RESEARCH ARTICLE

Measuring the cost-effectiveness of a home-visiting intervention to promote early child development among rural families linked to the Rwandan social protection system

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to environmental influences, with lifelong, possibly irreversible, effects on a person's wellbeing and productivity [2]. Therefore, interventions that promote positive parent-child interactions and nurturing care and protect against negative experiences in early childhood, such as family violence, have the potential to generate both immediate and long-term returns over the life-course [2±7]. Limited understanding among policy makers of the importance of intervention in the earliest days means that resources aiming to promote early development are often

In each scenario all costs are estimated from a provider perspective and are thus limited to the cost of implementing SA. We do not include the cost carried

number of staff required in each category and indirect cost were added. This cost was then divided by the number of families covered and the number of sessions provided. This allows us to report the cost per family covered and the cost per session. The data from the trial on staffing needs and expenditure were used to estimate scenario 1. For scenarios 2 and 3, changes were made to the staff ratios or the cost of inpuuaff

Table 4. Cost per family and per session, and proportion of costs by expenditure category, by scenario.

	Scenario 1: As implemented	Scenario 2: Expanded.	Scenario 3: Government delivery
Cost per family	$456	$262	$199
Cost per session	$38	$22	$17
Proportion of costs ($ value)	(500 families once off)	(2000 families every 3 months)	(2000 families every 3 months)
Salaries	0.52 ($118,560)	0.64 ($335,360)	0.59 ($234,820)
Training	0.24 ($54,720)	0.04 ($20,960)	0.05 ($19,900)
Communication	0.02 ($4,560)	0.03 ($15,720)	0.04 ($15,920)
Transport	0.16 ($36,480)	0.21 ($110,040)	0.22 ($87,560)
Office costs	0.02 ($4,560)	0.04 ($20,960)	0.06 ($23,880)
Overhead	0.04 ($9,120)	0.04 ($20,960)	0.04 ($15,920)
Total	$228,000	$524,000	$398,000

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Results

Cost analysis

The costs per family covered and per session and the breakdown of costs by expenditure category are summarised in Table 4, for each of the 3 scenarios. Staff costs are largest in all the scenarios.

Cost effectiveness

Table 5 reports the estimated impact on cognitive development per session. The impact is measured in standard deviation improvements and the number of sessions is based on the protocol for each study.

Discussion

The costs of the SM home-visiting intervention are within the range reported in the ECD literature. Costs per family for ECD interventions for under 3's range from $18 to $3,519 [18]. In all three scenarios the largest expenditure category is salaries, followed by transport costs, given that this is a human resource intensive intervention.

Scenario 1 is the most costly scenario per family. The higher costs stemming from the allocation of start-up costs to a few families and salaries of international staff. In Scenario 2 and 3 the cost per family is substantially reduced, reflecting the potential for economies of scale, and because we assume some improvement in efficiency associated with learning and enrolled households being closer together and so moving between them takes less time. If the assumption of efficiency is not made, the costs per family would be US$40 higher in both scenarios. The costs here are based on a programme delivered in rural areas, thus it is likely that there will be substantial cost savings in urban settings where households are closer together, allowing coaches to conduct more sessions in a week and lowering transport costs. For example, assuming coaches could visit 10 families a week in urban settings would lower the cost per family by close to $100 in scenarios 2 and 3.

The cost-analysis results for scenario 3 suggest that incorporating SM in its current structure into Government systems in rural areas would be associated with a further drop in the cost per family. This is a result of lower management costs associated with the shift from international to local management. It is important to note here that the current estimate for scenario 3 includes a payment to the coaches, which is not the norm in Rwanda. Removing this payment drops the cost by $20 per family (approximately 10%). However, the quality of the intervention may not be maintained if the coaches are not salaried.

The cost-effectiveness results when looking only at the cognitive development resulting from SM are relatively small, however, the intervention is nonetheless comparable, in cost effectiveness terms,is

sessions weighted 0.5); Kenya (0,034 home visits with group sessions weighted 0.5); and Brazil (0.040 home visits with group sessions weighted 0.5) [14, 17, 38, 40±46].

