Promoting early childhood development in Viet Nam: cost-effectiveness analysis alongside a cluster-randomised trial

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Summary

Background Economic evaluations are critical to ensure effective resource use to implement and scale up child development interventions. This study aimed to estimate the cost-effectiveness of a multicomponent early childhood development intervention in rural Viet Nam.

Methods We did a cost-effectiveness study alongside a cluster-randomised trial with a 30-month time horizon. The study included 669 mothers from 42 communes in the intervention group, and 576 mothers from 42 communes in the control group. Mothers in the intervention group attended Learning Clubs sessions from mid-pregnancy to 12 months after delivery. The primary outcomes were child cognitive, language, motor, and social–emotional development at age 2 years. In this analysis, we estimated the incremental cost-effectiveness ratios (ICERs) of the intervention compared with the usual standard of care from the service provider and household perspectives. We used non-parametric bootstrapping to examine uncertainty, and applied a 3% discount rate.

Findings The total intervention cost was US$169 898 (start-up cost $133 692 and recurrent cost $36 206). The recurrent cost per child was $58 (1 341 741 Vietnamese dong). Considering the recurrent cost alone, the base-case ICER was $14 and mean ICER of 1000 bootstrap samples was $14 (95% CI –0·48 to 30) per cognitive development score gained with a 3% discount rate to costs. The ICER per language and motor development score gained was $22 and $20, respectively, with a 3% discount rate to costs.

Interpretation The intervention was cost-effective: the ICER per child cognitive development score gained was 0·5% of Viet Nam's gross domestic product per capita, alongside other benefits in language and motor development. This finding supports the scaling up of this intervention in similar socioeconomic settings.

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For the Vietnamese translation of the abstract see **Online** for appendix 1

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For more on the **Sustainable Development Goals** see https://unstats.un.org/sdgs/

For more on the **Heckman equation** see https://heckmanequation.org/

Introduction

The early years of children's lives provide a foundation for their lifelong health and wellbeing. Children's brains develop rapidly, and children acquire cognitive, language, and social–emotional competencies in early childhood.[1] The significance of early childhood development (ECD) has been recognised widely, including in the 2030 Sustainable Development Goals (SDGs) target 4.2 (to ensure that all girls and boys have access to quality early childhood development, care, and preprimary education so that they are ready for primary education). The 2017 *Lancet* Series on early childhood development highlights that the most promotive experiences in the early years of life come from nurturing care and protection from parents, family, and community.[1] Nurturing care, as an overarching concept, requires multisectoral intervention packages across health, nutrition, education, child protection, and social protection.[1]

Heckman and colleagues have shown that early nurturing, learning experiences, and physical health from ages 0 to 5 years substantially affect success or failure in society, conceptualised as the Heckman equation. Their economic analysis showed that high quality birth-to-five programmes for children who are disadvantaged in the USA can deliver a 13% per year return on investment, considering beneficial effects on health and the quality of life, the labour incomes of participants and mothers, crime, and education.[2] Understanding the economic value of investing in ECD can influence policy makers, health professionals, and donors. Economic analyses can support optimal resource allocation and priority setting to maximise health benefits and efficiency. Cost-effectiveness analyses alongside clinical studies are particularly beneficial because they broaden the scope of information beyond clinical efficacy with high internal and reasonable external validity.[3] However, economic analyses of multicomponent interventions for ECD have not been widely done in low-income and middle-income countries. Emerging evidence from China,[4] India[5], Kenya,[6] and Pakistan[7] suggest that ECD interventions could be

Research in context

Evidence before this study

We searched PubMed for economic evaluations alongside clinical studies that assessed multicomponent early child development (ECD) interventions in low-income and middle-income countries published between Jan 1, 2000, and Dec 31, 2021. The key search terms were "economic evaluation", "early childhood development", and "low- and middle-income countries" with no language restriction. Additionally, we undertook backward citation searching to supplement database searching.

