Delivering parenting interventions through health services in the Caribbean: Impact, acceptability and costs

Susan P Walker, Christine Powell, Susan M Chang, Helen Baker-Henningham, Sally Grantham-McGregor[a], Marcos Vera-Hernandez[b] and Florencia Lopez Boo[c]

Tropical Medicine Research Institute, The University of the West Indies, Kingston, Jamaica

[a]Institute of Child Health, 30 Guilford Street, University College London, UK;

[b]Department of Economics, University College London, Gower Street, London, UK;

[c]Social Protection and Health Division, Inter-American Development Bank, Washington DC;

Acknowledgements

The work reported was funded by the Inter-American Development Bank. We thank the Ministry of Health, Jamaica, in particular the Kingston and St Andrew Health Department, and the Ministries of Health of Antigua and St Lucia for facilitating the study and their cooperation throughout. We thank the intervention supervisors and the evaluation team for their commitment and professionalism. Special thanks to the nurses and, community health workers for their contribution to the success of the study and to the parents who made the study possible. FLB thanks Romina Tome for excellent research assistance.

Abstract

Integrating early childhood interventions with health and nutrition services has been recommended, however there is limited information on interventions that are effective and feasible for delivery through health services. In this trial we developed and evaluated a parenting program that could be integrated into primary health center visits. The intervention used group delivery at five routine visits from age 3-18 months, and comprised: short films of child development messages, shown in the waiting area; discussion and demonstration led by community health workers; and mothers' practice of activities. Nurses gave out and reviewed message cards with mothers, together with a few play materials. A cluster randomized trial was conducted in the Caribbean (Jamaica, Antigua and St Lucia) in 29 health centers. Centers, stratified by the 3 countries, were randomized to control (n=15) or health center intervention (n=14).

We also adapted the Jamaica home visit intervention to increase feasibility at scale, and evaluated this together with the group intervention in Jamaica only. A further 10 centers in Jamaica were randomized to home visiting only or home visits plus the health center intervention. Information on how participants and health staff viewed the program was obtained, and cost-benefit analyses conducted.

Participants were recruited at the 6-8 week child health visit. Primary outcomes were child cognition, language and hand-eye coordination, and secondary outcomes caregiver knowledge, practices, maternal depression, and child growth, measured after the 18 month visit. Multilevel analyses comparing health center only with control in all 3 countries showed significant benefits for cognitive development from the health center intervention with effect size of 0.3 SD and benefits to parenting knowledge with effect size 0·4. In analyses of the two interventions in Jamaica, both benefited cognitive development with effect sizes of 0.34 SD (home visit) and 0.38 SD (health center). There were no other benefits. Qualitative interviews showed mothers and health staff perceived intervention benefits for themselves and the children. The main implementation challenges reported were staff workload and managing groups. The most conservative analyses found benefit cost ratios of 5.3 for the health center intervention and 3.8 for home visits.

The interventions evaluated were effective and feasible for delivery through child health services. Integrating parenting interventions (through groups in clinics or home visits) into health services has the potential to reach a large number of children with benefits substantially higher than required investments.

Key words: child development, parenting interventions, home visits, primary care health service**,** cost-benefit, Caribbean

Introduction

Large numbers of children under 5 years in low and middle income countries do not attain their developmental potential due to risks associated with poverty, poor nutrition and inadequate stimulation (Grantham-McGregor *et al*, 2007;Walker *et al*, 2007). These children begin primary school without the cognitive and social-emotional skills needed to participate successfully and are at a serious disadvantage compared with more affluent children. They attain lower levels of education, which contributes to lower future income and poor parenting skills, thus continuing the poverty cycle. Improving early life experiences is a critical strategy to increase equity. Investment in early childhood can improve equality in society with benefits across the life course (Heckman, 2006;Campbell *et al*, 2014).

International agencies including the World Bank, IDB, UNICEF and WHO (Chan, 2013;Lake, 2011; Berlinski and Schady, 2015) have recognized Early Child Development (ECD) as an important priority. Improvements in nutrition and health are only part of what is needed, children also need interventions that promote quality parent-child interaction and opportunities to learn (Black *et al*, 2008;Chan, 2013; Berlinski and Schady, 2015). However there is limited information on parenting interventions which are both effective and feasible to be implemented at scale.

There is consistent evidence from efficacy trials in several countries of benefits to child development from home visit parenting programs (Walker *et al*, 2007;Walker *et al*, 2011b). In a Jamaican trial, weekly home visits by community health workers (CHWs) to improve mother-child interaction and demonstrate play activities, led to substantial gains in development in early childhood. Follow-up at 22 years of age has shown sustained benefits to adult IQ, educational attainment, and mental health; reductions in violent behavior and gains in income (Gertler *et al*, 2014;Walker *et al*, 2011a).

Integrating early childhood interventions with health and nutrition services has been recommended (Black & Dewey, 2014;Chan, 2013) and there is evidence from small scale trials that these interventions can be integrated with nutrition interventions without diminishing the

impact of the individual interventions (Grantham-McGregor *et al*, 2014) . If child development can be integrated with health services without reducing the impact of either then this approach would be more cost effective. The challenge is to develop feasible low cost programs that are effective at scale.

We developed an early childhood stimulation program that could be delivered to groups at routine primary health care visits for immunizations, and evaluated benefits to parents' knowledge, the amount of stimulation provided, and children's developmental levels. The parent training package was delivered in routine clinics without requiring additional staff and was designed to occupy the time the mothers spent waiting to see the nurse. The package comprised videos, followed by discussion with demonstration, and time for mothers' practice of activities, as well as provision of message cards and a few play materials to take home. The intervention was implemented and evaluated in Jamaica, Antigua and St Lucia.

In Jamaica, we also adapted our prior home visiting intervention to increase feasibility of scale up and evaluated the benefits of the adapted home visit intervention and the health center intervention given separately or combined. A further objective of the evaluation in Jamaica was to obtain the views of the health staff involved in intervention delivery (community health workers, nurses) and parents about the interventions including perceived benefits, and aspects which were challenging. This information on how participants valued the program as well as their concerns on feasibility and challenges of implementation is important in planning for scale up.

Information on costs of implementation and cost-benefit analyses are also essential for program and policy decisions. Data on implementation costs were collected in Jamaica and the impact of the original Jamaica home visit intervention on earnings (Gertler *et al*, 2014) used to extrapolate the long run labor market benefits of the two interventions evaluated here for the benefit cost analyses. The BC analyses are unique because the available data for Jamaica allow us to make a minimal number of assumptions.

Methods

Study Design and Sample

The trial was cluster randomized by public health center. An efficacy trial of weekly home visiting in Jamaica using CHWs employed to public health centers, demonstrated an effect size of 0.8 SD (Powell *et al*, 2004). Due to the limited number of contacts with mothers in the new health center intervention, we hypothesized an effect size of 0.375 SD and an intracluster correlation of 0.03. With 15 health centers per group (control or health center intervention), a sample comprising 10 children in each health center achieves 80% power to detect the hypothesized effect. Ten health centers from each of Kingston and St Andrew, Jamaica, Antigua and St Lucia were randomly assigned to the health center intervention or to a control group (Figure 1). Thirty children were enrolled from each center in Jamaica and 10 each from centers in Antigua and St Lucia, where the population is smaller. Following selection for the trial, one of the centers in St Lucia had to undergo repairs and was dropped. Additional participants were therefore recruited from two of the other centers in the trial.

In Jamaica only, ten additional health centers were randomized to home visits or both home visits and health center intervention. For the adapted home visit intervention we hypothesized an effect size of 0.5 SD. A sample size of 80 per group (home visiting yes/no) has 80% power to detect a difference of this size. Ten children were recruited per center in these arms of the trial. This gave 100 children receiving home visits (home visit only or both interventions) who were compared with the children who did not receive home visits (Figure 1).

