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Is an integrated model of school eye health delivery more cost-effective than a vertical model? An implementation research in Zanzibar

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ABSTRACT

Objective To review and compare the cost-effectiveness of the integrated model (IM) and vertical model (VM) of school eye health programme in Zanzibar.

Methods and analysis This 6-month implementation research was conducted in four districts in Zanzibar. Nine and ten schools were recruited into the IM and VM, respectively. In the VM, teachers conducted eye health screening and education only while these eye health components were added to the existing school feeding programme (IM). The number of children aged 6–13 years old screened and identified was collected monthly. A review of project account records was conducted with 19 key informants. The actual costs were calculated for each cost categories, and costs per child screened and cost per child identified were compared between the two models.

Results Screening coverage was 96% and 90% in the IM and VM with 297 children (69.5%) from the IM and 130 children (30.5%) from VM failed eye health screening. The 6-month eye health screening cost for VM and IM was US$6 728 and US$7 355. The cost per child screened for IM and VM was US$1.23 and US$1.31, and the cost per child identified was US$24.76 and US$51.75, respectively.

Conclusion Both models achieved high coverage of eye health screening with the IM being a more cost-effective school eye health delivery screening compared with VM with great opportunities for cost savings.

Key messages

What is already known about this subject?

- ► There is a dearth of information on the actual cost of school eye health (SEH) delivery. This was the first implementation research to review and compare cost-effectiveness of the integrated model (IM) versus the vertical model (VM) SEH delivery in Africa.

What are the new findings?

- ► VM used 1.2 times more resources per child screened compared with the IM and the cost per child identified in the VM is two times that of the IM, thus the IM is highly cost-effective.

How might these results change the focus of research or clinical practice?

- ► Stakeholders in low-income and middle-income settings will be better able to plan for a cost-effective SEH delivery model that suits their contexts and needs using these findings.

INTRODUCTION

Even though refractive errors can be easily corrected with a pair of inexpensive glasses, worldwide, there are still 12 million children living with vision impairment due to uncorrected refractive errors.[1] Left untreated, refractive error can negatively impact a child's quality of life,[2] education and future employment[3 4] and can cause significant distress.[5] The common barriers to the uptake of eye services in low and middle-income countries are lack of knowledge and access to available services, lack of trust and understanding of the treatment outcomes, cultural and social factors and parents unaware of the problem if their child does not complain.[6] To address refractive error challenges, many countries conduct school eye health screening programmes because they are simple to conduct, not resource intensive and benefit children with refractive errors.[7]

While there is no formal estimate of refractive errors in Zanzibari children, a case study from the school health integrated programme reported that about 42% of the children in rural Zanzibar communities who needed a pair of glasses did not have them.[8] It was also reported that 90% of vision impairment among Tanzanian children was due to refractive error.[9] Recognising the need to improve public health practices and access to disability-related services,[10] the Ministry of Health in Zanzibar endorsed free spectacle provision for children. Historically, school eye health screening programmes in Zanzibar were implemented in a vertical manner. While these vertical programmes bore the advantages of strong technical and financial control and focused objectives achievable in a limited time frame,[11] these were often led by non-governmental organisations and ended abruptly with the cessation of funding as they were not part of the National Health Plan. Hence, in collaboration with a non-governmental eyecare organisation, the Ministry of Health of Zanzibar proposed integrating the school eye health programme with its existing school feeding programme (SFP). This provided a valuable opportunity to conduct implementation research to compare the cost-effectiveness of an integrated versus a vertical school eye health programme, conducted in both Unguja and Pemba Islands, which are unique in their geographical features, culture and access to eye health services. We hypothesised that the integrated approach would maximise the limited health resources by using teachers' time to target both eye health and nutrition within one programme.

Rationale

Despite mathematical modelling suggesting that screening and correcting refractive error in school children is cost-effective in Africa,[12] there is very limited information on the actual costs of school eye health programmes at country level. Furthermore, previous studies on the cost-effectiveness of school eye health programmes in Thailand,[13] India[14] and Germany[15] gave mixed results. This makes it extremely difficult to persuade the Zanzibari government to formally integrate school eye health within the National Health Plan, as it needs careful planning and resourcing.[16] Hence, our study aimed to compare the total costs, the cost per child screened and the costs per child detected of the vertical model (VM) with the integrated model (IM). We also reviewed the different cost categories to aid realistic budgeting and identify opportunities for cost saving and cost sharing.

MATERIALS AND METHODS

School selection

This research protocol was approved by the Zanzibar Medical Research and Ethics Committee (ZAMREC/0001/January/17). The research was implemented in 19 rural schools from 1 April 2017 to 1 October 2017 in four districts in Unguja (North A and South Districts) and Pemba Island (Micheweni and Mkoani Districts).

