



Cost analysis for “The Magic Glasses Philippines” health education package to prevent intestinal worm infections among Filipino schoolchildren

Mary Lorraine S. Mationg,^{a,b} Gail M. Williams,^c Veronica L. Tallo,^b Remigio M. Olveda,^b Eindra Aung,^{a,d} Portia Alday,^b Mark Donald Reñosa,^b Chona Mae Daga,^b Jhoys Landicho,^b Maria Paz Demonteverde,^b Eunice Diane Santos,^b Thea Andrea Bravo,^b Siobhan Bourke,^a Syarifah Liza Munira,^a Franziska Angly Bieri,^a Yuesheng S. Li,^{e,f} Archie C.A. Clements,^g Peter Steinmann,^{h,i} Kate Halton,^j Donald E. Stewart,^{a,k} Donald P. McManus,^{e,1} and Darren J. Gray^{a,1*}

^aNational Center for Epidemiology and Population Health, The Australian National University, Canberra, Australia

^bDepartment of Epidemiology and Biostatistics, Research Institute for Tropical Medicine, Manila, Philippines

^cSchool of Public Health, University of Queensland, Brisbane, Australia

^dSt Vincent’s Clinical School, University of New South Wales, Sydney, Australia

^eMolecular Parasitology Laboratory, Infectious Diseases Division, QIMR Berghofer Medical Research Institute, Brisbane, Australia

^fHunan Institute of Parasitic Diseases, World Health Organization Collaborating Centre for Research and Control on Schistosomiasis in Lake Region, Yueyang, China

^gFaculty of Health Sciences, Curtin University, Perth, Australia

^hSwiss Tropical and Public Health Institute, Basel, Switzerland

ⁱUniversity of Basel, Basel, Switzerland

^jSchool of Public Health and Social Work, Queensland University of Technology, Brisbane, Australia

^kSchool of Medicine, Griffith University, Brisbane, Australia

Summary

Background Soil-transmitted helminth (STH) infections are a significant public health problem affecting over 900 million people globally. Health education has been shown to complement mass drug administration (MDA) for the control of these intestinal worms. We reported recently results of a cluster randomised control trial (RCT) showing the positive impact of the “The Magic Glasses Philippines (MGP)” health education package in reducing STH infections among schoolchildren in intervention schools with $\leq 15\%$ STH baseline prevalence in Laguna province, the Philippines. To inform decision making on the economic implications of the MGP, we evaluated the in-trial costs and then quantified the costs of scaling up the intervention both regionally and nationally.

Methods Costs were determined for the MGP RCT conducted in 40 schools in Laguna province. We estimated the total cost and the costs incurred per student for the actual RCT and the total costs for regional and national scale-up in all schools regardless of STH endemicity. The costs associated with the implementation of standard health education (SHE) activities and mass drug administration (MDA) were determined with a public sector perspective.

Findings The cost per participating student in the MGP RCT was Php 58.65 (USD 1.15) but if teachers instead of research staff had been involved, the estimated cost would have been considerably lower at Php 39.45 (USD 0.77). Extrapolating the costs for regional scale-up, the costs per student were estimated to be Php 15.24 (USD 0.30). As it is scaled up at the national level to include more schoolchildren, the estimated cost was increased at Php 17.46 (USD 0.34). In scenario 2 and 3, consistently, labour/salary costs associated with the delivery of the MGP contributed most to overall programme expenditure. Furthermore, the estimated average cost per student for SHE and MDA were Php 117.34 (USD 2.30) and Php 58.17 (USD 1.14), respectively. Using national scale up estimates, the cost of combining the MGP with SHE and MDA was Php 192.97 (USD 3.79).

Interpretation These findings suggest that the integration of MGP into the school curriculum would be an affordable and scalable approach to respond to the continuous burden of STH infection among schoolchildren in the Philippines.

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*Corresponding author at: Department of Global Health, National Center for Epidemiology and Population Health, College of Health and Medicine, The Australian National University, Australia.

E-mail address: darren.gray@anu.edu.au (D.J. Gray).

¹ Joint senior authors.

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Research in context

Evidence before this study

It has been shown repeatedly that STH control strategies relying exclusively on mass drug administration (MDA) are not sustainable long-term. The World Health Organisation has highlighted the importance of an integrated approach combining MDA and transmission control through improved sanitation, health education and behaviour change. Recently, we reported the results of an RCT showing the generalizability and applicability of the “The Magic Glasses Philippines (MGP)” health education package for the prevention of STH infections among schoolchildren in the Philippines. The trial demonstrated a statistically significant impact on the students’ overall STH knowledge and changes in their behaviour and was effective in preventing STH infections in intervention schools where the baseline prevalence was $\leq 15\%$. To evaluate the affordability and scalability of the MGP, we determined the costs incurred in the RCT itself and then we extrapolated the costs for regional and national scale-up in all Philippines schools. We searched the PubMed and Scopus Databases for studies assessing the cost or cost-effectiveness of health education for STH infections, using the terms, “STH” or “soil-transmitted helminths” or “intestinal worm” and “health education” and “WASH” or “hygiene promotion” and “cost” or “cost analysis” or “cost-effectiveness”. Cost analyses of health education programmes targeting STH infections are limited, and there are no cost analyses of any similar school-based interventions to allow for a direct comparison.

