported significantly higher knowledge and uptake of trachoma-related prevention activities including taking azithromycin, face and hand washing and using latrines. Through exploratory qualitative and quantitative studies, information should be collected on the daily activities of non-school-attending children in order to identify appropriate channels to target health education and promotion for this population to ensure they receive the full SAFE strategy.

5. Integrate MDA for trachoma and intestinal parasitic infections.

The overlap of trachoma disease and intestinal parasitic infections in the surveyed school-age children suggests that control strategies for NTDs could be integrated. Specifically, co-administering MDA for trachoma, STH infection and *S. mansoni* would allow simultaneous dissemination of multiple medications to treat infection. According to this analysis, the prevalence of NTD infections in the study areas warrants twice annual MDA for all school-age children to treat STH infections, and MDA every two years to all school-age children to treat *S. mansoni*. Current MDA for trachoma in the Amhara region is conducted annually, and, therefore, chemotherapy to treat STH infections could be included with the trachoma MDA, with an additional distribution of preventive chemotherapy for STH at another time during the year. Mass chemotherapy distribution for *S. mansoni* could be incorporated into routine trachoma MDA campaigns every two years.

CHAPTER 5: LESSONS LEARNED

For my thesis project, I have been immensely fortunate to participate in a complete study process, from development through analysis. From this experience, I learned tremendously valuable lessons during each stage of the process. The most important lessons learned are described below.

1. Use of standardized indicators. Standardized indicators should be incorporated into survey tools when possible, as this allows for comparability between studies that use the same metrics. For our study, standardized indicators for water, sanitation and hygiene were included in the household interview. Standardized indicators have been field-tested and should allow for the collection of meaningful and usable data, provided they are appropriate for the local context. The standardized indicators used in our study could be compared to those used in other studies in the Amhara region or elsewhere in Ethiopia.

2. Create a data analysis plan while developing survey tools. Although the data analysis plan may change during or after survey implementation, developing survey questions and response options should be considered in concert with how the data will be analyzed and what value it will add to the analysis. I created an analysis plan after the completion of the survey and then realized critical questions were not included on the survey tool that may have helped to better contextualize the results (see below, “Questions to be considered for future surveys”).

3. Develop context-specific questions with input from field supervisors and field workers, and pilot-test the survey tools. Few published studies documented differences between school-attending and non-school-attending children. Therefore, limited information was available to inform the development of our survey questions to ascertain whether school-attending and non-school-attending children were systematically different and on what measures they differed. Collaborating with field supervisors and field workers to modify questions ignited a dialogue about context-specific factors related to school-age children and school attendance. Such dialogues allowed us to incorporate additional questions, change response options and eliminate questions. Pilot-testing the survey tools provided valuable feedback on the comprehension and appropriateness of the survey questions, and also highlighted discrepancies in translation between English and Amharic. Spending time to pilot-test survey tools is essential to the success of the survey and quality of data collection.

4. Review collected data throughout the duration of the survey to identify and correct data errors. During the survey implementation, we identified a number of data entry errors, but did not learn the magnitude of such errors until the completion of the survey. Carefully reviewing data as it is collected throughout the survey would allow for the detection of errors and the opportunity to correct errors prior to the completion of data collection.

5. Questions to be considered for future surveys studying school-age children in Ethiopia

1. How many years have you regularly attended school?
2. Who teaches you about health at school?
    a. Teacher
    b. Health extension worker
    c. No one teaches health at school

3. How often do you learn about health at school?
    a. Daily
    b. Weekly
    c. Monthly
    d. Do not learn about health at school

4. What health topics do you learn about at school?

5. What do you spend the majority of your day doing?
    a. Attending school
    b. Caring for younger siblings
    c. Caring for cattle/livestock
    d. Farming
    e. Fetching water and household chores

6. (if child has taken azithromycin fewer times than the total number of MDA rounds in the community) Why did you not take medicine for trachoma during the annual campaign?
    a. Did not know about the campaign
    b. Was not at home during the campaign
    c. Did not want to take tablets