In the Caribbean, routine well child checks and immunizations are provided at child health clinics in primary care centers. Mothers and infants were recruited at the six week postnatal clinics (in Antigua recruitment was at the first child health clinic at 8 weeks of age as attendance for postnatal clinic in the public sector was low). Infants born preterm, multiple births, aged 10 weeks or older, or admitted to the special care nursery for > 48 hours following birth, were excluded. Participants were also excluded if they intended to use a different health center for child

immunizations or the person with the infant was not the mother or primary caregiver, or there was no consistent caregiver (Figure 1). Recruitment was conducted from August 2011 to March 2012.

Interventions

Health center intervention

Short films were developed to deliver a series of child development messages, in collaboration with a team experienced in effective use of media for health education (Development Media International, UK). Filming was conducted in Jamaica with 5 mother and child pairs. Nine modules were produced, each approximately 3 minutes in length, covering the topics: Love, Comforting baby, Talking to babies and children, Praise, Using bath time to play and learn, Looking at books, Simple toys mothers can make, Drawing and games, and Puzzles. The films focused on showing the mothers doing the behaviors we wished to encourage. DVDs with the films were produced and they were shown at all child health clinics while the mothers were waiting to see the nurse. Three topics were shown together at each of the 5 main child health visits between 3-18 months. This allowed topics to be shown on more than one occasion.

In each health center, community health workers (CHWs) were trained to discuss the messages on the films with the mothers, and demonstrate the activities they had seen. Mothers were given the opportunity at the center to practice the activities, and they were encouraged to do them at home. Median duration of the discussion sessions was 16 minutes with an IQR of 14-20 minutes. All mothers attending the child health clinic received the intervention and the median number of mothers during the sessions was 37 (IQR 26, 50).

Training of the CHWs comprised 3 full day workshops with viewing of the films and role play. A manual was provided that included program objectives, guidelines to engaging with mothers in the discussion and demonstration sessions, and the content for each of the sessions. The workshops were followed by coaching in the clinics by a supervisor from the research team prior to beginning the topics for each of the 5 routine health visits. The supervisor reviewed the topics for

that visit and provided additional guidance in running the discussions and practice. Approximately once every 6 weeks, a supervisor also monitored the quality of implementation.

All children attending the child health clinics are seen by a nurse. A workshop was held on two days for the nurses to provide an overview of the program, the CHW role and review of films and materials so that they could provide support for the CHWs. Nurses were also asked to ensure that the intervention was implemented on all child health clinic days. Message cards were produced that reinforced the topics on the films, and nurses were asked to review these with the mothers and then give to them. They were also asked to encourage the mothers to do the activities at home and to check they had seen the film and if not ask them to view it before leaving. For children ages 9 and 12 months, the nurses distributed a simple picture book to the mothers and at age 18 months a 3-piece puzzle. The estimated additional time for the nurses per patient is about 2 minutes.

Home visit intervention

The home visit intervention was based on the curriculum used previously in Jamaica (Grantham-McGregor *et al*, 1991;Powell & Grantham-McGregor, 1989) modified to increase the feasibility of scaling up. Visit frequency was reduced from weekly to twice monthly, visit duration was shorter, and the amount of play materials provided was reduced. Children were visited fortnightly from 6 to 18 months of age by trained CHWs who conducted play sessions with the mother and child to improve mother-child interaction and show mothers how to promote development. At each visit, the health worker chatted with the mother about activities she had done with her child since the last visit and asked her to demonstrate them. New play and language activities were then shown and practiced.

The home visiting intervention was delivered to mothers in the evaluation sample only. In each health center CHWs were assigned up to 5 families each, giving a maximum of 2-3 visits to be conducted weekly in addition to their usual duties. Community health workers were trained in three-day workshops during which the toys and activities in the intervention were demonstrated.

The trainer also demonstrated how to conduct specific visits with the mother and child combining the activities. Emphasis was placed on the approach to the visits which, in addition to skills taught, seeks to enhance the self-esteem of both mother and child. After practicing in small groups the CHWs then demonstrated the visits using role play and received feedback from the trainer. A manual was provided to each of the CHWs. This described general principles in conducting visits with mothers and teaching children and the materials used in the program. Each visit (6 month visit, 6 ½ month etc.) was then outlined giving the toys, messages and activities to be used. A record book was also provided for them to indicate the activities completed and any challenges. Books and toys for the visits were provided to each health center.

Measurements

Baseline Measurements

Baseline data on maternal, household and child characteristics were obtained on enrolment. Mothers were interviewed in the health center to obtain information on: mothers' age, education, occupation and family structure, presence of father, crowding (persons/room) and household possessions. The mothers' vocabulary was measured with the Peabody Picture Vocabulary Test (Dunn & Dunn, 2007) and maternal depressive symptoms with the CES depression scale (Radloff, 1977) . Both measures have been piloted and used previously in Jamaica.

A parenting knowledge scale was developed to assess mothers' knowledge and attitude concerning child development. The scale comprised 10 statements with which the mother was asked to indicate whether she agreed completely, agreed a little bit, disagreed a little bit or disagreed completely and covered topics such as age of introduction of some learning activities, importance of play activities, and maternal child interaction (e.g. love, praise, talking). Items were modified from earlier questionnaires on parenting knowledge which we had used in Jamaica (Powell *et al*, 2004).

Information on the child's date of birth and birth weight were obtained from the child's health records or, where not available, maternal recall. Child length, weight and head circumference were measured using standard procedures. Interviewers were trained in the administration of the questionnaires and anthropometry, details of measurement reliability have been reported elsewhere (Chang *et al*, 2015).

Post-intervention measurements

Measurements were conducted by testers/interviewers with graduate level training in psychology or nutrition. Post intervention measurements were conducted a minimum of two weeks after the 18 month clinic visit. The primary outcomes were the children's development and vocabulary measured using the cognitive, language, and eye and hand coordination subscales of the Griffith Mental Development scales (Griffiths R & Huntley M, 1996) and the MacArthur-Bates Short Form of the Communicative Development Inventory (CDI) (Fenson *et al*, 2003). The CDI was piloted and adapted for Jamaica, changing a few words to others more appropriate for Jamaican children (e.g. bear to goat, candy to sweetie).

Maternal depression and parenting knowledge were re-measured. Two additional items were added to the parenting scale to increase variability in scores. Maternal practices were assessed with the HOME (Caldwell & Bradley, 2003), administered as part of the interview at the clinic, using only items assessed by interview and observation of the mother and child. Children's length, weight and head circumference were re-measured.

Qualitative interviews

The aims of the qualitative aspect of the study were to evaluate the perceived benefits of the program to mothers, CHWs and nurses, to identify challenges the health staff faced in implementing the interventions and whether mothers and staff who had participated in the combined intervention had a preference between the two interventions. At the end of the trial, individual interviews using a semi-structured interview guide were conducted with a sample of mothers, CHWs and nurses. Participants were drawn from clinics with the health center intervention

only (5 clinics) and from the clinics conducting both the health center intervention and the home visits (5 clinics). Interviews were conducted with 24 mothers (14 from the health center only intervention and 10 from the combined intervention), 21 CHWs (9 from health center only and 12 from combined intervention) and 9 nurses (5 from health center only and 4 from combined intervention). Interviews with CHWs and nurses were conducted in the health center by a researcher who had not been involved in the intervention and interviews with mother in the participants' homes.

Analysis

Differences in the means of baseline measurements were determined using t-tests adjusted for clustering at the health center. Intervention impacts were estimated with mixed linear models to determine the effect of the interventions on primary and secondary outcomes, with random effects at the health center level. For the 3 country analyses of the health center intervention, fixed effects included a constant term, child's gender and age, country, group assignment (health center yes/no), and the following baseline variables: birthweight, height-for-age z-score, adolescent mother (age ≤ 19 years), mother's PPVT score, mother's depressive symptoms, mother's educational grade, household's crowding and possessions, and the baseline value of the outcome variable if collected. A further set of analyses was conducted for Jamaica only to examine the effect of the health center intervention and home visit intervention separately and combined. A second group assignment variable (home visit yes/no) and an interaction term computed from the health center and home visit variables were included in addition to the variables in the above model .