It is noteworthy that many of the studies which performed well in the cost effectiveness analysis included group sessions. Moreover, the Msingi Bora trial included an arm with only groups which they estimated led to a return of $15.5 for every $1 invested. These results suggest that group-based components may be efficient additions, or substitutes, for home visiting. Indeed, a recently evaluated group-based intervention trial in Rwanda had a successful impact on child cognitive outcomes [47]. Zhang et al noted that ªfor the cognitive development domain, the effect sizes were greater for interventions delivered through group sessions compared to individual sessions (ES = 0.53 vs. 0.28, Q = 4.99, p = 0.03)º [48]. However, a recent systematic review of parenting interventions to improve ECD and parent outcomes found there to be no statistically significant subgroup results by intervention setting be it home visit, clinic or community; thus, while parenting groups may prove less costly in some circumstances, a careful consideration of the context and the population served must inform the final design [49].

A cost-effectiveness study of an intervention similar to SM is that of the Pakistan Early Child Development Scale-Up (PEDS) trial, results of the intervention are included in Table 4 [19]. The PEDS trial integrated responsive stimulation and nutrition programs (alone or in combination) into an existing health care programme. It involved home visits and group meetings to improve child cognitive, language, and motor development. The responsive stimulation component was costed at US$4 per child per month when integrated within the existing community health programme for parents of children below the age of 2 years. As the PEDS visits occurred monthly, the cost per child per month is comparable to the SM cost per session, if also delivered monthly. To examine cost effectiveness, Gowani et al. divided the annualised cost of delivery staff by the average cognitive score of children in that arm [19]. The comparison suggests the PEDS intervention was less costly both per session and overall than SM. They found the combination (stimulation and nutrition) intervention to be most cost effective of the arms. While the PEDS CEA approach allows for comparisons between the study arms, it does not lend itself to effectiveness comparisons with other interventions because of differences in baseline results and measures of cognition, nor does it accommodate delivery cost differences within and across countries.

Verguet et al., recently suggested an analytical framework for evaluating ECD interventions to address variations in costs between countries they used standardised unit costs [18]. The advantage of Verguet et al.,'s approach is that it accounts for variations in the qualification levels of staff across programmes; not capture in approach of examining the cost per session. The disadvantage is that Verguet et al., do not account for differences in context which have an impact on the cost of delivery. For example, our approach allows the direct comparison of urban and rural programmes, while their approach would suggest a lower cost for the urban programme, given ease of delivery, which risks being interpreted as model efficiency. Our approach excludes variations in cost associated with the use of existing infrastructure. Verguet and colleagues found that a programme which was able to make use of the existing systems was the most cost effective, but this is not helpful for contexts without such infrastructure [18]. As an outcome measure, they similarly use standardised outcomes, but whereas we use only cognitive outcomes, they measure early childhood development through a weighted average of improvements in motor, language, socio-emotional and cognitive development. While this provides a more inclusive framework for evaluation, it is not clear how the weights should be determined. In their reported results they weigh outcomes equally. Two studies costed by Verguet et al., also included in this paper used home-visiting to effect changes in child development in Jamaica [40, 44]. Dividing the standardised cost Verguet et al., present for each of

these studies per child by the number of sessions delivered in the intervention costs one intervention at $53,42 per home visit delivering nutrition and stimulation or stimulation only [40] and the other at $24,8 per home visit delivering stimulation only [44]. The cost of the stimulation only programme at $24,8 dollars per home visit, as integrated into the primary health care system, is comparable with the $22 cost per visit of SM in Scenario 2.

Our analysis has focused on determining the relative cost efficiency of SM as an ECD intervention. However, it is important to note that some of the mechanisms through which the intervention aims to improve ECD outcomes have an intrinsic value. Most notably, the intervention aims to reduce family violence, including IPV. Focusing only on the ECD outcomes does not fully value reductions in violence and highlights the risks a narrow evaluative frame. To address this, improvements in mechanisms which have intrinsic value can be reported alongside cost effectiveness results to ensure policy makers are fully informed.

Our analysis has several

Supporting information

S1 Table. Comparison of interventions with a home-visiting and psychosocial stimulation component with positive early cognitive outcomes.
(DOCX)

S2 Table. Comparison of developmental outcomes included in interventions.
(DOCX)

S3 Table. Selected interventions reported standardised impact on development.
(DOCX)

S4 Table. Assumptions applied to expenditure data.
(DOCX)

S5 Table. Capital costs average useful life.
(DOCX)

S6 Table. Costing inputs.
(DOCX)

S7 Table. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) checklist.
(DOCX)

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