Four relevant studies were identified: a study from Pakistan published in 2014, two studies from India and China in 2020, and a study from Kenya in 2021. In Pakistan, early childhood interventions that include responsive stimulation were more cost-effective than a nutrition intervention alone in promoting ECD. Mother and child group sessions in India were as effective as home visiting at a lower cost. In addition, the integration of a parenting intervention within existing primary health care in China was cost-effective to improve ECD. Lastly, a study from Kenya indicated that the private and social returns of a parenting intervention are likely to largely outweigh its costs.

The existing evidence notes that ECD interventions are more likely to be cost-effective. However, we did not find any relevant studies from Viet Nam, and the small number of studies suggests that there is scarce economic evidence.

Added value of this study

Our study estimated the cost-effectiveness of the Learning Clubs multicomponent ECD intervention compared with the usual standard of care (pregnancy and child health-care services from commune health services) in rural Viet Nam. Mothers in the intervention group attended eight group sessions during pregnancy, had one home visit after giving birth, and had 11 group sessions during the first postpartum year in addition to the standard of care. The outcomes were child cognitive, language, motor, and social–emotional development scores at age 2 years. Cost data included intervention costs, mothers' time for participation, and out-of-pocket health-care costs.

The intervention was effective and low cost. Based on the recurrent cost, the incremental cost-effectiveness ratio per score increase in child cognitive development was US$14, which is around 0·5% of Viet Nam's gross domestic product per capita, alongside other benefits in language and motor development. This finding supports the scaling up of this intervention in similar socioeconomic settings. In addition, it contributes to the scarce economic evidence on investments in ECD in resource-constrained settings.

Implications of all the available evidence

The current evidence supports the economic benefits of investments in ECD. More economic evaluations, including studies with long-term time horizons, standardised outcomes that combine programme benefits, and equity considerations are required for strategic planning and resource allocation to reach optimal ECD.

cost-effective, but more research is needed to understand their economic value and ways to promote optimal resource allocation.

The General Statistics Office of Viet Nam and UNICEF have measured Viet Nam's progress towards realising the SDG indicators for children and women in 2020–21.[8] There were skilled attendants at 96% of births, the mortality rate in children younger than 5 years was 14 per 1000 births, and 45% of children younger than 6 months were exclusively breastfed.[8] Regarding child care, only 65% of children aged 24–59 months received early stimulation and responsive care from any adult household member,[8] suggesting that more investment in this area is needed. Multicomponent interventions are recommended to provide nurturing care by targeting multiple risks to child developmental potential.[1] Implementing multicomponent interventions requires resources, and evidence on cost-effectiveness of interventions is crucial to guide strategic budgeting and priority setting to accelerate ECD especially in resource-constrained settings. Thus, this study aimed to estimate the cost-effectiveness of the multicomponent ECD Learning Clubs intervention done in rural Viet Nam from 2018 to 2021.

Methods

Study design and participants

The Learning Clubs trial was a multicomponent intervention designed to improve the physical and mental health of mothers and the health and development of their infants in HaNam, a rural Red River delta province in northern Viet Nam.[9] According to the protocol, an independent statistician randomly selected 84 communes from the HaNam Province list of 116 communes, and allocated 42 communes to each trial arm using random numbers generated in Stata version 14.[9] The number of clusters and sample size were calculated using Stata to detect a difference in child cognitive development score ≤1 SD at age 2 years of 15% in the control group and 8% in the intervention group with 80% statistical power, a significance level of 0·05, and an intracluster correlation coefficient of 0·03.[9] Enrolment was completed in 2018, resulting in 669 mothers from 42 communes in the intervention group, and 576 mothers from 42 communes in the control group (usual standard of care). Mothers who were aged at least 18 years, pregnant, and at a gestation of less than 20 weeks, were eligible to participate.

Data on baseline characteristics were collected at recruitment.