Inverse Probability Weighting was used to correct for possible bias because of loss to follow-up.(Heytig *et al*, 1992;Wooldridge, 2002) A logistic regression for the variable "assessed at trial end" (yes 1, no 0) was estimated over a constant term and variables associated with loss (for 3 country analyses adolescent mother status; for analyses with Jamaica only, adolescent mother status and household crowding). The probability of being assessed was calculated and inverse probability weights computed as 1 divided by the estimated probability of being assessed. Multiple comparison

procedures were used to correct the risk of type 1 error (false positive). P-values for the null hypothesis were adjusted using the Holm-Šidák step-down procedure (Holm, 1979; Ludbrook, 1998). The family-wise type 1 error rate was fixed at 0.05 across the 11 outcomes that were tested.

Statistical analysis was carried out in STATA version 13.1 (2013). Z-scores for height for age, weight for height and head circumference for age were calculated using the WHO growth standards (WHO Anthro v3.2.2).

Results

3 country impact evaluation of health center intervention

501 mother-child pairs were recruited for the evaluation of the health center intervention. Of these 426 were tested following the 18 month visit. The reasons for loss to the study are given in Figure 1. There were no significant differences between the intervention and control groups in child and family characteristics on enrolment. Loss to the study did not differ by treatment group (16% children were lost in control and 14% lost in intervention). Adolescent mothers were more likely to be lost to the study than other women (P=0.021). This was the only variable associated with loss. Comparison of the follow-up sample showed that there was a greater proportion of boys in the intervention group (p=0.05) but no other child or family characteristics differed by treatment group in the sample tested at the end of the study.

According to parental report, < 1% of children missed any of the visits. The children's mother usually brought them to the clinic and 83.1% of mothers attended all 5 main visits. When mothers were unable to attend, children were brought by their father, other relatives and occasionally a non-relative.

Mean age on assessment was 19.7 months (SD 0.9) and mean scores by group for the primary and secondary outcomes are shown in Table 1. The intervention had a significant benefit to children's cognitive development with a treatment effect of 3·09 points (95% CI 1·31, 4·87),

equivalent to an effect size of 0.30 SD. There were no benefits to the language or hand and eye subscales. There was also no benefit to the CDI vocabulary score.

Mothers in the intervention group improved significantly more in their parenting scores than mothers in the control group, treatment effect 1·59 (95% CI 1·01 to 2·17). There were no effects of intervention on the other secondary outcomes. The children's mean height-for-age, weight-for-height and head circumference z-scores were close to the median value of 0 indicating that growth was comparable to the WHO growth standards. Few children were below – 2SD for either height-for-age (4.0%), or weight-for-height (2.1%). This is as would be expected within the English speaking Caribbean where substantial reductions in childhood undernutrition have been achieved.

The Jamaica impact evaluation of health center and home visit interventions

A total of 396 mothers and children were enrolled in the trial in Jamaica: control group n=150, health center only n=146; home visit only n=50, both interventions n=50. There were few significant differences in child and family characteristics on enrolment. 82.6% of the sample was assessed at the end of the trial (Figure 1). Loss to follow up was not significantly different in the treatment groups compared with the control group. Enrolment characteristics in the sample assessed at follow-up showed few differences. Compared with the control group, the health center only group had higher child weight-for-height z-scores, mothers with more years schooling and less crowded homes. The group receiving both interventions had lower child height-for-age z-scores, greater percentage of adolescent mothers and fewer fathers who lived in the household.

The mean scores by group for the primary and secondary outcomes are shown in Table 1. Children in the health center groups (health center only and combined interventions) had higher cognitive scores than those who did not receive this intervention (home visit only and control): 4.08 points (95% CI 1.67 to 6.50) representing an effect size of 0.38SD, while those who received the home visit intervention (home visit and combined) had scores 3.65 points higher than those who did not (95% CI 1.65 to 5.65) equivalent to an effect size 0.34SD. There were no significant

interactions between the interventions. The only other significant intervention effect was higher parent knowledge in those who participated in the health center groups 1.65(95% CI 1.01 to 2.29).

Participant and health staff interviews

Qualitative interviews were taped and transcribed except for one that was hand written. The transcripts were analyzed using thematic content analysis. Broad categories were created based on the interview guide, and themes were identified from the data under each of these categories. The identified themes were then used to code the transcripts, where segments of text contained more than one theme, all relevant codes were applied. The data were rearranged in charts of each theme and/or sub-theme within the coding hierarchy with separate charts for mothers, CHWs and nurses. The number of participants who reported each theme was recorded to indicate the salience of each within the data.

Mothers views of the programs

Interventions: Two thirds of the mothers had favorable views of the videos used in the clinic intervention. Mothers stated that the videos helped them to know more about their baby's development and how to help their baby to develop well. It also motivated them to play with their baby and spend more time with him/her. Mothers reported enjoying the singing on the videos and seeing the mothers interact with their children in addition to getting new ideas of how to play with their baby.

> *"Like certain things that you don't really know or aren't familiar with, it opens up your mind and shows you how to do certain things with the baby."*
> *"I didn't know to sing with her and play with her. My mommy didn't tell me that. Apparently my mommy didn't do that with me."*

One third of the mothers interviewed didn't watch some of the videos, either because they arrived too late or too early to see the video or because they chose not to watch it. Four of the mothers interviewed didn't watch the videos as they found them boring and repetitive. All mothers except one reported that they liked the mothers in the video; the most common reason was that they

liked the way the mothers interacted with their baby. Two mothers stated that more fathers should be depicted in the videos.

> *"I kept seeing mothers trying to be there for their child, ensuring that the child gets attention, love. I realize that I didn't see many fathers in the video. So basically I am saying where are the fathers?"*

Although mothers were asked about their views on the demonstration by the CHW and the cards given by the nurses, there were few meaningful responses. Most mothers stated that they liked these aspects of the intervention but their answers were vague suggesting that these were not salient aspects of the intervention for them. Two mothers complained that the demonstrations were too long and boring and led to delays in the clinic.

Mothers were generally positive about text messages that were sent as reminders between the 12 and 18 month clinic visits. Mothers reported that the texts reminded them about the messages and activities, motivated them to continue with the activities and made them feel valued and important.

> *"Sometimes you slip up on something so it's a reminder. Cause sometime she might be getting on my nerves and I get the text message say hug her and tell her you love her. I might just do that instead of slapping her."*

Only three mothers did not remember receiving any texts.

Nine of the ten mothers from centers with the combined intervention stated a preference for the home visits over the health center intervention. The main reasons for preferring the home visits were i) monetary reasons (need bus fare to go to the center), ii) the setting (more private, less noisy and fewer distractions in the home) and iii) effectiveness of intervention (baby learnt more). Only one mother preferred the health center intervention because she believed the CHW rushed the home visit and didn't spend enough time with her and her baby.

Benefits: Mothers perceived that the programs benefited them in several ways related to their interaction with their baby including increased knowledge of child rearing practices and

appropriate activities to do with young babies, and that they talked and played more with their baby and showed more love.

> "*If she's crying, I don't feel that I'm spoiling her, I just take her up and hush her and love her"*
>
> *"I didn't use to play with her before. I would just give her the toys and she would sit down and play with them. Since the program I'll sit with her, sing with her and play with her"*
>
> *"For example, I take him for a walk and show him different, different things and talk about them."*

Only two mothers made statements that indicated a lack of understanding of developmentally appropriate activities in that they mentioned teaching young babies to count and to know their ABC. The remaining 22 mothers described doing things with their baby that were part of the curriculum. Mothers also stated that the intervention helped their children's development, benefited them by exposing them to new experiences and would help children in terms of preparing them for school.

