10-year effect of Oportunidades, Mexico's conditional cash transfer programme, on child growth, cognition, language, and behaviour: a longitudinal follow-up study

Lia C H Fernald, Paul J Gertler, Lynnette M Neufeld

Summary

Background Mexico's conditional cash transfer programme, Oportunidades, was started to improve the lives of poor families through interventions in health, nutrition, and education. We investigated the effect of Oportunidades on children almost 10 years after the programme began.

Methods From April, 1998, to October, 1999, low-income communities were randomly assigned to be enrolled in Oportunidades immediately (early treatment, n=320) or 18 months later (late treatment, n=186). In 2007, when 1093 children receiving early treatment and 700 late treatment in these communities were aged 8–10 years, they were assessed for outcomes including physical growth, cognitive and language development, and socioemotional development. The primary objective was to investigate outcomes associated with an additional 18 months in the programme. We used cluster-adjusted *t* tests and multivariate regressions to compare effects of programme participation for height-for-age, body-mass index (BMI), and cognitive language and behavioural assessment scores in early versus late treatment groups.

Findings Early enrolment reduced behavioural problems for all children in the early versus late treatment group (mean behaviour problem score –0·09 [SD 0·97] *vs* 0·13 [1·03]; p=0·0024), but we identified no difference between groups for mean height-for-age *Z* scores (–1·12 [0·96] *vs* –1·14 [0·97]; p=0·88), BMI-for-age *Z* scores (0·14 [0·99] *vs* 0·17 [1·06]; p=0·58), or assessment scores for language (98·8 [13·8] *vs* 98·4 [14·6] p=0·90) or cognition (98·8 [12·9] *vs* 100·2 [13·2]; p=0·26). An additional 18 months of the programme before age 3 years for children aged 8–10 years whose mothers had no education resulted in improved child growth of about 1·5 cm assessed as height-for-age *Z* score (β 0·23 [0·023–0·44] p=0·029), independently of cash received.

Interpretation An additional 18 months in the Oportunidades programme has independent beneficial effects other than money, especially for women with no formal education. The money itself also has significant effects on most outcomes, adding to existing evidence for interventions in early childhood.

Funding Mexican Ministry of Social Development and the National Institutes of Child Health and Human Development.

Lancet 2009; 374: 1997–2005

This online publication has been corrected. The corrected version first appeared at thelancet.com on November 26, 2010

Published Online November 4, 2009 DOI:10.1016/S0140-6736(09)61676-7

See Comment page 1952

Community Health and Human Development, School of Public Health, University of California, Berkeley, CA, USA (Prof L C H Fernald PhD, Prof P J Gertler PhD); **Instituto Nacional de Salud Pública, Cuernavaca, Morelos, Mexico** (L M Neufeld PhD); and Micronutrient Initiative, Ottawa, ON, Canada (L M Neufeld)

Correspondence to: Prof Lia C H Fernald, School of Public Health, University of California, Berkeley, 50 University Hall, Berkeley, CA 94720-7360, USA **fernald@berkeley.edu**

Introduction

Poverty leads to poor outcomes in children,[1] which is why long-term reduction of poverty rather than short-term management of issues is crucial.[2] Conditional cash transfer (CCT) programmes—now in place in many countries—are a popular approach to alleviation of long-term poverty, and operate by provision of cash payments to families only if they comply with a set of requirements.[3] These programmes use cash both as a mechanism to allow parents to provide for their children's needs and as an incentive for parents to invest in their children's health and wellbeing.[4] Most programmes distribute benefits conditional on mandatory attendance at preventive health-care services and health and nutrition education sessions designed to promote positive behavioural changes, and some also require school attendance for school-aged children.[5] With simultaneous goals of immediate poverty alleviation through cash transfers that can be spent without restrictions, and long-term poverty reduction through investments in health, knowledge, and skills, CCTs have been embraced[3] and criticised[6] by the development community.

Mexico's Oportunidades (previously *Progresa*) was one of the first CCT programmes to be designed, and has been the model for programmes in Colombia, Ecuador, Guatemala, Turkey, Indonesia, Pakistan, the USA, and many other countries. The programme improved child growth after 2–5 years of enrolment in rural[7,8] and urban[9] areas, and effects were strongest in vulnerable subgroups.[8,9] Improvements in child height have also been reported in analyses of CCT programmes in Nicaragua,[10] Ecuador,[11] and Colombia,[12] but no effect on height was shown in assessments from Brazil[13] or Honduras.[14] We are aware of only three such programmes, in Mexico, Ecuador,[11] and Nicaragua,[15] that have included cognitive or language function as part of the range of outcome measures, with results suggesting some small but significant effects on a subset of these variables when comparisons were made between children who