Mothers in the intervention group attended eight group sessions during pregnancy, had one home visit after giving birth, and had 11 group sessions during the first postpartum year. The sessions followed a structured curriculum comprising stage-specific information and participatory learning opportunities to address multiple risks to ECD. Other caregivers, including fathers and grandparents, also joined the sessions when feasible. The intervention addressed maternal nutrition and mental health, parenting capabilities, infant health and development, and gender norms through participatory group-based learning activities, including short videos, roleplay, problem-solving discussions, and demonstrations of caregiving for optimal ECD. All content was validated by the Maternal and Child Health Department of the Ministry of Health for alignment with national policies and programmes in Viet Nam. Mothers in the intervention group were also able to access their usual standard of care, including pregnancy and child health care from commune health services (eg, antenatal and postnatal care, birth in a medical facility, nutrition, sexual and reproductive health education, national growth monitoring, and immunisation programmes). Mothers in the control group received only the usual standard of care.

The time horizon was 30 months.[10] Mothers in the intervention group attended Learning Clubs sessions for 18 months, from mid-pregnancy to when their children were age 1 year. The outcomes were measured when children were age 2 years, after a 12-month follow-up period. The trial has been described elsewhere, including the study protocols for economic and process evaluations.[9–11] As part of economic evaluations, this study focused on cost-effectiveness, cost-consequence, and cost-utility analyses. Return on investment analysis and potential effects of scaling the intervention up nationally will be the scope of another study, which requires a modelling approach to estimate long-term economic benefits of the intervention.

Approval for the project was provided by the Monash University Human Research Ethics Committee (certificate number 20160683), Melbourne, VIC, Australia, and the Institutional Review Board of the Hanoi School of Public Health (certificate number 017-017-377IDD-YTCC), Hanoi, Viet Nam. Participants provided informed consent.

Costs

We collected costs from the service provider and household perspectives. An accountant recorded the implementation cost of the intervention every month using a granular approach to present unit cost with quantity for each cost category. The costs were divided into start-up and recurrent costs (table 1). Start-up costs included Learning Clubs package development (eg, family books, manuals, and video clips), materials and supplies (eg, manuals, posters, dolls, toys, and books), workshops, and training. Start-up costs would not occur every year but typically a lower cost revision would occur within a span of 2–5 years. Recurrent costs included personnel, Learning Clubs session costs, and supervision or management costs. Personnel costs were salaries for a project coordinator. Costs for organising Learning Clubs sessions included tea breaks, travel support for facilitators, food for nutrition education, and facilitators' time. Facilitators' time was valued based on their salaries for commune health workers and kindergarten teachers. Women's union members were volunteers, and their time was valued at 16 591 Vietnamese dong (VND; US$0·72) per hour, based on the minimum wage in Viet Nam.[12]

Mothers' time to participate in the intervention was calculated according to the running time for each Learning Clubs session. Their time was also valued at 16 591 VND ($0·72) per hour, based on the minimum wage in Viet Nam.[12] In addition, out-of-pocket health-care costs for mothers and children were collected through structured interviews. Mothers reported their inpatient and outpatient costs during pregnancy, and inpatient and outpatient costs for their children from birth to 12 months, including medication, medical examination, and hospitalisation costs.

Costs were collected in VND in 2018–19 and converted to US$ ($1=23 050·24 VND).[13] In addition, we reported the costs in VND and international dollars based on the International Monetary Fund rates in 2019,[14] as reporting all currencies could be useful for national and international policy makers.

Outcomes

Because this was a multicomponent intervention to improve ECD, several outcomes were assessed. The primary outcomes were child development in terms of cognitive, language, motor, and social–emotional domains at the age of 2 years, which was assessed by the Bayley Scales of Infant and Toddler Development, Third Edition.[15] Child development outcomes were measured at community health stations. The cognitive subscale assesses sensorimotor manipulation and exploration, early memory and problem-solving skills, and concept formation. The language subscale measures receptive and expressive communication. The motor subscale assesses fine and gross motor skills. The social–emotional subscale measures emotional development and related behaviours. The scores were converted to standardised composite scores on the basis of the age-matched and sex-matched norms with a mean of 100 and SD of 15 (ranging from 40 to 160) for general comparisons.