> *"When they go to school now, they know these things already, so she will move faster"*
>
> *"With her skills, I think she is a bit advanced for her age. So I think it helped her in that way. Let her be more advanced"*
>
> *"It show her different things and every day she does something new and learns something new"*

Health Staff views of the interventions

Benefits to mothers and children: CHWs and nurses perceived similar benefits for mothers including helping mothers bond with baby, increased knowledge of child rearing practices and appropriate activities to do with young babies, talking and playing more with baby and showing more love. CHWs and nurses mentioned that the intervention led to more father involvement and increased mothers' motivation. CHWs also felt the interventions benefited

children in terms of preparing them for school and helping their cognitive and language development and benefiting self-esteem.

Benefits to CHWs and Nurses: CHWs reported increased job satisfaction, increased knowledge and better interpersonal skills after participating in the intervention and nurses believed that the intervention helped CHWs professional growth.

> *"I feel so proud of myself knowing that I can stand up and ask them and get persons to answer. It is so good when you can talk to persons. I feel wonderful doing it."*

> *"Showing these things to the babies, you realize you can start them off at a very small age. I never knew that."*

> *"I see with the growth of my staff, seeing my staff involved and taking an integral part. I can tell you that you can see it in their mannerism on a Monday morning when the clinic is happening and they are able to go out and do it." (Nurse)*

Nurses felt pride in the benefits they saw for the participants and CHWs and reported that they also benefited in terms of increased knowledge.

> *"Whenever they come at the different stages now, you're thinking okay what should they be doing, what should they be learning, what could they be learning and you are remembering the program"*

Intervention Preference: Nine out of twelve CHWs from centers with the combined intervention preferred home visiting to the health center intervention and two main reasons were given: i) the setting (less noisy, fewer distractions, more space) and ii) more interest and engagement of the mother. Two CHWs felt that both interventions were important and they could see advantages of both. Advantages of the health center intervention included being able to work with a group of mothers at one time and the mothers were available to listen and participate whereas at home they were sometimes busy with household chores. Advantages of the home visits included being able to see the home environment and work on a one-on-one basis with the mother. One CHW preferred

the health center intervention, largely because she felt under pressure with the workload in the clinic and she was concerned about the amount of time required for home visiting.

Challenges with intervention implementation: The main challenges mentioned by both CHWs and nurses were mothers' attitude or behavior and staff workload (Table 2). A few mentioned problems with equipment which included theft of equipment, occasional problems with electricity supply, difficulty setting up the equipment, as well as lack of seating.

CHWs reported that although they enjoyed conducting the intervention with the majority of mothers, some mothers were uninterested or would complain about the video and demonstration in the clinic and they found this burdensome. Both CHWs and nurses also mentioned the problem of uncooperative mothers in the home visiting intervention as mothers were not always at home during the pre-arranged time for the visit.

Staff workload was a key challenge for both the health center and the home visiting intervention especially in cases where staff members were on leave or where the center was already short staffed. Some CHWs mentioned that not all staff were willing to conduct the demonstration sessions and hence the work generally fell on one or two persons. CHWs stated that the clinic setting also led to challenges due to the crowded waiting areas and the overall level of noise and distractions. This problem was exacerbated where the waiting area was not only for persons attending the Mother and Child Health clinic but included other patients as well. One CHW found the home environment non-conducive due to the lack of an appropriate place within the house or yard to conduct the intervention.

Suggestions for Improvement: There was evidence that mothers, CHWs and nurses valued the program and believed it should be continued including expanding the intervention to include other health centers and other mothers, and extending the length of the program so that it continues until children enter preschool (Table 3). There were few other suggestions for improvement. Six CHWs believed that the program should be supplemented by parenting workshops in the community and

two CHWs mentioned broadcasting the videos on the television to ensure the intervention reached a greater proportion of mothers.

Cost benefit analyses for interventions in Jamaica

Costs of Health Centre Intervention

Table 4 summarizes the costs for a 12 months period.[1] The information presented was collected during a field trip to Jamaica, in July of 2012. In total, the cost of one year of intervention is US$20,178.4, and given that the evaluation sample is 200, the cost per child is US$100.9. [2] The intervention lasted 18 months, but, as this is a conservative analysis, we did the costing exercise for 2 years to take into account training and preparation of the intervention.[3] The yearly cost per child of the second year was discounted to get its present value (using a discount rate of 5%). The total present discounted value of the cost was US$197.1.

Benefits of Health Centre Intervention

In order to estimate the present value of benefits, our estimation assumes that children will enter the labor market at age 17 and they will retire at age 65. A Jamaican trial of home visiting using CHW had an impact on developmental quotient of 0.80SD (Grantham-McGregor *et al*, 1991). In this pilot, an effect size of 0.38SD on the cognitive scores was found, which is 47.5% of the former. In a follow-up of the Jamaica trial at age 22 years, Gertler et al. (2014) found an effect of 25% higher wages for the treatment group. We therefore multiply the 0.25 impact in wages by 0.475; in order to extrapolate the impact of the health center intervention on earnings giving 0.12 (or 12%). In 2012, the average wage in Jamaica was US$1,000. We multiply 0.12 by the average wage to estimate the yearly wage return of the intervention. In our conservative scenario, we use a discount rate of 5% to estimate the net present value of these income gains in 2012, and sum these gains to get the benefit

[1] Including the cost of producing the DVDs and spreading that over 5 years, takes the cost per child/year to US$ 134.3 and the BC ratio to 4.
[2] As shown in Figure 1, the health center intervention was evaluated in 10 clinics with 30 children per center/year in the health center only arm (5 centers) and 10 children per center/year in the combined home visit/health center arm (5 centers).
[3] We calculate costs for two years not only for the conservative analysis, but also in all sensitivity analyses.

for the 48 years of participation in the labor market. In total, the intervention yields a (present discounted value) benefit of US$1037.8.

Benefit-Cost ratios

Table 5 presents the BC ratios estimated under different assumptions. In the conservative analysis (columns 1 and 2) we considered the yearly cost per child of US$100.9 presented in Table 4. Because costs and benefits are experienced over a number of decades, it is desirable to discount them. A benefit of a given value (e.g., 10,000 dollars) that occurs in early life has a greater present discounted value (PDV) than a benefit of the same nominal value (10,000 dollars) decades later because in the interim the resources could be reinvested. Therefore PDVs of benefits should be estimated to compare them at different points in time. The choice of discount rates is important for benefits that occur later in the life cycle. For example the PDV of a $1,000 benefit experienced 50 years in the future (in prime adulthood after an ECD intervention was implemented) is $228.11 with a 3% discount rate, $87.20 with 5%, and $3.28 with 10% (Behrman et al, 2004, Table 7A.1). Typically discount rates of 3% to 5% are used for the social sectors. We use both rates to show the differences in the BC ratios. Considering a discount rate of 5% (column 1) the present value of the total cost per child is US$197 and the present value of the benefits of the intervention per child is US$1037.8. Thus, the most conservative estimate of the BC ratio is 5.3. In Table 5, column 2, we considered a discount ratio of 3%, and the BC ratio increases to 9.9.

Sensitivity analyses

Columns 3 to 8 in Table 5 present three different sensitivity analyses. In each one of them, we consider a discount rate of 5% (columns 3, 5 and 7) or 3% (columns 4, 6 and 8).

1. Taking the intervention to scale within clinics

The average clinic size is 20-90 children per clinic and the clinics are run once a week, we therefore calculated the median clinic size as 220 children per month (55 children*4 weeks) or

2,200 children in total for 10 clinics. If the intervention was reaching all the children in these 10 clinics, this greater number of children receiving the program would increase the total amount of wages for the nurses to US$3,715.9 and the materials costs to US$10,251.8. The time spent by nurses on the intervention is dependent on the number of children seen, whereas the time spent by a CHW on the intervention is unchanged as this is the time for each child health clinic day (and not dependent on the number of children). The other costs presented in Table 4 remain unchanged. We estimated that the total cost for 2,200 children during one year is US$30,694.6, and the yearly cost per child is US$14. Using a discount rate of 5%, we estimated the present value of the cost for the first and second year of intervention. The present value of the total cost per child comes to US$27.3. Considering that the present value of the benefits of the intervention is US$1,037.8, as in the conservative scenario, the BC ratio stands at 38.0 (Table 5, column 3).