Added value of this study

We estimated the total cost and cost per student participating in the MGP RCT and the projected cost if scaled up as part of the school curriculum. We estimated an initial cost of Php 58.65 (USD 1.15) per student, but this cost would have been reduced considerably to Php 39.45 (USD 0.77) if the school teachers (and not research staff) had been utilized in the delivery of MGP in the RCT. We estimated regional and national roll-out of the intervention would cost Php 15.24 (USD 0.30) and Php 17.46 (USD 0.34) per student, respectively. Costs associated with the implementation of the standard health education (SHE) activities in school and MDA were also collected to provide comparison. The estimated average cost per student for SHE and MDA were Php 117.34

(USD 2.30) and Php 58.17 (USD 1.14), respectively. The estimated cost of combining MGP (using estimates from the national scale up) with SHE and MDA was Php 192.97 (USD 3.79). Adding the MGP to SHE and MDA would result in the cost increasing by 9.9%.

Implications of all the available evidence

The results of the cost analysis suggest that the MGP is affordable and highly scalable. Although the impact of the MGP was shown in schools with baseline STH prevalence of $< 15\%$ only, our scale up strategy assumed delivering the intervention in all schools regardless of STH endemicity. Thus, in areas with a higher force of infection, additional measures such as WASH infrastructure and high MDA coverage would be necessary. Taken together, the results from the MGP RCT and the cost-analysis reported here indicate the integration of health education into the current school-based STH control programme in the Philippines can provide an effective strategy to respond to the continuous burden of STH infection among schoolchildren.

Introduction

Soil-transmitted helminths (STH) are among the most common human parasites, with 909 million people infected worldwide.^{1,2} They are persistent contributors to ill health, resulting in major economic burden that sustains a continuous cycle of poverty, especially in poor communities with inadequate access to clean water, a limited level of sanitation, and poor hygiene. Worm diseases cause severe disability and malnutrition, including iron and vitamin deficiency, they hinder growth and impact on productivity and cognitive development; children are disproportionately affected.^{3,4} The 2019 Global Burden of Disease study estimated that STH accounted for approximately 1.97 million disability-adjusted life years (DALYs) lost annually.⁵

Over the past decade, the global control of STH has focused on reducing disease morbidity through regular mass drug administration (MDA) (also referred to as preventive chemotherapy) with albendazole or mebendazole, targeting pre-school aged children (PSAC) and school-aged children (SAC). In 2012, to control and eliminate STH infections, the World Health Organization (WHO) recommended MDA coverage of at least

75% of PSAC and SAC in endemic areas by 2020^{6,7}; however, this target was not met as indicated in the new WHO roadmap for NTDs released in 2020 for the period 2021–2030.⁸ While repeated MDA has contributed to some success in decreasing long-term morbidities, children usually suffer from high rates of reinfection. As a standalone intervention, MDA has shown limited effectiveness in the long-term control of STH.⁹ Thus, complementary approaches such as improvements in water, sanitation and hygiene (WASH) infrastructure and hygiene education are necessary to sustain the effect of MDA.

WHO has repeatedly highlighted health education in addition to MDA as an important component of STH control.^{10,11} The integration of this strategy into school-based deworming programmes was endorsed by WHO based on the rationale that through improved knowledge and behaviour modifications, exposure to STH would be reduced and reinfection interrupted.¹⁰ Indeed, the effectiveness of health education in the long-term control of STH infection has been shown in a number of studies.^{12–16} Integrating health education in the control of STH infections can potentially reduce the overall costs associated with decreasing the disease burden but there is limited information on the cost or cost-effectiveness, affordability and scalability of a health education programme targeting intestinal worms. Majority of the available cost and cost-effectiveness studies have evaluated the MDA or PC component only of STH control programmes.¹⁷

We recently reported the results of the Magic Glasses Philippines (MGP) video-based health education intervention implemented in schoolchildren in Laguna province on the island of Luzon, in the Calabarzon region of the Philippines.¹² The trial aimed to determine the effectiveness of the intervention in reducing STH infections among schoolchildren. At 10 months post-intervention, the study reported a significant impact in the students' overall STH knowledge and behaviour but was only effective in preventing STH infection among schoolchildren in intervention schools that had a baseline prevalence of $\leq 15\%$.¹² Here, we estimated the cost of the MGP health education package within the context of the trial itself and determined the cost of scaling-up the package to assist policy makers in budgeting for immediate and future costs if the programme is expanded beyond the trial setting. Key cost drivers were examined to inform which factors to consider in implementing or scaling up the programme. In addition, to provide comparison, cost analysis was undertaken to estimate the cost of implementing school-based MDA and the standard health education activities in schools.

Methods

Intervention trial design, setting and sample

The cost analysis we present was a component of the cluster randomised trial (RCT). The RCT investigated

the impact of a school-based health education package targeting STH infection among schoolchildren aged 9–10 years old in 40 schools in Laguna province, conducted from June 2016 to January 2017. The details of the trial design and the impact of the intervention are presented elsewhere.^{12,18} In brief, 20 schools were randomised to receive the MGP health education package together with the standard health education (SHE) activities as part of the Water, Sanitation, and Hygiene in Schools (WinS) Program for the promotion of correct hygiene and sanitation practices among schoolchildren. Both the intervention and control groups received deworming treatment with albendazole as part of the National Deworming Month program at each survey time point.^{12,18}

Study oversight

The study protocol was approved by the Institutional Review Board of the Research Institute for Tropical Medicine (RITM), the Philippines (approval number: 2013–16) QIMR Berghofer Medical Research Institute Human Ethics Committee, Australia (approval number: P1271), and the Australian National University Human Ethics Committee (approval number: 2014/356). The trial is registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12616000508471).