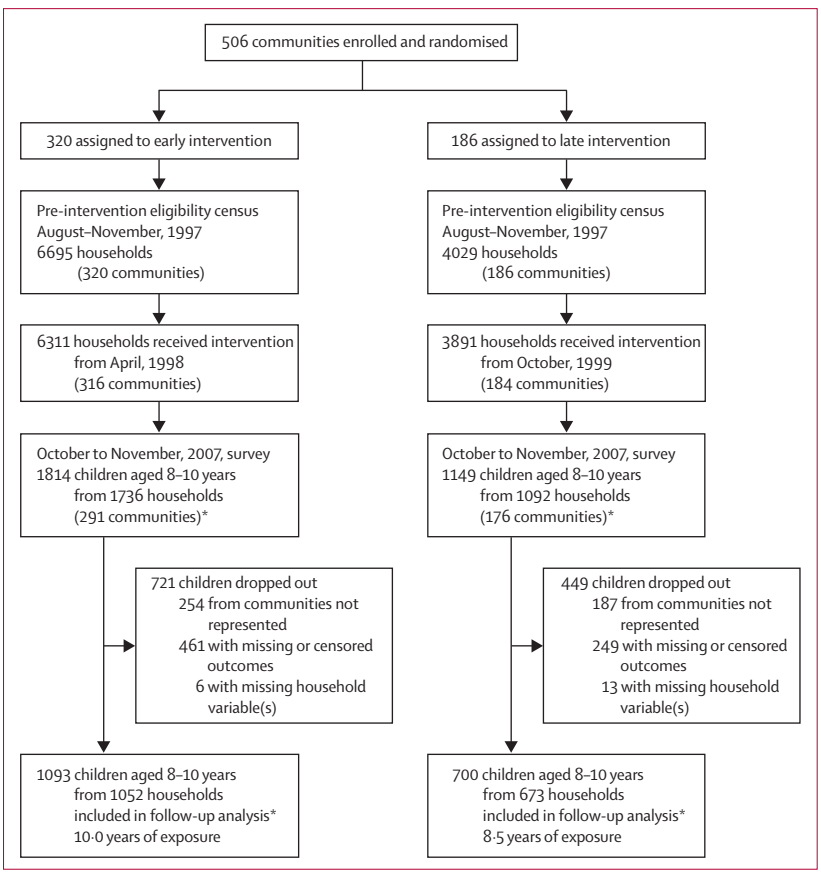

Figure 1: **Trial profile**
*To create the primary analysis group, children were omitted if they were from households living in localities not represented, if they had either missing or censored outcome measures even though their localities were represented, and if their household had a key variable missing after imputation (eg, asset wealth).

See Online for webappendix

did and did not receive the programme. Children in the Oportunidades assessment—the only CCT programme assessment that we are aware of to include behavioural measures of young children—also showed better psychosocial functioning in the medium term than did those who were not enrolled.[16]

The cash component of the programme was associated with small but significantly improved outcomes in child height, cognition, and language development 3·5–5·0 years after the programme started in children who had been enrolled since birth.[17] We now replicate these analyses for children who are several years older, and extend our analysis to include the psychological functioning of these children.

Methods

Participants and programme design

Oportunidades incorporated low-income families living in poor, rural communities (with 501–2499 inhabitants).[18] Briefly the Mexican Government randomly chose 320 early intervention and 186 late intervention communities in seven states for 506 experimental communities (figure 1). 90% of households chose to participate in the programme.[19] Random assignment was generated without weighting with randomisation commands in STATA version 2.0. No sites were told that they would be participating in the programme, and information about timing of programme roll-out was not made publicly available.

This sample of communities was representative of Oportunidades rural beneficiary communities and was well balanced, suggesting that randomisation effectively generated truly exogenous variation in the two groups.[19] Eligible households in early intervention communities received benefits starting in April, 1998, and those households in late intervention communities did not receive benefits until October, 1999. Although recruitment rates into the programme differed in these communities, households within communities did not differ by any measured characteristic.[18]

Cash transfers, which increase household income by 20–30%, are given to the female head of the household. Such transfers are conditional on children attending school and family members obtaining preventive medical care and attending *pláticas*—education talks on health-related topics.[17] Compliance was verified by clinics and schools, and about 1% of households were denied cash transfers for non-compliance. Cash transfers are provided once every 2 months in two forms—a fixed stipend intended for food, and educational scholarships for school-aged children, which vary by grade and sex. Total cash transfers for any given household are capped at a pre-established upper amount. According to programme rules, differently composed households are eligible to receive varying transfer amounts. The equations used for calculation of transfer amounts are in the webappendix (p 1). Families also receive a milk-based fortified food supplement for all pregnant and lactating women (until 1 year post partum), for children aged 6–24 months, and for those aged 2–4 years with low bodyweights.