2. Costing of nurses time

One of the potential benefits of integrating ECD services into the health sector is the potential for lower costs due to the use of the same personnel (i.e., no new hires). It is an empirical question whether there will be a (negative/positive) impact on the existing service because of taking away the staff from their initial duties. This particular evaluation did not find any impact on the existing service (either immunization rates or growth) (Chang *et al*, 2015). For the Jamaica case, we might therefore consider that nurse's time should not be included in the costing exercise because they are in the clinics anyway, there is limited impact on the existing service, and the time they allocate to this intervention is 2 minutes per child. We run such robustness check in columns 5 and 6 in Table 5, and the benefit-cost ratio stands at 47 (using a discount rate of 5%).[4] However, at a larger scale the total amount of time would increase and may need to be considered.

[4] Not doing the costing of nurses in the evaluation sample does not make much difference (BC ratios turn to be 6.95 and 12.9 with 5% and 3% discount rates, respectively). This makes sense because the total number of hours being considered for the costing is minimal.

3. Attenuation of benefits at scale

In column 7 we assumed an attenuation of benefits (i.e. smaller effect size in cognition) due to loss of fidelity of the intervention (less monitoring and supervision, training and so on). Assuming the effect size is 0.20SD at scale, the BC ratio, with a 5% discount rate, is 20.[5]

Costs of Home Visits Intervention in Jamaica

The costs for a 12 months period are summarized in Table 6. The total cost of one year intervention is US$36,761.6, and given that the evaluation sample is 150 children[6], the yearly cost per child is US$245.1.

Benefits of Home Visits Intervention

To estimate the present value of the benefits of the home visits intervention we use the same assumptions described for the health center intervention. We assumed that children will participate in the labor market from age 17 to age 65, the average wage of Jamaica in 2012 was US$1,000, and this home visits pilot had an impact on cognition of 0.34SD, and an effect on wages of 11%.[7] We used a discount rate of 5%. Adding the net present value of the income gains in 2012, we get the total benefit of the intervention per child: US$928.6.

Benefit-Cost ratios of Home Visits Intervention

The yearly cost per child is US$245.1. As described in the previous section, the benefits of the intervention show a present value of US$928.6. Therefore, the most conservative estimate of the BC ratio is 3.8, considering a discount rate of 5% (column 1, Table 7).

[5] We use 0.20SD based on the literature of larger scale home visits. Attanasio et al., (2014) find a 0.26SD effect in a home visiting pilot within an existing Conditional Cash Transfer in Colombia; while Lopez Boo et al. (2014) found a very modest effect of 0.13SD in an integrated ECD program in Nicaragua. The latter found BC ratios of 1.5-2.3.

[6] As shown I nFigure1, the home visits intervention was evaluated in 10 clinics, and although the evaluation sample was 10 children per clinic, 15 children per clinic could have been visited if all 3 CHWs visited 5 children each, so 150 children would have received home visits from 6 months to 18 months, or a total of one year.

[7] This is 42.5% of the impact in cognition and of the effect on wages founded in the original interventions in Jamaica, 0.80SD and 25%, respectively.

Sensitivity analysis

In columns (3) to (6) in Table 7 we run two sensitivity analyses. In each one of them, we consider a discount rate of 5% (columns 3 and 5) or 3% (columns 4 and 6). Firstly, we cost the intervention as if it was taken to scale within the clinic (columns 3 and 4) and secondly, we estimated the BC ratios considering an attenuation of the benefits at scale.

1. Taking the intervention to scale within clinics

The median number of CHWs per clinic is 4. Each CHW can visit a maximum of 5 children per clinic, therefore a total of 20 children per clinic could potentially receive home visits. Taking as a basis 10 clinics, the total number of children and CHWs comes to 200 and 40, respectively. These greater numbers of CHWs and children receiving home visits increase the material costs to US$4,941.4, the cost of CHWs travel to homes to US$7,920.0, and the cost of CHWs phone credits to US$480.0. Considering that the other costs presented in Table 6 remain unchanged, we estimated that the cost for a 12 month period is US$39,946.9. Despite the larger total cost,the cost per child is US$199.7 due to a proportionally higher number of children visited. As in the conservative scenario, we calculated that the present value of the benefit of the intervention using a discount rate of 5% is US$928.6, so the BC ratio is 4.7 (column 3 in Table 7).

2. Attenuation of benefits at scale

Columns 5 and 6 in Table 7 takes into account the attenuation of benefits due to scale up. The BC ratio is now 2.7 with a 5% discount rate.

Discussion

The new parenting intervention delivered during routine well child visits in primary care health centers in three countries in the Caribbean was effective in improving cognitive development in children below aged 2 years and mothers knowledge of child care. The size of the cognitive benefit was comparable to other more intensive programs elsewhere (Attanasio *et al*, 2014;Hamadani *et al*, 2006) although it was smaller than previous Jamaican home visiting interventions (Grantham-

McGregor *et al*, 1991;Powell *et al*, 2004) and benefits were limited to cognition, with no benefits to the children's language or fine motor development. There was only one intervention contact after 12 months, which is a time of rapid expansion in language. Moreover the children's greatest deficit in development was in cognitive development, and their mean language scores were age appropriate. It may be easier to benefit developmental domains where deficits are greatest.

The benefit to parenting knowledge from the health center intervention suggests that the mothers remembered the messages delivered. The mothers shown on the films were of similar social background to the majority of women in the clinics and this may have helped the mothers to see the behaviors and activities modeled on the films as relevant to them. Feedback from mothers in the qualitative interviews support this, as mothers liked the mothers in the films and the way they interacted with their children.

In Jamaica, we evaluated both the group delivery at health centers and an adapted home visit model delivered by the staff employed at the centers. Both the group approach based at the health centers and the home visit model benefited children's cognitive development with similar effect size. There was no additional benefit to development where parents received both interventions and the benefits from both these approaches were less than those from more intensive home visit interventions (Grantham-McGregor *et al*, 1991).

There were no benefits of either intervention for HOME scores which measure maternal child interaction and stimulation provided at home. It is possible that more modeling and practice is needed than could be provided in the limited number of contacts in the health center intervention. Maternal depression was also not reduced. Benefits have been seen with a more intensive home visit parenting program (Baker-Henningham *et al*, 2005).

The qualitative interviews showed that mothers generally had positive views of the interventions and saw benefits for themselves and their children. The health staff perceived similar benefits for mothers and children and also felt the program benefited them in areas such as

increased knowledge, job satisfaction and personal growth. This suggests that the programs were valued and that with appropriate support and supervision could be taken to scale. When asked to suggest improvements to the programs the most common responses were to expand the intervention to include other health centers and other mothers, and extend the duration so that it continued until children enter preschool.

The health staff also reported challenges to implementing the interventions with the most common issues being concerns of nurses and CHWs about staff workload, and challenges that the CHWs had with motivating and working with some mothers who were not interested. These challenges affected both the health center and home visit interventions. The interventions were implemented with no additional staff. Part of the rationale for promoting integration of ECD interventions with health and nutrition services is the advantage of shared delivery mechanisms. However some additional resources and staff are likely to be necessary to expand services.

Another challenge to implementation was that clinics were often noisy and crowded, which meant that some mothers would have difficulty hearing and seeing the films. It also made it more difficult for the health workers to interact with all the mothers during the demonstration and practice. The setting was mentioned by some of the CHWs as a challenge they faced in delivering the intervention.