Description of the intervention

MGP intervention package. The package included a 15-minute cartoon informing schoolchildren about the transmission and prevention of STH accompanied by a classroom discussion, followed by the distribution of a pamphlet summarizing the key messages in the cartoon and a drawing competition. To reinforce knowledge about STH transmission and prevention, the video, was shown again to the schoolchildren approximately 6–8 weeks after the initial delivery, together with an essay-writing competition. The delivery of the MGP intervention during the RCT was conducted by research staff from the Research Institute of Tropical Medicine, Manila.

SHE activities. Both study arms of the RCT received the SHE activities delivered by teachers in school as part of the WinS program.^{12,18} The key concepts of the WinS program are incorporated in the kindergarten to Grade 12 curriculum.^{12,18} In the case of the study participants, the activities of the WinS program were mainly integrated into the Health subject in Grade 4. Correct knowledge and understanding of the importance of proper hygiene and sanitation practices was integrated in the health subject, while health and hygiene-related topics were also briefly discussed in the Science

curriculum.¹⁹ These topics were delivered only during the second quarter of the school year (i.e., 50 min per week for two weeks for Health and 40 min for a week for Science). In addition, if applicable, hygiene promotion was discussed for five minutes before the start and/or during each of the eight Grade 4 subjects.

School-based MDA. As indicated earlier, study participants across the control and intervention schools received 400mg of albendazole as per the WHO recommendations for deworming. The DOH is responsible for the delivery of the deworming tablets from the Central Office facility to the different school divisions and provides guidelines for the conduct of MDA in schools.²⁰ However, the implementation of the semi-annual school-based MDA programme in the Philippines is primarily overseen by the DepEd. The administration of albendazole to children is coordinated by a deworming teacher coordinator supervised by health personnel from the DepEd on a specified day, scheduled during the first and third quarter of each school year. The deworming teacher coordinator in each school oversees the overall conduct of deworming activities conducted by the section advisers for each grade level. The section advisers perform the following tasks: secure parental consent before the deworming, handing out the albendazole tablets to all students, ensure that the students swallowed the drugs by inspecting the mouths of individual students, and report any serious adverse events after the deworming activity to the school nurses. In case of an adverse event, the school nurses manage and refer students to the DepEd School Division's medical officer for further evaluation and management, or immediately refer the student to a nearby government hospital. At MDA completion, each school prepares an MDA accomplishment report, which is submitted and consolidated by District School Office; these are then sent to the School Division Office, where the data from the districts are aggregated. The School Division Office submits the consolidated report to the DepEd Regional Office, which in turn consolidates all the reports from the school divisions, and endorses them to the DOH-Regional Office, which submits them finally to the DOH-Central Office. The DOH-Central Office is the repository of the MDA coverage reports from all the different Regional Offices.

Economic study and setting

The cost analysis undertaken and presented here was conducted from a public sector perspective, encompassing that of the DOH and DepEd. The costs associated with the implementation of the MGP, SHE and MDA were determined, with the time horizon of the analysis was over the course of the 10-month RCT. The study followed an ingredients-based approach whereby the different resources essential to implement the intervention were listed, measured and valued.²¹

Financial and opportunity costs associated with each strategy were also considered in the costing. We quantified the 2016 cost at the market rate and then inflated the cost to the 2020 Philippine peso (Php) using the inflation gross domestic product deflator,²² and presented them in 2020 US Dollars (1 USD = 50.921 Php using the exchange rate information by Bangko Sentral ng Pilipinas²³) and international US dollars (purchasing power-adjusted).²⁴

MGP health education package costs. We undertook a retrospective costing to quantify the cost of delivering the MGP intervention. Cost resources were categorised under Phase 1, which include start-up costs (video development) and Phase 2, which include operational costs (post start-up) referring to the cost of initial delivery of the intervention and video reinforcement. To estimate the cost of delivering the MGP intervention within the context of the trial, we included expenses for materials, research staff labour costs and teachers' relief for the lost time due to disruption of classes during the delivery of the MGP (details of the costing are provided in the next sections below). The cost of research activities, such as the expenditure for the formative research and for the development of the video and its production and pilot testing, travel expenses and per diems of the research staff during the delivery of the intervention were excluded as these items would not be incurred should the intervention be incorporated into the school curriculum in the future. The MGP health education cost per student was determined from the total intervention cost divided by the total number of Grade 4 students enrolled across the 20 intervention schools. Details on the resources employed and the quantities expended in the delivery of the MGP intervention in the RCT are itemized in Supplementary Table 1.

Materials cost to deliver the MGP. Material expenses included the cost of printing the education materials (pamphlets) provided to the children to take home, and the cost of television and USB flash drives. Circa 80% of the 40 schools included in the trial had existing audio-visual facilities; televisions were provided only to intervention schools without such facilities. The cost of the televisions and USB flash drives were annuitized over their useful life using a discount rate of 5%, as per the international economic evaluation guidelines for low and middle income countries.²⁵ The useful years applied were in accord with the guidelines of the Philippines Commission on Audit (COA) on economic useful life years for school equipment.²⁶ For TV and USB flash drives, we have used economic useful years of five and two, respectively. Such annuitization permits an equivalent annual cost to be projected and reflects the value in-use of capital items, rather than reporting when the item was purchased. The annuitized costs were calculated by adopting Levin's 1983 formula.²⁷

Staff labour and teachers' relief costs. Staff labour costs were calculated based on the number of research staff and the number of hours they spent in delivering the intervention per school. The estimated total time spent was multiplied by the research personnel's computed salary per hour. Since the delivery of the intervention was conducted during class hours, the opportunity costs due to lost teacher's time because of class disruption were included in the costing. Teachers' relief was calculated based on the number of hours lost multiplied by the teachers' reported salary grade (SG) 11 rate in 2016 (Php 19,077).