APPENDICES

Appendix A. Map of study area

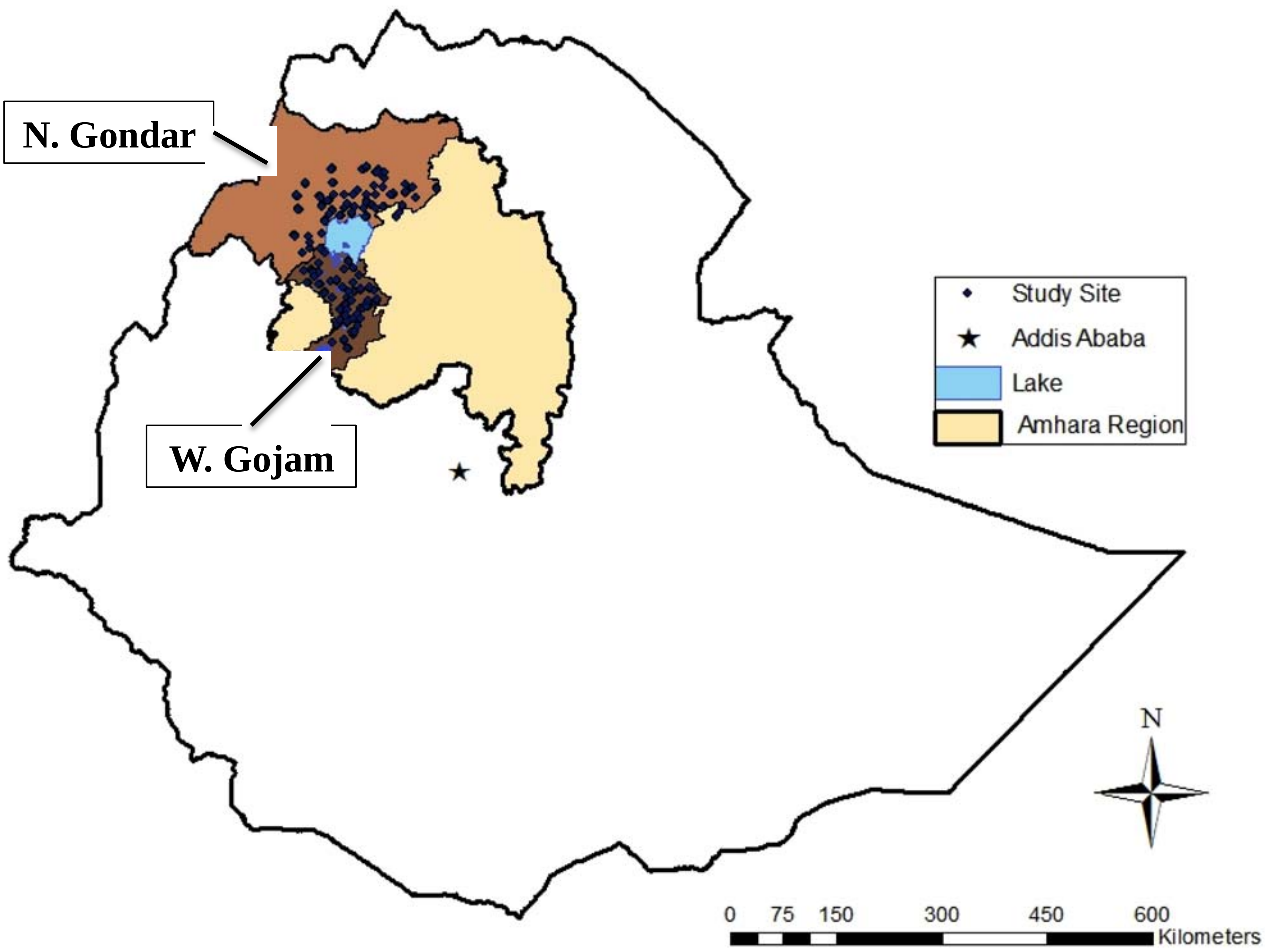

Figure 4. Map of study areas in North Gondar and West Gojam zones in Amhara region, Ethiopia.

Appendix B. Study tools

Household questionnaire

Trachoma Impact Evaluation Survey – Amhara, Ethiopia: 2012

HOUSEHOLD QUESTIONNAIRE

Team number: |__|__|__|	Cluster Number (1-220): |__|__|__|__|	Household number: |__|__|__|	
Serial Number:	|__|__||__|__|__||__|__| Team Cluster Household	Gott name:	
Woreda name:		Health Cluster Name:	
Kebele name:		Development team name:	
Survey Date (DD/MM/YYYY) |__|__|/|__|__|/|__|__|__|__|	GPS	Latitude: (N) |__|__| **.** |__|__|__|__|__|	
Household interview consent given? No= 0 Yes= 1		Longitude: (E) |__|__|__| **.**|__|__|__|__|__|	
Are there children living in this house under 16 years of age? No=0 (skip to M1); Yes=1		Elevation: |__|__|__|__| m Accuracy: |__|__| m	