All nine schools (6242 children aged 6–13 years old) with an existing SFP were included in the IM. We purposefully selected 10 schools with no SFP into the VM because the remaining schools in the study area had fewer students. To ensure similar characteristics in the schools enrolled in the two models, we only included rural primary schools that had student school-going rates of approximately 75%, with a similar number of boys and girls and within 5 km of the nearest eye centres.

Patient and public involvement

Community beneficiaries (parents, teachers and children) were involved in the development of the school eye programme through four patient and public involvement meetings during the initiation and development stage. They provided input on the research questions, suggestions on timing for recruitment and implementation. Community beneficiaries were invited to the dissemination of the findings, with a breakout session to obtain their views and suggestions.

Description of intervention

Phase 1: training

In April 2017, six master trainers (n=4 for IM and n=2 for VM) were trained in vision screening, recording and referral pathways and delivering health education to children. As a result of the recommendations made by the local stakeholders, we trained four master trainers for the IM to avoid overburdening the master trainers and compromised the quality of teachers' training. More master's trainers were trained for the project. They subsequently trained 60 teachers (n=30 in both IM and VM) who were appointed by the school head teachers. The training for the IM and VM was a 2-day session and a 1-day session, respectively.

Phase 2: screening and referral

Following their training, teachers returned to their schools and conducted eye health screening from April to September 2017. In the VM, the schools received only the eye health intervention. Teachers conducted the screening, recorded all students screened and identified the students who required follow-up. A list of children who were identified with an eye condition was compiled from the student eye screening register. A week after the completion of the eye health screening, children received eye health education using the materials that were developed in collaboration with the Ministry of Health and approved by the Health Promotion Unit. The eye health material package provided to teachers included a handbook and training manuals on health promotion, posters for display around the school compound and an eye health education booklet for use during health education sessions.

For schools in the IM, eye health intervention was added to the SFP. As part of the screening programme, teachers also measured the children's height and weight (anthropometry measurement). On top of the eye health component, the health education materials included additional information on nutrition, face and hand washing and deworming for children.

Phase 3: monitoring and evaluation

The research coordinator visited the schools monthly to collect the list of children who were screened (eye screening in VM and eye screening and anthropometry in IM) and those who failed screening. Children who failed the eye health screening were referred to a

Table 1 Description of the school eye screening programmes: integrated and vertical model

	Integrated model	Vertical model
Number of participating schools	10	9
Number of master trainers trained	4	2
Number of teachers trained	30	30
Number of children enrolled in the schools	6242	5713
Intervention	Eye health, school feeding, deworming and sanitation awareness through teachers training, and information, education and communication materials Eye health screening by teachers and referral of pupils identified with eye health problems to the nearest vision centre	Eye health awareness through teachers training, and information, education and communication materials Eye health screening by teachers and referral of pupils identified with eye health problems to the nearest vision centre
	Anthropometry measurement, eye health screening by teachers and referral of pupils identified with eye health problems to the nearest vision centre Children with weight problem were referred to the nearest health centre	

designated vision centre for vision management and children with weight problems were referred to the nearest health centre. The optometrists at the vision centres examined the referred children and managed their eye conditions. The free treatment provided at the vision centre included spectacles and basic eye medication (as per national health policy). The detailed vision screening protocol and referral criteria are included as online supplemental appendices.

The optometrists compiled lists of the children examined and their diagnoses. Cases that could not be managed at the vision centre were referred to Muhimbili Hospital in Dar-es-Salaam for further management. The hospital management was informed of the study so that they were prepared for the increased referrals the screening could create. The description of the IM and VM school eye screening programme is shown in table 1.

Phase 4: costing analysis

Project account records were reviewed to collect information on resources used by the interventions (resource types, numbers and unit costs). Primary data collection was conducted by interviewing key informants from schools, vision centres, districts ministry offices and project sites. Informed consent was obtained from key informants prior to their participation in the study. The key informants were representatives of the Ministry of Health (n=1), Ministry of Education (n=1), District Education Officers (n=4), head teachers (n=4), trained teachers (n=4), optometrists (n=2), project coordinator (n=1), project administrator (n=1) and principal investigator (n=1). The cost categories with their cost components are shown in table 2.

The collected information was entered, cleaned and analysed in Excel. Staff time was estimated using the recall method. Costing was done for the period of 6 months (April to September 2017), the actual time taken to implement the two models. Project start-up expenses are considered to assess the project implementation costs but are not included in the costs per child screened and costs per child identified. This rests on the hypothesis that the project start-up costs are only incurred in the first year of the project and absorbed by the relevant ministry costs hereafter. Cost-effectiveness of the models was compared in terms of cost per child screened and cost per child identified.