MGP costing scenario analysis. To provide meaningful comparisons for consideration of adopting or scaling up the MGP in schools, we evaluated the costs under three different scenarios (Table 1). Scenario I explored the potential cost of the MGP assuming that the intervention would be delivered by existing in-school teachers as an alternative to the research staff employed in the RCT; we assumed that the impact of the intervention would not be affected if delivered by the teachers. The teachers would be provided with training materials, including a lesson plan and a basic orientation/training video detailing the procedures on how to deliver the MGP activities for self-orientation. Resources incorporated into the costing for this scenario are material expenses (including the annuitized cost of televisions and USB drives; and the development costs of the teachers' training materials), teachers' relief for self-orientation and the cost of teachers' salaries to deliver the intervention. To estimate the teachers' relief and salary, we have employed the 2016 rate for SG 11 as reported by teachers. A sensitivity analysis was conducted using the 2016 rate for SG 13 (Php 22,328) to provide comparison.

Scenario II assessed the costs based on the assumption that the MGP would be entirely integrated into the school curriculum and implemented in all schools in the Calabarzon region with available audio-visual facilities (80% coverage) in order to facilitate rapid scale up of the intervention. The following factors were assumed in the costings for the delivery of the intervention: 1) the MGP would be delivered to 4,131 schools with audio-visual facilities (out of the total of 5,164 schools) in the Calabarzon region where 1,470,811 million public elementary students are enrolled and with 48,337 full time school teachers; 2) the MGP would be delivered school-wide to Grades 1-6 as a supplementary activity to the hygiene-related topics discussed in the Health subject taught in schools; 3) the MGP would be provided twice per school year (for 60 mins during the first and third quarter) before the implementation of the semi-annual deworming activities scheduled in July/January of the school year; and 4) substitute the pamphlets used in the RCT with a poster containing the same information as

in the pamphlet, recommended to be placed in one strategic or central area in each school. It is also assumed that the impact of the intervention would not be affected by the replacement of the pamphlets with a poster since the core component of the intervention would still be the video. Resources in the costing of this scenario included material expenses (included annuitized cost of posters, televisions, and USB drives), the development of teachers' training materials, teachers' relief for self-orientation, and teachers' labour costs to deliver the intervention.

In scenario III, the same inputs used in the Scenario II model were scaled up to provide an estimate of the costs of implementing the MGP to all schools nationwide in the Philippines with available audio-visual facilities (80% coverage), comprising 40,022 public elementary schools (out of a total of 50,277 schools), encompassing 10,944,998 elementary students (Grades 1-6) and 411,279 full time public elementary school teachers. For scenarios II and III, the estimated costs of salaries were assumed to be the same for all teachers across the different grade levels (Grade 1 to Grade 6). We also assumed that the majority of the teachers who will deliver the MGP intervention is in the range of salary grade 11 to 13. The salary per day was calculated based on the 2020 rate of salary grade 13 (Php 26,754). A detailed breakdown of the costs for the three scenarios is shown in Supplementary Table 2. A sensitivity analysis was also conducted using the 2020 rate for SG 11 (Php 22,316) to provide a comparison.

SHE costs. The costing of the SHE activities implemented in schools included the teachers' salary costs and health promotion materials used inside classrooms and developed by the teachers. This material uses "tarpapel" (a term coined from tarpaulin and "papel" or paper), a low cost alternative to tarpaulin printing, detailing the handwashing steps and posted in the classroom wall board, near handwashing facilities and/or toilets. Information on the cost of the health promotion materials was collected from Grade 4 teachers in a sample of schools (n=20) included in the original RCT. Salary costs for teachers were calculated according to the number of teaching hours spent (a) for hygiene-related topics incorporated in the Health (50 mins/week for two weeks) and Science (40 mins for one week) subjects; and (b) in integrating a 5-minute hygiene promotion talk in all eight subjects in Grade 4 delivered every day for one grading quarter. The estimated total time spent by each teacher was converted to an equivalent number of 8-hour working days, which was then multiplied by the teacher's computed salary per day based on the 2016 rate for SG 11 as reported by teachers. The standard health education cost per student was determined from the total cost of delivering the SHE divided by the total number of Grade 4 students enrolled in the 40 schools that participated in the RCT. A complete