Mothers preferred the home visit intervention to the health center intervention. Reasons included the costs involved in going to the health center despite the intervention requiring no additional visits to the center by the mothers. The mothers also preferred the privacy of the home setting and thought the intervention benefited children more. The CHWs also tended to prefer the home visit interventions although a few did not indicate a preference. The reasons for preferring home visits related to it being easier to deliver the intervention and engage the mothers in their homes. The health center intervention was delivered to all mothers in the waiting area and therefore the large group size would have made interactive sessions challenging. Group sessions are likely to

be more difficult for community women to lead, particularly in noisy, crowded health clinics, and this needs to be considered when deciding whether to choose a group model over one-on-one interaction in the home.

The cost of the health center intervention was relatively low and the BC ratio was high in relation to other similar interventions. We find positive BC ratios for both the health center and the home visits interventions, even when considering only the evaluation sample. Our estimates are robust to different assumptions. Moreover, because of the unique longitudinal data from the original Jamaica home visiting trial we were able to estimate benefits on wages from this earlier, similar intervention and relied on relatively few assumptions for our estimation of benefits. The earlier trial had more comprehensive benefits to early childhood development whereas in the current trial benefits were only to the cognitive score, thus our main assumption in estimating benefits is that the long term impact can be estimated based on the relative effects sizes. It is not established, and will have to be tested, whether interventions with effects of the magnitude found here will result in 11-12% higher wages as we have extrapolated.

Supervision of the intervention was provided by the research team and this may have been an important factor for success (Yousafzai & Aboud, 2014). Consideration of which personnel could provide supervision would be important in planning for scale up of the intervention. A considerable portion of the cost (26% of costs in home visits and 20% in the health center intervention) comes from the supervision side. It could be tested at scale what the costs and benefits would be if less qualified personnel did the supervision.

There were no adverse effects on nutrition or immunization status of the children and other small scale studies suggest that ECD and nutrition activities can be integrated without a negative impact on either component (Grantham-McGregor *et al*, 2014). However, this is an issue that will need attention as programs are scaled up, especially where children's health and nutrition are poorer and the capacity of health services more limited. Linking delivery of the health center intervention to primary care child health visits in these Caribbean countries has the advantage of excellent

coverage and compliance with health visits. The intervention required investment in equipment, materials and staff training, but was implemented by the existing staff. It also did not require any additional visits or time at the center for the parents, and as mothers generally have to wait for some time to see the nurse it is an efficient use of their time.

In Jamaica, two approaches to delivery through health services were evaluated with both designed to be scalable and targeted to children up to age 18 months which is the period with most consistent contact with the health service. Both benefited child cognitive development. Mechanisms to provide continuing support for parents and children, after health center contacts decrease, through to entry in pre-primary or primary schools need to be developed. Disadvantaged or high risk children probably need additional support and could be targeted for continued home visiting.

Conclusions

We have shown that it is feasible to integrate a child development intervention with routine child health services with no additional contacts. The health center model is a promising component of an early childhood development strategy with potential benefits for large numbers of children. We have also shown that community health workers employed to these centers can deliver an adapted home visit program. The benefits from both interventions were less comprehensive than more intensive Jamaican home visit models, and it is not known whether the benefits will be sustained.

This study showed that both interventions have great potential. Countries that want to impact children's lives are likely to find scaling-up these interventions to be some of the best investments they can make. It is important to note that our arguments are based on economic calculations. We believe this is important because this is precisely the type of calculation that the Ministry of Finance and Planning Commission officials make. The paper presents valuable information for policy makers: first, to help them justify in economic terms this type of ECD investment, second, decide between public investment alternatives, and, third, understand that

integrating parenting interventions into the health services has the potential to reach a large number of children in a cost-effective manner. Even when considering an attenuation of the benefits, both interventions have BC ratios higher than 1 and therefore worth making the investment. Moreover, the detailed presentation of data on costs and benefits of both interventions is likely to be a contribution to the ECD literature.

Figure 1 Overall Study Sample (file HC total study sample.pdf)