Respondents' demographics (Adult females: women and mothers of children are the preferred respondents)			
RD1	Description of Respondent	Head of household=1 Wife of head of household=2 Other =99	
RD2	Gender of Respondent	Male= M Female= F	
RD3	How old are you? *(round months down)*	*(write age in years)* |__| __|	
RD4	What is the HH head's primary occupation?	Farming and/or Cattle rearing = 1 Formal employment (monthly salary) = 2 Trade (business) = 3 Daily labourer = 4 Other = 99	
	Does your household have any of the following? ES1 Functioning radio set ES2 Functioning Television ES3 Working electricity ES5 Functioning mobile phone	 No=0; Yes=1 No=0; Yes=1 No=0 ; Yes=1; Yes, generator=2 No=0 ; Yes=1	
S1	For the children living in this household 6-15 years of age, do all of them attend school?	No=0; Yes=1; No children 6-15 years old=88	If yes, skip to S3
S2	For the children who do not attend school, why do they not attend? (check all that apply)	Child isn't ready to start school=1 Child is needed to work/help at home=2 It is too expensive=3 School is too far away=4 Other=99	
S3	How long does it take to walk to school from here?	Write number in minutes:	
S4	What is the highest level of school anyone in this household has attended? *(If "none," ask "have anyone had any non-formal education?")*	None=0 Religious=1 Primary school (grade 1-6)=2 Junior secondary=3 Senior secondary=4 College/University=5 Non-formal Education=6	
K4	What can happen to a person who has trachoma? *(multiple response)* *(After each response ask 'anything else?' Do not read choices. Please mark all responses given.)*	K41 Nothing happens ☐ K42 Blindness ☐ K43 Reduced vision ☐ K488 I do not know ☐ K499 Other ☐	

K5	How can someone protect him/herself from trachoma? *(multiple response)* *(After each response ask 'anything else?' Do not read choices. Please mark all responses given.)*	K51 Face washing/hygiene ☐ K52 Take antibiotics or medicine ☐ K53 Trichiasis surgery ☐ K54 Keeping environment clean ☐ K55 Using pit latrines ☐ K588 I do not know ☐ K599 Other ☐	
FW2	If you have children under 6 years of age, how often are their faces washed? *(Indicate one answer)*	No children less than 6 years =88 Never=0 Every other day=1 Once a day=2 Twice a day=3 Three or more times a day=4 No children under 6 years =88	
M1	Was this household registered for MalTra?	No=0; Yes=1; I don't know=88	
WS1	Is the water source you use for drinking the same water source you use for bathing?	No=0; Yes=1	If yes, skip to WS3
WS2	If no, how long does a round trip take for you to collect water used for bathing – including time to walk there, collect water and return home?	<30 minutes=1 30 minutes to 1 hour=2 > 1 hour=3	
WS3	What is the main source of water your household uses for drinking?	Unprotected spring=1 Protected spring=2 Unprotected dug well=3 Hand pump/Tube well / borehole=4 Surface water (river, dam, lake, stream, canal)=5 Public piped water/ tap/standpipe=6 Private piped into Yard/dwelling=7 Rainwater collection=8 Other=99	
WS6	What do you do to the water to make it safe to drink? *(check all that apply)*	Nothing=0 Strain it through a cloth=1 boil=3 add bleach / chlorine=4 let settle=5 Other =99	
WS4	How long does it take to collect water from the source of water used for **drinking** –including time to walk there, collect water, and return?	<30 minutes=1 30 minutes to 1 hour=2 > 1 hour=3	
WS5	How often do you replenish your drinking water supply?	1 or fewer times per day=1 2-3 times per day=2 More than 3 times per day=3	
ES7	**Observation:** what is the main construction material for the roof in this household? *(One response only)*	thatch=1 stick and mud =2 corrugated iron/metal =3 Other=99	
ES8	**Observation:** Are cattle kept *beyond* 10 meters of the living spaces of the household?	No=0; Yes=1; No cattle=88	
WS7	**OBSERVATION**: How is drinking water being stored?	Open container without lid=0 Container with lid=1 Other=99	
PL1 PL2 PL3	**OBSERVATION**: Currently, is there a latrine in this household? Is this the first latrine in this household? How long ago was this latrine built?	No=0; Yes=1 No=0; Yes=1 ________***MONTHS ago***	If No proceed to census
LO1	**OBSERVATION:** Evidence of latrine usage (*faeces in pit)?*	No=0; Yes=1	

LO2	Hand washing container by the latrine?	No=0; Yes=1	If No proceed to census
LO3	Water in hand washing container?	No=0; Yes=1	
LO4	Is there anything by the hand washing container to clean hands?	No=0; Soap=1; Ash=2	