Description	Scenario I	Scenario II	Scenario III
Detailed assumptions	<ul style="list-style-type: none"> • Use of in-school teachers to deliver the MGP as an alternative to the research staff employed in the MGP RCT • Teachers will be provided with training materials, to include a lesson plan and basic orientation video (detailing the procedures to on how to deliver the MGP activities) for self-orientation/training. 	<ul style="list-style-type: none"> • The MGP would be scaled up and integrated as part of school curriculum region-wide (Calabarzon Region) • The MGP would be delivered to 4,131 public elementary schools with audio-visual facilities (out of the total of 5,164 schools). • The MGP would be delivered school-wide to Grades 1-6 as a supplementary activity to the hygiene-related topics discussed in the Health subject taught in schools • The MGPPEP would be provided twice per school year (for 60 mins during the first and third quarter) before the implementation of the semi-annual deworming activities scheduled in July/January of the school year; • The pamphlets used in the RCT would be substituted with a poster containing the same information as in the pamphlet, recommended to be placed in one strategic or central area in each school 	<ul style="list-style-type: none"> • The MGP would be scaled up out nationwide • The MGP would be delivered to 40,022 public elementary schools with audio-visual facilities (out of a total of 50,277 schools) • Same as Scenario II • Same as Scenario II • Same as Scenario II
Resources incorporated into the costing	<ul style="list-style-type: none"> • Material expenses include the annuitized cost of pamphlets, televisions, USB drives • Development costs of the teachers' training materials • Teachers' relief for self-orientation • Teachers' salaries to deliver the intervention. 	<ul style="list-style-type: none"> • Material expenses include annuitized cost of posters, televisions, USB drives) • Development of teachers' training materials • Teachers' relief for self-orientation • Teachers' salaries to deliver the intervention. 	<ul style="list-style-type: none"> • Same as Scenario II

Table 1: Description of MGP scaling up costing scenario.

breakdown of the resources and the quantities used in the delivery of the standard health education activities are detailed in Supplementary Table 3. To provide comparison, a sensitivity analysis was also conducted based on 2016 rate for SG 13.

School-based MDA costs. The costs associated with the school-based MDA in Laguna province were also collected for the school year 2016-2017 when two rounds of MDA (i.e., in July 2016 and January 2017) were conducted. Data were collected through interviews using a semi-structured questionnaire with key individuals from the DOH-Central Office and Regional Offices, the DepEd-Regional and Division Offices, and the

principals and school teachers in the 40 schools participating in the RCT who were directly involved in the delivery of the MDA.

The costs associated with the implementation of the school-based MDA were identified, quantified, and organized into the following categories: 1) drug costs; 2) drug distribution expenses (transport of drugs from the DOH Central storage facility to school divisional offices); 3) capacity building/orientation on deworming guidelines provided by the Regional DOH Office to school divisions and Local Government Units (LGUs); and 4) the salaries of DepEd health personnel and teachers (estimated based on their time for the delivery of MDA).

The total cost of albendazole treatment was calculated by multiplying the number of enrolled students from Kindergarten to Grade 11 (ages 5–18) receiving treatment by the price per tablet and the number of tablets received during the two rounds of deworming in Laguna province. Data on the drug price (Php 1.00/tablet) and the deworming coverage were obtained from the Department of Health. To determine expenses incurred in MDA drug distribution, we interviewed staff from the DOH-Region 4A responsible for the collection of the MDA drugs from the DOH-Central facility and distribution to the different school divisions in Laguna province. Expenses in the drug distribution incorporated fuel costs, toll fees and the salary per day of the driver. The costs incurred relating to the capacity building conducted in Laguna province in June 2016 was also collected from the DOH-Region 4A. This capacity building was done to provide orientation to the DepEd school divisions and LGUs on the revised guidelines on the implementation of the Harmonised Schedule and Combined MDA (HSCMDA) for the prevention and control of lymphatic filariasis, schistosomiasis and STH. The expenses included venue rental, meals, snacks of the participants, and transport allowance of study participants.

To estimate the salary of teachers and DepEd health personnel, we conducted interviews with medical officers (n=5), nurses (n=9), representatives from the five school divisions in Laguna province and among teachers and/or school principals in a sample of schools involved in the RCT (n=20). The respondents were asked to estimate the amount of time they had spent on the MDA implementation. The estimated total time spent was then multiplied by the respondent's computed salary depending on their salary grade level. The estimated salary costs were extrapolated for the entire Laguna province. The total salary costs of health personnel were calculated by multiplying the total number of DepEd medical officers and nurses in Laguna province involved in the MDA implementation by their computed salary (based on the number of days spent to administer the MDA to all schools) and the number of MDA rounds.

The total salary cost for teachers was calculated based on the total number of public elementary and junior high school teachers involved in the conduct of the MDA multiplied by one-day salary according to their roles assumed in the delivery of the MDA. The 2016 rate for SG 13 (Php 22,328) was used in the calculation and was assumed to be the same for all teachers in all grade levels (Kindergarten to Grade 11). It was also assumed that the majority of the teachers taking part in the MDA implementation is in the range of salary grade 11 to 13. A sensitivity analysis was also conducted using SG 11 (Php 19,077) to provide a comparison.

The MDA cost per student was then calculated based on the total cost of MDA implementation divided by the

total number of children dewormed in Laguna province during the two deworming rounds. The detailed distribution of costs associated with the delivery of the MDA is presented in Supplementary Table 4.

Role of funding source

The funders of the study had no role in study design, data collection and analysis, interpretation of data, decision to publish, or preparation of the manuscript. All authors had full access to all the data in the study and had the final responsibility to submit for publication.

Results

MGP intervention costs (during the RCT)

The MGP was delivered during the RCT to 3,139 schoolchildren in 20 intervention schools in Laguna province at a total cost of Php 184,090.75 (USD 3615.22). The initial cost per student was Php 58.65 (USD 1.15). A large component of the expenditure was associated with materials (50.8%) followed by human resources, including the research staff labour cost (41%) and teachers' relief (8.2%). Costs by category are shown in Table 2 and Supplementary Table 1 and the cost distribution in Figure 1.