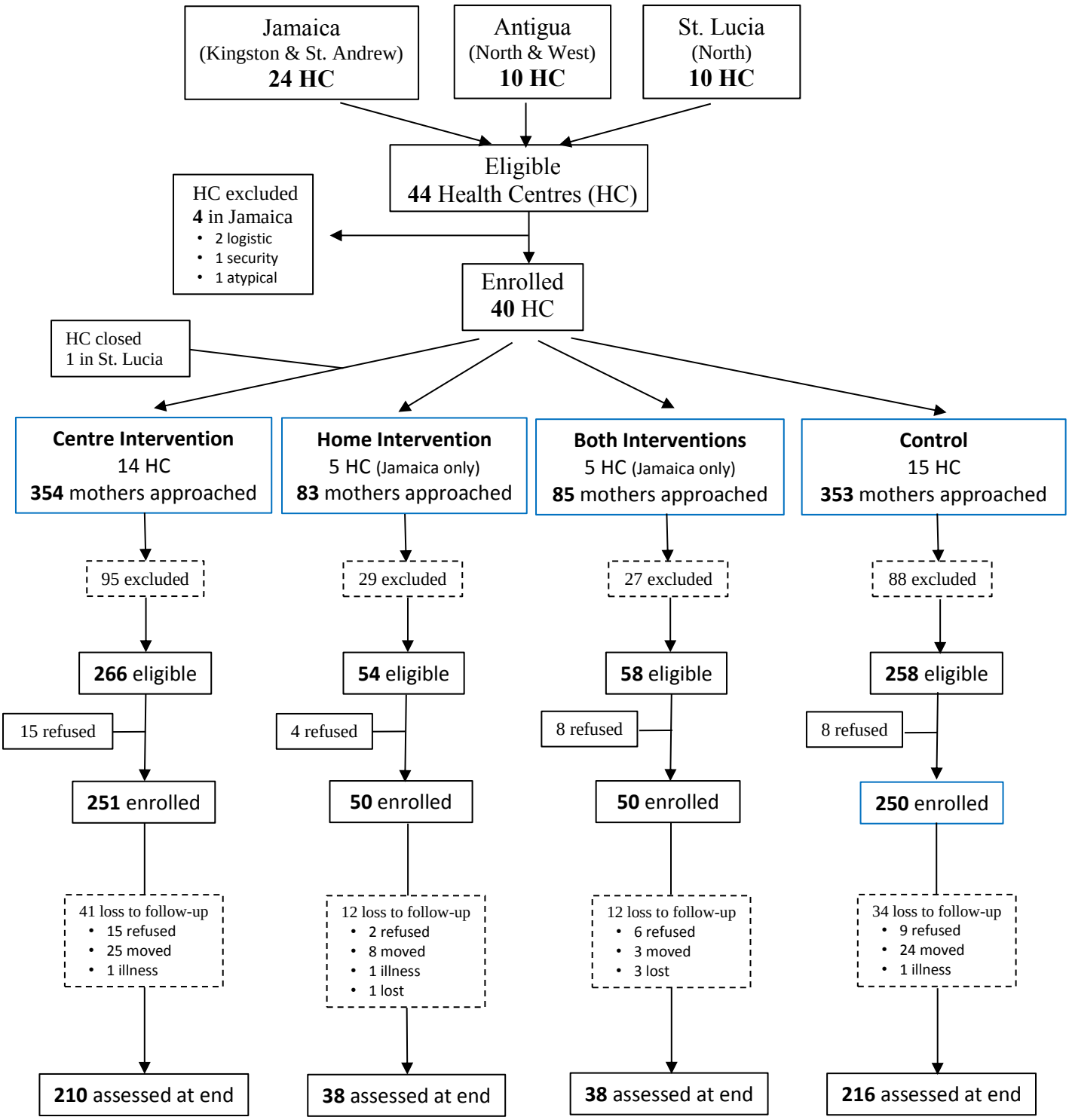

Table 1 Primary and secondary outcomes at end of trial

	3 Countries		Jamaica			
	Control (n=210)	**Health Centre Only (n=216)**	**Control (n=123)**	**Health Centre Only (n=128)**	**Home Visiting Only (n=38)**	**Both interventions (n=38)**
Primary Outcomes						
Developmental Quotient	94·7 (8·2)	96·1 (9·4)	95.0(7.4)	95.7(9.6)	97.6(7.9)	96.5(7.1)
Cognitive	89·5 (10·6)	92·7 (11·6)	87.7(10.1)	91.7(11.3)	92.0(8.5)	91.7(11.1)
Language	100·0 (13·6)	99·8 (14·0)	100.7(12.8)	99.1(14.0)	103.6(16.0)	100.0(11.0)
Hand and eye	94·6 (9·9)	95·9 (10·2)	96.6(8.5)	96.4(10.3)	97.4(9.0)	97.7(8.6)
Vocabulary (CDI)	39·6 (20·5)	38 (18·4)	41.9(19.9)	40.2(18.3)	41.8(20.2)	40.2(16.3)
Secondary Outcomes						
Parenting score	39·6 (4·1)[a]	41·3 (3·6)	39.7(3.8)	41.8(3.5)	39.7(3.4)	41.6(3.7)
HOME	28·3 (4·8)[a]	29 (4·9)	27.4(4.7)	28.6(4.4)	29.2(4.1)	28.7(4.7)
Depressive symptoms	17·3(11·4)[b]	18·2(11·4)[c]	18.8(11.6)[a]	19.2(11.1)[d]	17.2(10.8)[a]	19.0(13.3)[a]
Head circumference-for-age z-score	-0·01 (1·3)	0·36 (1·1)[a]	0.15(1.1)	0.4(0.1.0)[a]	0.07(1.1)	0.14(1.0)[a]
Height-for-age z-score	-0·11 (1·1)	-0·1 (1·1)	-0.31(1.0)	-0.17(1.05)	-0.27(1.23)	-0.37(1.1)[a]
Weight-for-height z-score	0·15 (1·1)[a]	0·15 (1·0)	0.17(1.0)	0.18(0.96)	0.18(1.12)	0.10(1.0)[a]

Data are mean (SD). [a] Data are missing for one child, [b] data missing for two children. [c] data missing for five children, [d] data missing for three children.

Table 2 Challenges with intervention implementation (values in brackets are numbers of persons reporting)

Themes	Quotations
Perceptions of CHWs (n=21)	
Mothers' attitude or behavior (15)	"They complain that they watch it already, that it's only one video we have" "It's good if you're doing the program and mothers are enjoying it but with some of the mothers, where you have to pulling the mother eventually it becomes overburdened" "For the home visits, when you go, you might call them before you go and when you go they are not there. And they tell you they are at this address and when you go, you can't find them, they move"
Staffing (6)	"I needed the other CHWs on the program to get in the discussions also" "I had to be giving the talks a lot, persons just back out" "Maybe I'm not on the road working this week but I need to do visits. There are times I need to go visit and I can't because we are short-staffed" "If we have a full clinic, worse if it's me alone working that morning and I have to weigh the babies, see they watch the video and then go and give the talk and the nurses are waiting for the docket"
Setting (4)	"If they come when we have a full clinic, sometime the ones that are supposed to be participating not getting the chance. The others, for instance, they come for family planning, they don't want to hear, they don't want to watch and it can be disruptive" For the home visit, sometimes I have to sit outside and you don't always have a seat or something so I don't get to work as I would want to with the baby"
Equipment (3)	"They stole the VCR and the television. That was the problem" "You might want to show the tape and you can't get the TV up"
Transportation (1)	"It depends where the persons are and I have a baby way up in the hill part and vehicles don't really go up there"
Father attitude (1)	"They don't have any patience. They impatient, they impatient more than the mothers"
Perceptions of Nurses (n=9)	
Staff workload (5)	"There are days when we really do feel overwhelmed, when the workload is heavy … to stop to this part of the implementation going in the clinic setting, it can be tedious" "They have to do their other home visits plus your babies" "Where we don't have enough staff, sometimes we have to pull from other areas to make sure the persons go and do the teaching"
Equipment (3)	"At the beginning we didn't have electricity" "Some persons were not able to be there because there are no benches, there are no seats"
Mothers' attitude or behavior (3)	"Some of them felt that they had been there, done that because this is not their first child" "Some of the clients are uncooperative. So when the CHW want to visit them, they are not at home when they said they would be"

Table 3: Suggestions for Improvement (values in brackets are numbers of persons reporting)

Themes	Quotations
Perceptions of mothers (n=24)	
Extend length (6)	"I think it should continue longer. Until at least school age, about 3 or so"
Expand program (4)	"It would be good if it could be done in the rest of the health centers"
Improve toys (2)	"Once they see the bottles, they know chubby bottles, so they are aiming for their mouths. I think they should use different containers"
Improve video (1)	"The video, put a little more hype you know, spice it up a little more"
Make it compulsory (1)	"Instead of asking parents if they would like to join the program, make them join the program"
No suggestions (12)	
Perceptions of CHWs (n=21)	
Continue the program (9)	"I would like to see it go up to when they are starting preschool"
Do parenting workshops in community (6)	"Like how we had a training, if the mothers could get training themselves. Like have a parenting workshop."
Expand the program (5)	"Get more mothers involved" "Take it further than the clinic" "Instill it in the clinic and in every clinic"
Increased resources (2)	"We didn't have enough books" "We need more toys, we didn't get enough"
Put videos on TV (2)	"I wish it could go wider – you could have it like televised cause some mothers that really need it you can't reach"
No suggestions (8)	
Perceptions of nurses (n-9)	
Expand the program (4)	"I think more people should be involved"
Involve nurses more (2)	"We should be more involved because we don't actually see what they are doing with the babies. We could have been in on the home visits."
More training (1)	"We had all the workshops before and then the practical. If you had a workshop during the period the intervention was going on it would be better"
No suggestions (2)	

Table 4: Yearly Cost of Health Center Intervention

Nº	Description	Amount in US$	Cost type
1	Equipment purchase	1,265.6	Fixed
2	Materials	3,113.8	Variable
3	CHWs wage	667.5	Variable
4	CHWs training	8,550.0	Fixed
5	Nurses wage	337.8	Variable
6	Nurses Training	2,100.0	Fixed
7	Supervisor wage	2,643.8	Variable
8	Supervisor Training	1,500.0	Fixed
	Total Cost	**20,178.4**	
	Total Cost per Child	**100.9**	

Notes: Total number of children intervened: 200 in a total of 10 clinics. 40 CHWs, 27 nurses and one supervisor have worked in the pilot intervention

Table 5: Benefit Cost Ratio Health Center Intervention

	Conservative		**Sensitivity analysis**					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PDV Total Cost per child* (Yearly Cost per child)	197.1 (100.9)	197.3 (100.9)	27.3 (14.0)	27.6 (14.0)	22.1 (11.3)	22.3 (11.3)	27.3 (14.0)	27.6 (14.0)
PDV benefit per child*	1,037.8	1,943.7	1,037.8	1,943.7	1,037.8	1,943.7	546.2	1,023.0
Benefit-cost ratio	**5.3**	**9.9**	**38.0**	**70.5**	**47.0**	**87.3**	**20.0**	**37.1**
Num. Children	200	200	2,200	2,200	2,200	2,200	2,200	2,200
Effect size cognition	0.38	0.38	0.38	0.38	0.38	0.38	0.20	0.20
Nurse wages	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Discount rate	5%	3%	5%	3%	5%	3%	5%	3%

Table 6: Yearly Cost of Home Visit Intervention

Nº	Description	Amount in US$	Cost type
1	Materials	3,856.1	Variable
2	CHWs wage	10,012.5	Variable
3	CHWs training	5,700.0	Fixed
4	Nurses wage	405.0	Variable
5	Nurses Training	1,050.0	Fixed
6	CHWs Travels to homes	5,940.0	Variable
7	CHWs Phone credit	360.0	Variable
8	Supervisor wage	7,938.0	Variable
9	Supervisor Training	1,500.0	Fixed
	Total Cost	**36,761.6**	
	Total Cost per Child	**245.1**	**.**

Note: Total number of children intervened: 150 in a total of 10 clinics. A total of 30 CHWs, 10 nurses and one supervisor are estimated to have worked in the pilot intervention.