The secondary outcomes including infant health, women's health, and home environment are in appendix 2 (pp 1–4). All outcomes were assessed by a trained research team masked to the allocation of the trial arms.

See Online for appendix 2

	Unit cost	Quantity	Total costs
Start-up cost			
Package development			
Development of family books, manuals, and video clips	$61 311	1	$61 311
Revisions based on comments from provincial agencies and family participants	$2180	1	$2180
Translation and proofreading	$2429	1	$2429
Pilot testing	$4587	1	$4587
Materials and supplies			
Participant manuals	$5·43	800	$4341
Facilitator manuals	$0·86	1000	$858
Posters	$1·29	300	$388
Leaflets	$0·08	2000	$152
USBs	$6·46	100	$646
Dolls	$26	150	$3905
First aid manikin	$1283	1	$1283
Toys and books	$65	45	$2903
Yoga mats	$6·51	160	$1041
Bathing sets	$56	45	$2538
Baby illness care kits	$4·28	45	$192
Workshops			
Launching workshops	$6790	1	$6790
Technical workshop at province level	$369	1	$369
Technical workshop at commune levels	$1048	1	$1048
Training			
Training for provincial trainers	$1058	4	$4232
Training for commune facilitators: course 1	$9774	1	$9774
Training for commune facilitators: course 2	$5419	1	$5419
Training for commune facilitators: course 3	$5340	1	$5340
Training for commune facilitators: course 4	$5340	1	$5340
Training for commune facilitators: course 5	$5261	1	$5261
Training supervision	$1368	1	$1368
Total start-up cost	..	..	$133 692

(Table 1 continues in next column)

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	Unit cost	Quantity	Total costs
Recurrent cost			
Personnel			
Project coordinator per month	$249	18	$4489
Session costs			
Tea breaks, photocopying for session reminders, travel support for facilitators, and communication costs per commune	$431	42	$18 115
Nutrition sessions per commune	$171	42	$7182
Commune health workers' opportunity cost per hour	$1·89	20	$38
Women's union members' opportunity cost per hour	$0·72	6	$4·29
Kindergarten teachers' opportunity cost per hour	$1·55	6	$9·29
Supervision and management			
Supervision at central level per trip	$64	30	$1932
Supervision at provincial and district levels per person-days	$11	316	$3387
Management at provincial level per month	$44	18	$786
Management meetings at commune level per meeting	$112	2	$224
Household costs			
Participation cost per hour	$0·72	35	$25
Travelling time per hour	$0·72	6·3	$4·51
Fuel cost per km	$0·03	323	$9·50
Total recurrent cost	..	..	$36 206
Total cost	..	..	$169 898
Total cost per child	..	..	$273
Recurrent cost per child	..	..	$58

Cost data were collected in VND and converted to US$ ($1=23 050·24 VND) in the year 2019. Numbers might not add up due to rounding. VND=Vietnamese dong.

Table 1: **Cost of intervention**

Statistical analysis

The intervention cost per child was calculated by dividing the total costs of the intervention by the number of children in the trial. The total incremental costs included the intervention cost per child and incremental out-of-pocket health-care costs compared with the control group. To estimate the mean difference in costs and effects, we used generalised linear mixed models based on the intention-to-treat principle. We used the SAS GLIMMIX procedure with gaussian family and identity link including random intercepts. The models were adjusted for cluster effects with a SUBJECT option in the RANDOM statement. The costs and outcome results are presented as mean and 95% CI. The arithmetic mean is the usual summary statistic to consider the total cost and total effect from the budgetary perspective, and the minimisation of the mean cost and maximisation of the mean effect from the social perspective.[16] We did analyses for study protocol specified outcomes (appendix 2 pp 1–4).

The incremental cost-effectiveness ratios (ICERs) were estimated by dividing the mean difference in costs by the mean difference in effects. The ICERs represent additional cost per additional unit of health effect gained.