MGP costs based on scenario analysis 1-3

The costs associated with implementing the MGP based on the three scenarios are shown in Table 3 and Supplementary Table 2. The total costs of the MGP derived from the Scenario I model, whereby in-school teachers would be utilized in the delivery of the intervention instead of the research staff in the RCT, resulted in a cost reduction from Php 184,090.75 (USD 3,615.22) to Php 123,835.24 (USD 2,431.91) with the cost per student reduced to Php 39.45 (USD 0.77). These costs were 33% lower than those estimated for the actual RCT. Material expenses (81.6%) accounted for the largest share of the costs, followed by the cost of the teachers' salaries (12.3%) and the teachers' self-orientation relief (6.1%).

In Scenario II, it is assumed that the MGP would be implemented as part of the school curriculum across only one region – the entire Region 4A (Calabarzon) in 4,131 schools having audio-visual facilities with a total school enrolment of 1.4 million public elementary students. The programme cost was estimated at more than Php 22.4 million (USD 440,086.78) overall or Php 15.24 (USD 0.30) per student during the first year of implementation (Table 2; Supplementary Table 2). In comparison with Scenario I, modifications considered with Scenario II included omitting the cost of televisions and replacing the educational pamphlets with a poster. These adjustments resulted in a 61.4% reduction in the estimated costs per student, from Php 39.45 (USD 0.77) to Php 15.24 (USD 0.30). After the

Particulars	Total in Php	Total in USD
Phase 1		
Start-up costs (Adaptation and development of the MGP)		
Formative Research	118,919.52	2,335.37
Production of the video	8,039,360.00	157,879.07
Pilot testing of the video	40,250.03	790.44
Total cost	8,198,529.55	161,004.88
Phase 2		
Post start-up costs (Delivery of the intervention)		
First Delivery of intervention		
Television costs ^b	20,076.67	394.27
USB file storage costs ^b	257.08	5.05
Staff labour costs	37,682.44	740.02
Teachers' relief ^a	7,536.31	148.00
Video Reinforcement		
Pamphlets	73,319.51	1,439.87
Staff labour costs	37,682.44	740.02
Teachers' relief ^a	7,536.31	148.00
Total Cost	184,090.75	3,615.22
Total number of school children in 20 intervention schools	3,139	3,139
Cost per student	58.65	1.15

Table 2: Cost breakdown of the MGP implemented in 20 schools in Laguna province, Philippines during the RCT.

All the 2016 costs were inflated to 2020 Philippine Peso²² and converted to US Dollars²³ and international purchasing power-adjusted US dollar.²⁴

^a Lost time due to disruption of classes during the delivery of the MGHEP.

^b Annualized costs.

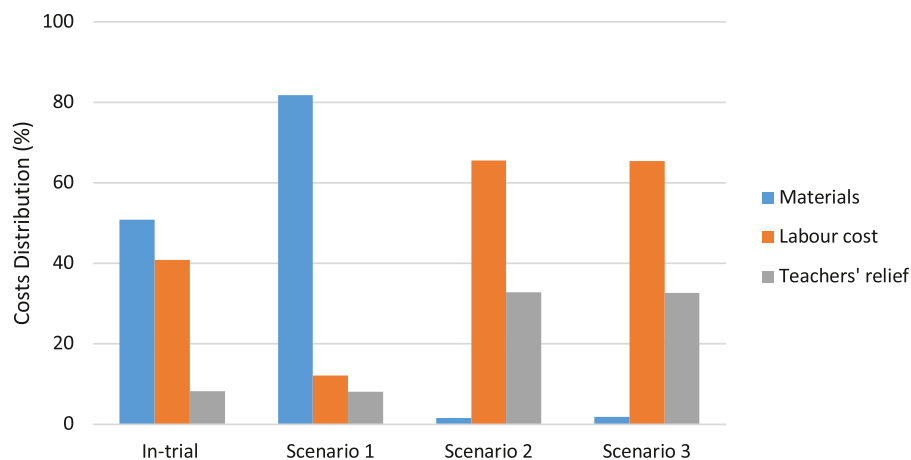


Figure 1. In-trial and scenario cost component distribution.

adjustments had been made, it was evident that the major cost driver in terms of the cost categories was the expenditure for the teachers' salary costs (accounting for 65% of the total cost).

Under Scenario III, which involved rolling out of the intervention nationwide to an estimated 40,222 schools with audio-visual facilities, and a population size of >10.9 million public elementary students, the projected total expenditure was estimated to be about Php 191 million (USD 3.7 million), with an estimated cost per

student of Php 17.46 (USD 0.34) (Table 3; Supplementary Table 2). Similar to Scenario II, the teachers' salary costs contributed considerably to the overall estimated expenditure. Figure 1 shows the cost component distribution by scenario analysis.