Table 7: Benefit-cost ratio Home Visit Intervention

	Conservative		**Sensitivity analysis**			
	(1)	(2)	(3)	(4)	(5)	(6)
Total Cost per child (1 year)*	245.0	245.0	199.7	199.7	199.7	199.7
PDV benefit per child*	928.6	1739.2	928.6	1739.2	546.2	1023.0
Benefit-cost ratio	**3.8**	**7.1**	**4.7**	**8.7**	**2.7**	**5.1**
Num. Children	150	150	200	200	200	200
Num. CHWs	30	30	40	40	40	40
Effect size cognition	0.34	0.34	0.34	0.34	0.20	0.20
Discount rate	5%	3%	5%	3%	5%	3%

*Amounts in US$.

References

Attanasio,O.P., Fernandez,C., Fitzsimons,E.O., Grantham-McGregor,S.M., Meghir,C., & Rubio-Codina,M. (2014) Using the infrastructure of a conditional cash transfer program to deliver a scalable integrated early child development program in Colombia: cluster randomized controlled trial. *BMJ*, 349, g5785 doi:10.1136/bmj.g5785**.**

Baker-Henningham,H., Powell,C., Walker,S., & Grantham-McGregor,S. (2005) The effect of early stimulation on maternal depression: a cluster randomised controlled trial. *Arch.Dis.Child*, 90, 1230-1234.

Behrman J., Alderman H. & Hoddinott J. (2004) Hunger and malnutrition. In: *Global Crisis, Global Solutions* (ed. B. Lomborg), pp 363–442. Cambridge University Press: Cambridge, UK

Berlinski, S. and Schady, N. eds. 2015, in press. *The Early Years: Child Well-being and the Role of Public Policy*. Development in the Americas Series. New York: Palgrave MacMillan, and Washington, DC: Inter-American Development Bank

Black,M.M. & Dewey,K.G. (2014) Promoting equity through integrated early child development and nutrition interventions. *Ann.N.Y.Acad.Sci.*, 1308, 1-10.

Black,M.M., Walker,S.P., Wachs,T.D., Ulkuer,N., Gardner,J.M., Grantham-McGregor,S., Lozoff,B., Engle,P.L., & de Mello,M.C. (2008) Policies to reduce undernutrition include child development. *Lancet*, 371, 454-455.

Caldwell,B.M. & Bradley,R.H. (2003) *Home Inventory Administration Manual,* University of Arkansas, Little Rock, AR.

Campbell,F., Conti,G., Heckman,J.J., Moon,S.H., Pinto,R., Pungello,E., & Pan,Y. (2014) Early childhood investments substantially boost adult health. *Science*, 343, 1478-1485.

Chan,M. (2013) Linking child survival and child development for health, equity, and sustainable development. *Lancet*, 381, 1514-1515.

Chang S.M., Grantham-McGregor S.M., Powell C.A., Vera-Hernández M., Lopez-Boo F., Baker-Henningham H.,& Walker S.P. (2015) Integrating a Parenting Intervention with Routine Primary Health Care: A Cluster Randomized Trial. *Pediatrics* published online: July 6, 2015 (doi: 10.1542/peds.2015-0119).

Dunn,L.M. & Dunn,D.M. (2007) *Peabody Picture Vocabulary Test, 4th edition,* Pearson, San Antonio, TX.

Fenson,L., Marchman,V.A., Thal,D.J., Dale,P.S., Reznick,S., & Bates,E. (2003) *MacArthur-Bates Communicative Development Inventory,* Brookes Publishing, Baltimore, MD.

Gertler P, Heckman J, Pinto R, Zanolini A, Vermeerch C, Walker,S., Chang,S., & Grantham-McGregor,S. (2014) Labor market returns to an early childhood stimulation intervention in Jamaica. *Science*, 344, 998-1001.

Grantham-McGregor,S., Cheung,Y.B., Cueto,S., Glewwe,P., Richter,L., & Strupp,B. (2007) Developmental potential in the first 5 years for children in developing countries. *Lancet*, 369, 60-70.

Grantham-McGregor,S.M., Fernald,L.C., Kagawa,R.M., & Walker,S. (2014) Effects of integrated child development and nutrition interventions on child development and nutritional status. *Ann.N.Y.Acad.Sci.*, 1308, 11-32.

Grantham-McGregor,S.M., Powell,C.A., Walker,S.P., & Himes,J.H. (1991) Nutritional supplementation, psychosocial stimulation, and mental development of stunted children: the Jamaican Study. *Lancet*, 338, 1-5.

Griffiths R & Huntley M (1996) *The Griffiths Mental Development Scales from birth to 2 years*, The Test Agency Limited, Oxford, UK.

Hamadani,J.D., Huda,S.N., Khatun,F., & Grantham-McGregor,S.M. (2006) Psychosocial stimulation improves the development of undernourished children in rural Bangladesh. *Journal of Nutrition*, 136, 2645-2652.

Heckman,J.J. (2006) Skill formation and the economics of investing in disadvantaged children. *Science*, 312, 1900-1902.

Heytig,A., Tolboom,J.T.B.M., & Essers,J.G.A. (1992) Statistical handling of drop-outs in longitudinal clinical trials. *Statistics in Medicine*, 11, 2043-2061.

Holm,S. (1979) A simple sequentially rejective mulitple test procedure. *Scand Journal Med*, 6, 65-70.

Lake,A. (2011) Early childhood development-global action is overdue. *Lancet*, 378, 1277-1278.

Lopez Boo, F., Palloni,G., & Urzua, S. (2014) Cost–benefit analysis of a micronutrient supplementation and early childhood stimulation program in Nicaragua *Ann. N.Y. Acad. Sci.*, 1308, 139–148

Ludbrook,J. (1998) Multiple comparison procedures updated. *Clin.Exp.Pharmacol.Physiol*, 25, 1032-1037.

Powell,C., Baker-Henningham,H., Walker,S., Gernay,J., & Grantham-McGregor,S. (2004) Feasibility of integrating early stimulation into primary care for undernourished Jamaican children: cluster randomised controlled trial. *BMJ*, 329, 89-91.

Powell,C. & Grantham-McGregor,S. (1989) Home visiting of varying frequency and child development. *Pediatrics*, 84, 157-164.

Radloff,L. (1977) The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas*, 1, 385-401.

Stata Statistical Software: Release 13. 2013. College Station, TX, StataCorp LP.

Walker,S.P., Chang,S.M., Vera-Hernandez,M., & Grantham-McGregor,S. (2011a) Early childhood stimulation benefits adult competence and reduces violent behavior. *Pediatrics*, 127, 849-857.

Walker,S.P., Wachs,T.D., Gardner,J.M., Lozoff,B., Wasserman,G.A., Pollitt,E., & Carter,J.A. (2007) Child development: risk factors for adverse outcomes in developing countries. *Lancet*, 369, 145-157.

Walker,S.P., Wachs,T.D., Grantham-McGregor,S., Black,M.M., Nelson,C.A., Huffman,S.L., Baker-Henningham,H., Chang,S.M., Hamadani,J.D., Lozoff,B., Gardner,J.M., Powell,C.A., Rahman,A., & Richter,L. (2011b) Inequality in early childhood: risk and protective factors for early child development. *Lancet*, 378, 1325-1338.

Wooldridge,J. (2002) *Econometric analysis of cross section and panel data*, pp. 587-590. MIT Press, Cambridge, MA.

Yousafzai,A.K. & Aboud,F. (2014) Review of implementation processes for integrated nutrition and psychosocial stimulation interventions. *Ann.N.Y.Acad.Sci.*, 1308, 33-45.