Household census

ID		01	02	03	04	05	06	07	08	09
Name										
Age										
Sex (M/F)										
Absent Present=0, Out=1, Travel=2, Refuse=3, At school=4										
School (for children 6-15) Do you attend? No=0, Yes=1, Adult=88										
Antibiotics during MalTra	Ever taken No=0, Yes=1									
	# times									
Use Latrine Never=0, Some=1, Always=3										
Discharge (children 1-9) None=0, Ocular=1, Nasal=2, Adult =88										
Right Eye (check signs present; if no trachoma sign, check None)	None									
	TF									
	TI									
	TS									
	TT									
	CO									
Left Eye (check signs present; if no trachoma sign, check None)	None									
	TF									
	TI									
	TS									
	TT									
	CO									

School-age child questionnaire

Individual data collection form for randomly selected school aged children

Child's Unique ID

Child assent no=0 yes=1
(if no, say thank you and end survey)

Name ____________________ **Age (years)** ______ **Sex M=1 F=2**

Do you live with your birth parents? no=0 yes=1
Do you usually attend regular school? no=0 yes=1
What grade are you in?
Do you usually wear a uniform to school? no=0 yes=1 not required=88
Do you help take care of younger siblings? no=0 yes=1 no younger siblings=88
From where have you heard about trachoma? *(do not read responses, check all that apply)*

not heard=0
trachoma volunteers =1
health extension workers =2
mass media (TV, radio, etc.)=3
health facility = 4
school=6
school child=7
other=99

How can someone protect him/herself from trachoma? *(do not read responses, check all that apply)*

face washing/hygiene =1
take antibiotics/medicine =2
surgery=3
clean environment=4
using pit latrines=5
I do not know=88
other=99

How often do you wash your face?

never=0
once per week=1
every other day=2
once a day=3

twice a day=4
other=99

Where did you last defecate?

school latrine=1 *(skip to hand_wash)*
family's latrine=2 *(skip to hand_wash)*
open field=3
backyard =4
other=99

Why did you not use a latrine? (multiple responses)

too far=1
family doesn't have one=2
school doesn't have one=3
smells bad=4
didn't think to use one=5
other=99

Did you wash your hands after you defecated?

Yes, with water only=1
Yes, with water and soap=2
No=3

Which of the following activities do you do in the stream, river, or lake?

swim	no=0	yes=1
fish	no=0	yes=1
wash clothes	no=0	yes=1
bathe	no=0	yes=1
collect water	no=0	yes=1
Irrigation	no=0	yes=1

Have you had worms in the last year?

no=0
yes=1
I don't know=88

Has your child taken medicine for worms in the last year? (ask the parent)

not taken=0 *(skip to health)*
yes=1
I don't know=88

In the past month, have you had any of the following?

Blood in urine	no=0	yes=1
Blood in stool	no=0	yes=1
Diarrhea	no=0	yes=1
Abdominal pain	no=0	yes=1
Headache	no=0	yes=1

Is the child currently wearing shoes? *(Observation)*

no shoes=0

slippers=1
closed toe shoes=2

Weight (to nearest 0.1 kg)		___________
Height (to nearest 0.1 cm)		___________
MUAC (to nearest 0.1 cm)		___________
Stool sample provided?		no=0 yes=1 waiting=88
Is barcode already on container?		new barcode=1 old barcode=2
Bar code label	_____________	
Weight collected	_____________	
Time since passed	_____________	
Consistency	Formed=1 Soft=2 Loose=3 Watery=4	

Appendix C. Institutional Review Board exemption letter

EMORY UNIVERSITY | Institutional Review Board

24 April 2012

Aisha Elizabeth Pomfret Stewart
Emory University
Rollins School of Public Health
1518 Clifton Road Northeast
Atlanta, GA 30329

RE: Determination: No IRB Review Required
Paper Study Number 079-2006 Title: ***Evaluation of national trachoma control programs supported by the Carter Center in Sudan, Ethiopia, Mali, Niger, Ghana and Nigeria***
PI: Paul Emerson

Dear Ms. Stewart:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition(s) of "research" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will be conducting public health non-research program evaluations.

Please note that this determination does not mean that you cannot publish the results. If you have questions about this issue, please contact me.

This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Julia Duckworth, MS
Research Protocol Analyst
This letter has been digitally signed

Emory University
1599 Clifton Road, 5th Floor - Atlanta, Georgia 30322
Tel: 404.712.0720 - Fax: 404.727.1358 - Email: irb@emory.edu - Web: http://www.irb.emory.edu
An equal opportunity, affirmative action university

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