Sensitivity analysis employing the 2016 rate for SG 13 to approximate the teacher's salary in scenario 1 showed an estimated cost of Php 40.68 (USD 0.80) per student. Meanwhile, the MGP cost per student derived from sensitivity analysis for scenario 2 and 3 using

Cost items	Scenario 1		Scenario 2		Scenario 3	
	MGP costs of the RCT		Regional wide roll-out of the MGP		Nationwide roll-out of the MGP	
	Php	USD	Php	USD	Php	USD
First Delivery of intervention						
Televisions ^b	20,076.67	394.27	-	-	-	-
USB file storage ^b	257.08	5.05	265,509.13	5,214.14	2,585,012.11	50,765.15
Training materials for ^c teachers	1,238.24	24.32	1,139.76	22.38	1,139.76	22.38
Teachers' relief ^a	7,536.31	148.00	7,347,676.97 ^c	144,295.61 ^c	62,518,551.19 ^c	1,227,755.76 ^c
Teachers' salary costs	7,536.31	148.00	7,347,676.97 ^c	144,295.61 ^c	62,518,551.19 ^c	1,227,755.76 ^c
Video Reinforcement						
Pamphlets	79,654.32	1,564.27	-	-	-	-
Poster ^b	-	-	99,979.17 ^c	1,963.42 ^c	973,402.94 ^c	19,115.94 ^c
Teachers' salary cost	7,536.31	148.00	7,347,676.97 ^c	144,295.61 ^c	62,518,551.19 ^c	1,227,755.76 ^c
Total Cost	123,835.24	2,431.91	22,409,658.97	440,086.78	191,115,208.39	3,753,170.76
Total number of school students	3,139	3,139	1,470,811	1,470,811	10,944,998	10,944,998
Cost/student	39.45	0.77	15.24	0.30	17.46	0.34

Table 3: Implementing the MGP based on the three cost scenarios.

All 2016 costs were inflated to the 2020 Philippine Peso²² and were converted to US Dollars²³ and international (purchasing power-adjusted) US dollars.²⁴

^a Teachers' relief for the lost time in self-orientation on how to deliver the MGP activities in schools.

^b Annuitized costs.

^c Cost estimated in the year 2020.

2016 SG 11 rate for teachers were Php 12.75 (USD 0.25) and Php 14.62 (USD 0.29), respectively.

SHE and MDA costs

The total cost of implementing the SHE was Php 643,011.36 (USD 12,627.63) and the average cost was Php 117.34 (USD 2.30) per student. Teachers' salaries were by far the major costs accounting for 98% of the total expenditure. Details of the costs involved in the delivery of the SHE are provided in Supplementary Table 3. The sensitivity analysis for SHE using 2016 SG 13 rate in estimating the teachers' salary has derived a cost of Php 136.99 (USD 2.69) per student.

The total number of albendazole tablets administered during the first round of MDA (July 2016) was 337,270 out of a total of 520,929 enrolled students from Kindergarten to Grade 11 (age 5-18) in all public elementary and high schools in Laguna province, corresponding to a coverage rate of 64.7%.²⁸ For the second round of deworming (January 2017), the number of dewormed students was 344,993 out of the total of 528,611 enrolled students in the same schools, corresponding to a coverage of 65.2%.²⁹ The total cost of the semi-annual MDA provided to an estimated 682,263 students in the two rounds in Laguna province, was Php 39,690,162.82 (USD 779,455.86) with the average MDA cost per student being Php 58.17 (USD 1.14). The major proportion of the expenditure was due to labour-related costs (the salaries of teachers and health staff) associated with the MDA delivery, accounting for 97% of the total cost; the actual cost of the purchased deworming albendazole drug accounted for only 2% of the total. The distribution

of costs for the semi-annual school-based MDA is presented in Supplementary Table 4. Furthermore, we did a sensitivity analysis to determine the MDA cost using SG 11 and the cost was estimated at Php 50.71 (USD 1.0) per student.

The combined cost of the three interventions (derived from adding the estimated cost of MGP (using the scenario 3 model), SHE and MDA) was Php 192.97 (USD 3.79) per student. The addition of the cost of MGP with SHE and MDA resulted in only a 9.9% increase in the total cost.

Discussion

In addition to MDA programmes targeting school-age children, the WHO recommends the integration of health education as an important component in the control of STH infections.¹⁰ While there have been multiple costing evaluations and cost-effectiveness studies for potential STH treatment strategies,¹⁷ there have been limited studies in relation to health education interventions targeting STH infections. Having shown the positive impact of the MGP health education package in improving the students' overall STH knowledge and behaviour and in reducing STH infections among schoolchildren in intervention schools with less than 15% STH baseline prevalence in a RCT in Laguna province, Philippines,¹² this study was undertaken to assess the cost of the trial and to determine the costs of scaling up the intervention regionally and nationally.

The total cost of the MGP intervention over the course of the 10-month RCT, was Php 184,090.75 (USD 3,615.22), resulting in the intervention being

delivered at a cost of Php 58.65 (USD 1.15) per student. However, our Scenario I model showed that utilizing the school-teachers instead of the research staff in the RCT would have substantially lowered the cost to Php 39.45 (USD 0.77) per person. In our Scenario II, upscaling the MGP region-wide in Region 4A (Calabarzon) would result in a projected cost of Php 15.24 (USD 0.30) per student. The reduction in the cost in contrast to Scenario I was due to the removal of the cost for television sets (since the MGP would be rolled out in schools with available audio-visual facilities) and the replacement of pamphlets with posters. Scenario III, building on similar inputs used in the Scenario II model, indicated that delivering the MGP nationwide would result in an estimated cost of Php 17.46 (USD 0.34) per student. The differences in costs estimated in scenario II and III could be explained by economies of scales, as the intervention is scaled up to reach more at risk schoolchildren nationwide, the projected cost related to the delivery (in terms of the number of teachers to be involved and posters to be reproduced) also markedly increased. Furthermore, in our sensitivity analysis for scenario 2 and 3 have shown reduction in cost when using salary grade 11 for teachers was used. The estimated cost per student was Php 12.75 (USD 0.25) and 14.62 (USD 0.29), respectively.