We estimated the ICERs for outcomes with significant differences between the two groups. In addition, we used a non-parametric cluster bootstrapping to investigate the uncertainty around the ICERs by generating 1000 estimates of the mean difference in costs and the mean difference in effects. We presented the results as mean and 95% CIs. We plotted the difference in costs on the vertical axis and the difference in effects on the horizontal axis on the four quadrants of cost-effectiveness plane to visually represent the uncertainty around cost-effectiveness from 1000 estimates. Cost-consequence analyses for secondary outcomes are presented in appendix 2 (pp 1–4).

We did multiple imputations to handle missing data on out-of-pocket health-care costs. There were 238 (20%) missing cases for maternal health-care costs, and 44 (4%) missing cases for child health-care costs (appendix 2 pp 5–6). The imputed values were estimated with the log multiple imputation predictive mean matching algorithm considering the zero-inflated cost data in economic evaluations as recommended.[3,17] The imputed values were estimated on the basis of sociodemographic characteristics, including age, education level and occupation of mothers and fathers, household wealth, and the number of household members from 20 imputations.

For discounting, we followed WHO's methods for the economic evaluation of health care-assigned interventions.[18] Due to the absence of consensus regarding discounting health benefits, WHO presented the results for two scenarios, one applying a 3% discount rate to costs only (main scenario), and the other scenario using a 3% discount rate for both health benefits and costs.[18] Following a similar approach, we estimated ICERs under these two scenarios with a 3% discount rate on costs occurred after the first year. In addition, we did sensitivity analyses with discount rates of 0% and 5%. All analyses used the SAS 9.4 software and Microsoft Excel Office 2019. This study followed Consolidated Health Economic Evaluation Reporting Standards 2022[19] and best practices for trial-based economic evaluations.[3]

Role of the funding source

The funders had no part in study design, data collection, analysis, interpretation of data, writing of the report, and the decision to submit the paper for publication.

Results

In total, complete data were contributed by 616 mothers (92·1%) and 622 infants in the intervention group, and 544 mothers (94·4%) and 546 infants in the control group (appendix 2 p 7).[20] The trial profile, including the reasons for dropouts such as unavailability, refusal, or migration, is reported by Fisher and colleagues.[20] The two groups had similar sociodemographic, reproductive health, household, and infant characteristics as reported by Fisher and colleagues (appendix 2 pp 8–9).[20] The participation rate in intervention sessions was 96%.[20]

	Intervention	Control	Mean difference
Maternal health-care cost during pregnancy	$9 (5 to 14)	$7 (2 to 12)	$3 (–4 to 9)
Child health-care cost from birth to age 1 year	$142 (96 to 187)	$147 (99 to 195)	–$5 (–72 to 61)
Total health-care cost	$151 (105 to 197)	$154 (105 to 202)	–$3 (–70 to 64)

Data are mean (95% CI). Costs are in US$ 2019. Cluster effects were adjusted for using SUBJECT in the RANDOM statement in the SAS GLIMMIX procedure.

Table 2: **Out-of-pocket health-care costs**

	Intervention	Control	Mean difference
Cognitive	99·7 (98·7 to 100·7)	95·7 (94·6 to 96·7)	4·0 (2·5 to 5·5)
Language	99·5 (98·2 to 100·9)	97·0 (95·6 to 98·5)	2·5 (0·5 to 4·4)
Motor	104·0 (103·0 to 105·1)	101·3 (100·2 to 102·4)	2·7 (1·2 to 4·2)
Social–emotional	103·2 (100·5 to 105·8)	100·9 (98·2 to 103·6)	2·3 (–1·5 to 6·1)

Data are mean (95% CI). The standardised composite score adjusted for child age and sex was measured by the Bayley Scales of Infant and Toddler Development, Third Edition. Cluster effects were adjusted for using SUBJECT in the RANDOM statement in the SAS GLIMMIX procedure.