RESULTS

Children screened and identified for eye diseases

At the end of the intervention period, 11 987 children were enrolled in the schools, with 6257 children (3127 boys and 3130 girls) in the IM and 5721 children (2960 boys and 2761 girls) in the VM. A total of 11 134 (93%) children were screened from April to November 2017, with 5992 children (96%) from the IM and 5142 children (90%) from the VM. Of those who were screened, 427 (3.8%) children failed eye health screening, of which 297 (69.5%) were from the IM and 130 (30.5%) from the VM.

Breakdown of eye health costs in IM and VM

Eye health costs accounted for 60.4% of the total direct cost for the IM. While costs incurred for the training of trainers, teachers' training and monitoring and evaluation were similar in the two components, costs incurred for teacher's salaries, printing and screening kits were higher in the eye health component (table 3).

Table 2 Cost categories and cost components for the project

Cost category	Cost components
Meetings	Participants' per diem, venue rental, refreshment for one project kick-off meeting, one multistakeholder planning meeting and two local project team meetings
Staff salaries	Optometrist hourly rate × time spent on examining and managing referred children*, full time staff hourly rate × time spent on eye health activities†, teachers' hourly rate × time spent on eye health screening‡
Outreach activities	Staff per diem, transport, spectacles, eye medication
Equipment	Autorefractors, ophthalmoscope/retinoscope sets, slit lamps, trial frames, trial lens
Screening kit	Occluder, Visual Acuity chart, torch, tape measure, vision cards, a height and weight scale, educational books, record books, and posters
Monitoring and evaluation	Teachers' hourly rate × time spent on monitoring and evaluation activities§, per diem, transport¶, accommodation, communication**
Consumables	Spectacles, eye medications
Printing	Manuals, branding stickers, posters, and referral forms.
Training of trainers	Participants' per diem, venue rental, refreshment
Teachers training	Participants' per diem, venue rental, refreshment
Baseline and end-line survey	Training costs (venue, per diem, refreshment), data collectors' wages, transport¶, accommodation, communication**

*Optometrists' time spent on examining and managing the children varied between 7 min and 60 min depending on the complexity of the case at hand.
†Full-time staff spent between 25 min and 5 hours per school on the eye health activities depending on how well the activities were being implemented.
‡Teachers spent 4–5 min screening one child. Class time used for teaching eye health to students ranged from 10 to 45 min per class session.
§Teachers' time spent 4–12 hours per quarter conducting monitoring and evaluation activities.
¶Means of transportation for monitoring and evaluation included public transport and motorcycle, with the cost being between US$0.50 and US$2.70 per school visit, depending on school distance.
**Money spent on mobile phone communication was US$0.50–US$0.90 per day.

Cost per child screened and cost per child identified in VM and IM

The eye health cost for the VM and IM was US$6 728 and US$7 355, respectively. A total of 5142 children were screened in the VM and 5992 children were screened in the IM. Thus, the cost per child screened in the VM was US$1.31 and IM, US$1.23. With 130 children identified in the VM and 297 children in the IM, the cost per child identified was US$51.75 and US$24.76, respectively (table 4).

DISCUSSION

This study aims to compare the cost-effectiveness of delivering school eye health using an IM versus a VM. Our findings show that we were able to screen a high number of children in both models and that the IM is a more cost-effective eye health screening model compared with the VM.

Children screened and identified for eye diseases

The eye health screening coverages in both models were high (90% in VM and 93% in IM). This screening efficiency was achieved because school children are a captive audience and can be reached more easily in schools compared with the general population and there was good coordination in planning and implementing the interventions between the partners of the programme, schools and teachers. We conducted all school screening activities in the first 2 months of the school semester and before the monsoon season in June because the school attendance rate is highest in this period.

Costing analysis

Our costing analysis shows that the VM used 1.2 times more resources per child screened than the IM. The incremental cost of screening the additional 850 children in the IM was US$627 (US$0.74 per child). If we perform a projection on the cost per child screened for screening an additional 850 children in the VM, the cost per child screened decreases from US$1.31 to US$1.26, only marginally different to the IM.

Furthermore, our findings show that the cost per child identified in the IM was about half that of the VM, making the IM highly cost-effective. In the VM, there were about 2.5 in 100 children identified with an eye problem. When we factor in the 21 children identified, projected from an additional 850 children screened, the cost per child identified in the VM decreases slightly from US$51.75 to US$50.12. However, this is still two times the cost of the IM.

A previous study on the cost-effectiveness of school eye screening versus a primary eye health model to provide refractive error services for Indian children by Lester[17] concluded that school eye screening in India is a highly cost-effective method of correcting visual impairment due to refractive errors in school-age children. However, the study used cost per Quality-adjusted Life Years (QALY) as their cost-effectiveness measure and did not describe in detail the difference between the two models and the cost categories of his cost calculation, making it impossible for meaningful comparison between our findings.