The results of the MGP RCT in Laguna showed that the health-education package was only effective in preventing STH infections in the intervention schools where the baseline prevalence was $\leq 15\%$ ¹² but our scale up scenario models assumed delivering the MGP intervention in all schools regardless of STH endemicity. As a result, roll-out of the MGP intervention in areas with STH infection prevalence $> 15\%$ would require additional WASH measures and high MDA coverage.¹² Unpublished data from the national STH survey among school-aged children conducted in 2013–2015 by the Research Institute for Tropical Medicine (RITM) in Manila showed that about 40.3% of the surveyed schools across the Philippines have $\leq 15\%$ STH prevalence (personal communication with Dr. Fe Esperanza Espino). With the ongoing national programme of MDA, it is expected that the prevalence and intensity of infection will be reduced; hence, the application of the MGP intervention as a scalable approach would mitigate infection risk among schoolchildren in Philippines.

Implementing SHE for Grade 4 classes in the RCT would result in an estimated cost of Php 117.34 (USD 2.30) per student. As for the school-based MDA implementation in Laguna province, the MDA treatment cost per student was Php 58.17 (USD 1.14), which is higher than the cost estimates documented from other studies.^{30–32} The low coverage rates of deworming reported in Calabarzon province (65% in both rounds) may have impacted on the estimated cost per student.

We have previously shown, the MGP intervention resulted in a significant increase in MDA uptake among participating children.¹² As the MDA cost is influenced

by the deworming coverage rate, including MGP as part of the school-based deworming program could potentially help reduce the overall cost of STH treatment through increasing the deworming uptake. As demonstrated in other studies,^{17,30,33} because of economies of scales, the cost per treatment is likely to decrease with increasing number of people treated. In this study, it could be observed that some cost associated in the delivery of school-based MDA (i.e., salaries of teachers/DepED nurses) are fixed and do not depend on the number of schoolchildren dewormed, therefore, increasing the coverage of schoolchildren dewormed could reduce the average fixed cost per treatment. We estimated the cost of the combined MGP (using the Scenario III model estimate) plus SHE and MDA to be Php 192.97 (USD 3.79). Unfortunately, there have been limited cost analyses of health education programmes in schools targeting STH infections and to our knowledge, there are no cost analyses of a similar school-based intervention to allow a direct comparison.

There are a number of potential policy implications arising from this study. First, our scenario analyses present costs that are likely to be representative of regional and full-scale national roll-out. In particular, the three scenarios show that the cost of integrating the MGP as part of the school curriculum was relatively low compared with MDA and SHE. This demonstrates that the MGP health education intervention is affordable and its integration into the regular school-based delivery of MDA and SHE would be a scalable approach.

Our cost analysis approach had several potential limitations. We collected the costs for the MGP intervention retrospectively, although project records relevant for the intervention planning, preparation and delivery were kept throughout the trial, thus providing accuracy by minimizing recall bias. The costs relating to the SHE and MDA relied also on the retrospective collection of data. As the cost analysis was undertaken in November 2018, two school years after the semi-annual MDA was conducted in June 2016 and January 2017, recall bias may have occurred. Nevertheless, interviews conducted with key personnel from both the DOH and DepEd who were directly involved in the MDA implementation as well as discussion with the teachers who conducted the SHE and MDA activities in the schools, would have added robustness to our cost estimates. Furthermore, the chances of recall bias may have been minimized because some of the data on resources use and expenditure were digitized.

Health education specifically targeting STH infections, is still not included in the school curriculum,³⁴ emphasising the need for an integrated control strategy to optimize the approach to school-based STH control in the Philippines. Health education delivered in schools may help reduce STH transmission, prevent the re-emergence of infections, and improve the coverage and sustainability of the current school-based STH

control program. While there are ongoing school-based MDA and WinS program, sustainability of their implementation continues to be a major challenge,^{34–37} suggesting the need for health education. In this study, we provide details of the costs involved in integrating the novel MGP health education package into the school curriculum. Our findings suggest that the amalgamation of the MGP with school-based MDA and SHE activities would likely be an affordable and scalable strategy to respond to the persistent burden of STH infection.^{34,38} The analysis we present provides further evidence for the Philippines authorities to consider an integrated control program including health education, at minimal additional costs (<10%), to target the burden of STH in schoolchildren.

Contributors

DJG, DPM, GMW designed the study. DJG, DPM, GMW, MLM, RO, VLT, EA, PA, MDR, CMD, JL, MPD, EDS, TAB, FAAB, ACAC, DES, PS, YSL, AB, and KH) contributed to the study operations; MLM, DJG, VLT, RO, FAAB, EA, PA, MDR, CMD, JL, MPD, EDS, and TAB, undertook the fieldwork. MLM did the cost estimation analysis with the inputs from DG, GW, DM, SB, SLM and VLT. MLM wrote the first draft of manuscript. All authors contributed to the drafting of manuscript.

Data sharing statement

Please contact Mary Lorraine Mationg (Mary.Mationg@anu.edu.au) and Darren Gray (darren.gray@anu.edu.au) regarding data requests.

Declaration of interests

All authors declare no competing interests.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.lanwpc.2022.100597](https://doi.org/10.1016/j.lanwpc.2022.100597).

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