Table 3: **Child development outcomes**

The start-up cost was $133 692 and recurrent cost was $36 206 (table 1). The total intervention cost per child was $273 and recurrent cost per child was $58 (equivalent to 6 296 134 VND and 1 341 741 VND). The mean and 95% CI of out-of-pocket maternal, child, and total health-care costs are in table 2. There was no statistically significant difference between the two groups in total health-care costs ($151 in the intervention group; $154 in the control group). The adjusted mean difference in cost was –$3 (95% CI –70 to 64). Out-of-pocket health-care costs by child sex are in appendix 2 (pp 10–11).

Children in the intervention group had higher development standardised composite scores compared with the control group (table 3). There was a significant improvement in the child's cognitive, language, and motor development scores.[20] The mean difference in the score was 4·0 (95% CI 2·5 to 5·5) for cognitive development, 2·5 (95% CI 0·5 to 4·4) for language development, and 2·7 (95% CI 1·2 to 4·2) for motor development. The social–emotional development score showed no significant difference between groups: the mean difference was 2·3 (–1·5 to 6·1). Child development outcomes by sex are in appendix 2 (pp 10–11).

The base-case ICER per increase in child cognitive development score was $14 with a 3% discount rate on costs based on recurrent cost (table 4). The mean ICER of bootstrap samples per increase in child cognitive development score was $14 (95% CI –0·48 to 30), with a discount rate of 3% for cost based on recurrent cost. The base-case ICERs per child language and motor development score increase were $22 and $20, respectively, with a discount rate of 3% for cost based on recurrent cost.

	Base case	Bootstrapping
Based on start-up and recurrent cost		
A discount rate of 3% for cost only		
Child development score increased		
Cognitive	$68	$68 (45 to 100)
Language	$109	$129 (59 to 346)
Motor	$99	$101 (60 to 177)
A discount rate of 3% for both cost and outcome		
Child development score increased		
Cognitive	$70	$70 (47 to 103)
Language	$112	$133 (61 to 356)
Motor	$102	$104 (62 to 182)
Based on recurrent cost		
A discount rate of 3% for cost only		
Child development score increased		
Cognitive	$14	$14 (−0·48 to 30)
Language	$22	$27 (−0·78 to 96)
Motor	$20	$21 (−0·70 to 52)
A discount rate of 3% for both cost and outcome		
Child development score increased		
Cognitive	$14	$14 (−0·49 to 30)
Language	$23	$27 (−0·80 to 99)
Motor	$21	$21 (−0·72 to 53)

Data are mean (95% CI). Costs are in US$ 2019, converted from Vietnamese dong and rounded to the nearest whole dollar. The ICERs from the base-case analysis were estimated by dividing the mean difference in costs by the mean difference in effects. The ICERs from the bootstrapping analysis were from 1000 estimates of the mean difference in cost divided by the mean difference in effects. The standardised composite score adjusted for child age and sex was measured by the Bayley Scales of Infant and Toddler Development, Third Edition. Cluster effects were adjusted for using SUBJECT in the RANDOM statement in the SAS GLIMMIX procedure. ICER=incremental cost-effectiveness ratio.