We also made a conservative assumption, based on Baltussen *et al*[12] that the equipment will have a useful life of 10 years. However, equipment useful life greatly depends on the existence of a functioning maintenance and repair (M&R) service. In a resource-constrained

Table 3 Total integrated programme costs breakdown

Cost category	Eye health cost, US$ (percentage of integrated programme cost)	Nutrition, deworming and sanitation cost, US$ (percentage of programme cost)	Integrated programme cost, US$
Training of trainers	916 (50%)	917 (50%)	1833
Teachers training	1 650 (49.4%)	1 690 (51.6%)	3340
Monitoring and evaluation	1 300 (50%)	1 299 (50%)	2599
Teachers' salaries	545 (69.7%)	237 (30.3%)	782
Printing	504 (66.8%)	251 (33.2%)	755
Screening kit	2 440 (85.3%)	420 (14.7%)	2860
Total cost (6 months)	7 355 (60.4%)	4 835 (39.6%)	12 170

location such as Zanzibar, where there are no existing M&R services for eye equipment, realistic equipment useful life may be less than 10 years. The Ministry of Health has plans to upskill its M&R services to routinely maintain eye equipment, but the timing of this is not yet confirmed.

Future cost-saving opportunities of the IM lie mainly in more efficient use of teacher's time, shorter training and fewer monitoring activities. The IM has a greater opportunity of further reducing resource use as many inputs can be shared with other school-level programmes such as nutrition and other health education programmes.

Training of trainers and teachers' training in this pilot project incurred 25.3% of the total project cost. The 1-day (VM) and 2-day (IM) training sessions were needed as these were new approaches for the local implementing personnel. However, investment in intensive training will decrease in subsequent years and be replaced with less resource-intensive refresher sessions.

Table 4 Eye health cost per school child in vertical model and integrated model

Cost category	Eye health cost	
	Vertical model US$	Integrated model US$
Training of trainers	786	916
Teachers training	1650	1650
Monitoring and evaluation	1114	1300
Teachers' salary	478	545
Printing	504	504
Screening equipment for schools	2196	2440
Total cost (6 months)	6728	7355
Total number of children screened	5142	5992
Total number of children identified	130	297
Cost per child screened (6 months)	1.31	1.23
Cost per child identified (6 months)	51.75	24.76

This pilot project required close and frequent monitoring of the teachers' eye health screening accuracy. Retraining on site was conducted when required. We foresee both models incurring less cost as the programme continues and the teachers become more experienced. In the short term (5 years), we project that staff numbers will remain constant with salaries increasing by approximately 4% annually.

One of the long-term aims of the school health programme is to integrate health into the school curriculum, including secondary schools, hence increasing the age intervals of the children screened. Once the integration is achieved, economies of scale will further reduce programme costs. Our findings align with Baltussen *et al*'s[12] analysis, which showed that while screening a broader-age interval is costlier than a single age-interval, cost per capita can be less because of economies of scale.

All children who required refractive correction were provided with custom-made spectacles regardless of the magnitude of the refractive error, costing between US$6.80 and US$14.60 per pair depending on their prescriptions. However, the ability to correct refractive error for many children with ready-made spectacles that are significantly cheaper than custom made spectacles could reduce programme costs and offer on-the-spot refractive corrections.[18–20]

Limitation

The optometrists', teachers' and staff time spent on the activities were determined using the recall method and may have presented a certain level of recall bias. This method might have underestimated or overestimated the time spent on the activities. However, we masked the key informants from the model the schools were enrolled into and to minimise response bias.

Baltussen *et al*'s[12] findings showed that screening of 11–15 years old is the most cost-effective in all regions of the world. However, we implemented our research among primary school children (6–13 years old) because the existing SFPs were in primary schools (IM). To make meaningful cost comparisons between the IM and VM, we implemented the VM in primary schools where the socioeconomic profiles were similar to the IM schools.

This was a 6-month pilot that limits our ability to extrapolate referral data and calculate the models' cost-effectiveness for longer terms. Hence, these findings must be interpreted cautiously, and further research is recommended to determine the long-term cost-effectiveness of the different models.

CONCLUSION

To the authors' knowledge, this was the first implementation research that reviewed and compared cost-effectiveness of the IM versus the VM school eye health delivery in Africa. While the total implementation cost of the IM was higher than the VM, more children were screened and identified in IM, making it the more cost-effective school eye health delivery model on a per capita basis. Compared with the VM, the IM offers greater cost-saving opportunities to achieve long-term sustainability. Using these findings, stakeholders in low-income and middle-income settings will be better able to plan a cost-effective school eye health delivery model that suits their contexts and needs.

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Data availability statement All data relevant to the study are included in the article.

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