Table 4: **Cost-effectiveness results**

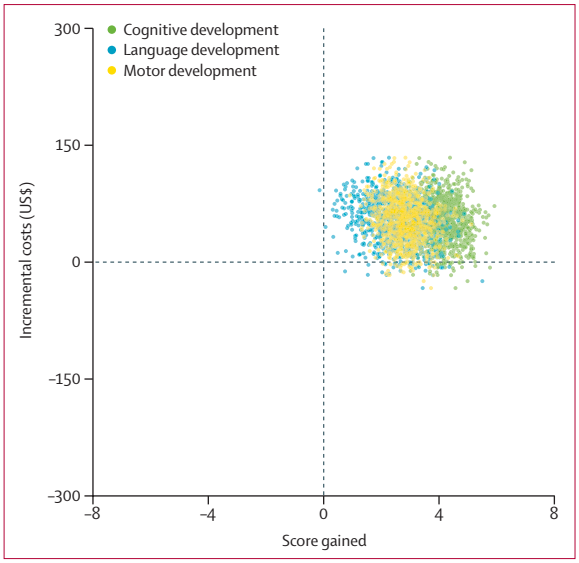

Figure: **Cost-effectiveness plane**
The difference in recurrent costs on the vertical axis and the difference in child development outcomes on the horizontal axis are plotted on the four quadrants of cost-effectiveness plane based on 1000 bootstrapped estimates. The standardised composite score adjusted for child age and sex was measured by the Bayley Scales of Infant and Toddler Development, Third Edition. Costs are presented in US$ 2019. Cluster effects were adjusted for using SUBJECT in the RANDOM statement in the SAS GLIMMIX procedure.

Considering total costs (start-up and recurrent costs), the base-case ICER per increase in child cognitive development score was $68 with a 3% discount rate on costs. Cost-effectiveness results in VND and international dollars are in appendix 2 (p 12). Sensitivity analyses with discount rates of 0% and 5% are in appendix 2 (p 13).

The bootstrapped estimates of the mean difference in recurrent costs and the mean difference in effects were heavily concentrated in the northeast quadrant (figure), suggesting that the intervention is more costly and more effective than the usual standard of care. The bootstrapped estimates of each domain of child development are in appendix 2 (pp 14–16).

The intervention with a short time horizon is likely to be cost-effective to improve child cognitive development as the ICERs were around 0·5% of Viet Nam gross domestic product (GDP) per capita ($2786 GDP)[21] along with other benefits in language and motor development. A benchmark of 2% of GDP for investment in ECD has been proposed with a minimum benchmark of 1% as part of the G20's initiative.[22] In addition, interventions are considered cost-effective or very cost-effective when ICERs per disability-adjusted life-years averted are less than three or one times GDP per capita, as per the WHO Commission on Macroeconomics and Health.[23]

Discussion

Our findings suggest that the Learning Clubs is a cost-effective intervention for promoting ECD compared with the usual standard of maternal and child health care in rural Viet Nam with a 30-month time horizon. Based on recurrent cost, the ICER per score increase in child cognitive development was $14 with a 3% discount rate to costs, which is around 0·5% of Viet Nam's GDP per capita ($2786). In addition, children in the intervention group had better language and motor development with the ICERs per score gained of $22 and $20, respectively. The ICERs were below the minimum investment benchmark for ECD of G20's initiative and the WHO Commission on Macroeconomics and Health's thresholds. When both start-up and recurrent costs were considered, the ICER was $68 per score increase in child cognitive development. The total intervention cost per child, and recurrent cost per child for the 18 month-intervention was $273 and $58, respectively.

The cost-effectiveness of the Learning Clubs intervention appears reasonable compared with previous economic evaluations done alongside cluster-randomised trials in low-income and middle-income countries. An early childhood intervention for responsive stimulation and nutrition in rural Pakistan was more cost-effective than a nutrition or a stimulation intervention alone.[7] The

cost-effectiveness ratios were $18 to improve child cognitive score, $17 to improve language score, and $16 to improve motor development score (price year 2012).[7] Similarly, another parenting intervention from urban China was cost-effective to improve ECD compared with the routine primary health-care services based on the country's GDP per capita.[4] The costs for increasing the communication, fine motor, and overall Ages and Stages Questionnaires scores by 1 SD were $196, $268, and $203, respectively (price year 2014).[4] Additionally, in rural Kenya, a parenting intervention based on a group-only delivery model was more cost-effective than a mixed-delivery model with a 0·37 SD improvement in cognition, 0·30 SD improvement in receptive language, and 0·16 SD improvement in socioemotional outcomes per $100 invested (price year 2020).[6] Direct comparison to our findings to these studies was not possible because of the differences in contexts, health systems, interventions, comparators, and time horizons. Unlike other studies, the Learning Clubs intervention started before the babies were born and addressed maternal nutrition and mental health in addition to child development, which required extra resources. On the contrary, some intervention costs can be reduced in terms of personnel, equipment, and operation if the intervention is integrated into the national system and the government use their existing resources. Our findings are likely to be generalisable to other areas with similar characteristics to this area of Viet Nam, especially in rural and resource-constrained settings. Neighbouring countries could use our findings when designing and implementing ECD interventions with considerations of sociopolitical and health-care contexts.

One of the major strengths of our study is that the economic evaluation is designed alongside the cluster-randomised trial with a study protocol published before trial completion.[10] Trial-based economic evaluations can provide the economic value of interventions to guide resource allocation decisions, yet economic evaluations have rarely been included in ECD trials. As such, our study contributes to the scarce economic evidence of multicomponent ECD interventions. Furthermore, our findings could be a potential source for future health economic modelling to estimate the economic value in different settings or long-term benefits of investing in multicomponent interventions for ECD. As a limitation, we did not have a standardised outcome that captures all effects comprehensively: we presented ICERs for each domain of child development individually. This makes our estimated ICERs for each domain conservative. The impossibility of summing cost-effectiveness ratios across different outcomes was also raised in a previous study[7] because it can be confusing to policy makers who might be interested in an intervention's cumulative effect. Capturing multiple effects altogether to estimate the cost-effectiveness of interventions can be useful for policy makers. A standardised outcome to measure ECD in economic evaluations or a return-on-investment analysis can help policy makers understand its economic value more clearly. Another limitation is that we used the alternative GDP-based cost-effectiveness thresholds because there was no threshold in Viet Nam to determine a value for money of ECD intervention. We used the investment benchmark for ECD of G20's initiative[22] and the WHO Commission on Macroeconomics and Health's thresholds for disability-adjusted life-years averted.[23] Using the GDP-based WHO thresholds at the country level has been controversial, because it could lead to more interventions being recommended as cost-effective.[24] However, there is no global consensus on how countries should develop their thresholds, so it remains the most frequently used threshold in low-income and middle-income countries,[24] including another ECD study from China.[4] The ICERs of the Learning Clubs intervention were below two benchmarks over a short time horizon, which indicates good value for money to scale up the intervention. Viet Nam-specific cost-effectiveness thresholds are required to make further evidence-based decisions. In addition, long-term effects are not explored due to the scarce time horizon and resources to follow up outcomes over time. A 2022 study from Jamaica reported possible long-term benefits of an early childhood stimulation intervention at age 2 years, such as better cognition, executive function, mental health, and psychosocial skills, and fewer risk behaviours among participants up to age 31 years,[25] suggesting a need for incorporating long-term benefits in economic evaluations. Lastly, our cost-effectiveness analysis did not capture equity considerations. Considering the distribution of costs and benefits by socioeconomic groups will support fair decision-making processes. Further research which addresses long-term and equity considerations will provide a more complete picture of economic value to strengthen strategic budget allocation and priority setting.

In conclusion, our study showed that the Learning Clubs intervention improves child cognitive, language, and motor development and is cost-effective compared with the usual standard of care in rural Viet Nam over a short time horizon. Achieving optimal ECD requires a holistic approach across health, nutrition, education, child protection, and social protection. Collective work across multiple sectors is often challenging, and understanding the economic value could be even more difficult as extra resources and considerations are required. However, economic evaluations are crucial to ensure that we use scarce resources effectively and efficiently. Our findings can aid policy makers, health professionals, and donors in development of cost-effective programmes to bolster ECD in a sustainable way.

Contributors

All authors contributed to the study design and data interpretation.
YB wrote the first draft of the manuscript and did the data analysis with

support from ZA, ThT, AO, and JF. All other authors reviewed and revised the manuscript. All authors approved the final draft. All authors had access to all the data in the study and had final responsibility for the decision to submit for publication. YB, ThT, HT, and JF have accessed and verified the data, and YB and JF were responsible for the decision to submit the manuscript.

Declaration of interests

We declare no competing interests.

Data sharing

Deidentified individual data can be made available upon written, detailed requests directed to the corresponding author. Requests will be reviewed on the basis of scientific merit, ethical review, legal issues, and regulatory requirements.

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