The Oportunidades assessment was approved by the Research, Biosecurity, and Ethics Commissions at the National Institute of Public Heath in Mexico, and the Committee for the Protection of Human Subjects at the University of California at Berkeley, CA, USA. All participants signed an informed consent declaration.

Data collection

Between Sept 1, and Dec 15, 2007, we undertook a comprehensive follow-up survey with all the original communities that had at least five beneficiary families and five children younger than age 2 years. Within these communities we identified children born between March 1, 1997, and Oct 31, 1998, who had participated in the previous survey rounds (October–November, 1997, and September–December, 2003). We merged 2007 data with data from a previous assessment round (2003), data from the pre-intervention household socioeconomic and demographic assessment (1997), and administrative

records from Oportunidades recording the amount of cash transferred to every family (2007).

We report whether previous short-term and medium-term growth and development findings were retained in children who are now aged 8–10 years. A second objective was to investigate the interaction of length of programme participation and two key measures of socioeconomic status (maternal education and a baseline index of housing and assets) on child outcomes, and our third objective was to disaggregate mechanisms by which Oportunidades could affect outcomes.

We assessed height and weight with standardised techniques.[20,21] Cognitive development and language ability were assessed with the Wechsler abbreviated scale of intelligence, which is a shorter version of the Wechsler intelligence scales III.[22] This scale was used instead of the Wechsler intelligence scales because of time constraints in the field, and was adapted for use by researchers at the Mexican Perinatal Hospital in Mexico City, Mexico.[23] We assessed child behaviours with an adapted version of the strengths and difficulties questionnaire administered through personal interview to participating mothers, who were asked to report about behaviours of their children. This questionnaire has been used worldwide,[24] and was piloted and adapted as necessary.[25]

The treatment variable was defined as random assignment to early enrolment (an additional 18 months of exposure to the programme) or late enrolment. Cumulative cash transfers were used as another primary independent variable, and were defined as the total amount of cash a family had received since enrolment into Oportunidades up to the time when the survey was undertaken in 2007. The amount of cash accumulated during the time enrolled in the programme (webappendix p 1) was used instead of cash transfers in the last month because a cumulative transfer shows exposure of a child to cash during crucial periods for growth and development better than does the amount of cash received in a specific short-term period, such as the previous month.

Interviews were done with the mother or primary caregiver of every child to obtain information about date of birth, age (as a set of indicator variables), and sex. Household information was obtained at baseline in 1997, and included composition of the household (ie, age and sex of all family members), education of the mother and father, maternal age, number of people in the household, whether an indigenous language was spoken or understood by any member of the household, presence of electricity and water in the household, and number of small and working animals owned. We created a baseline asset index on the basis of possession of household goods (irrespective of their working condition), which is a good estimation of consumption—the gold-standard measure of socioeconomic status.[26,27] Principal components analysis was used to consolidate the asset variables into one measure, and the first principal component was retained. If household data were missing from the 2007 survey, then rosters or surveys from 2003, or 1997, were used to fill in gaps in information. In about 10% of cases, missing household and parental information was imputed with the mean for the community.

	Participation in 10-year follow-up			p value*
	Included (NH=1725)	Not included (NH=1103)	Total (NH=2828)	
Characteristics (continuous)				
Number of people in household	6·30 (2·39)	6·66 (2·62)	6·44 (2·48)	0·0035
Household composition (number of people)				
Male				
Children (0–5 years)	0·94 (0·85)	0·90 (0·87)	0·93 (0·86)	0·26
Children (6–17 years)	0·99 (1·10)	1·10 (1·23)	1·03 (1·15)	0·018
Working-aged adults (18–49 years)	1·05 (0·46)	1·10 (0·60)	1·07 (0·52)	0·04
Older adults (>50 years)	0·14 (0·35)	0·20 (0·42)	0·16 (0·38)	0·0004
Female				
Children (0–5 years)	0·91 (0·86)	0·90 (0·86)	0·90 (0·86)	0·88
Children (6–17 years)	1·04 (1·16)	1·06 (1·17)	1·05 (1·16)	0·66
Working-aged adults (18–49 years)	1·10 (0·48)	1·17 (0·59)	1·12 (0·52)	0·0027
Older adults (>50 years)	0·14 (0·36)	0·22 (0·45)	0·17 (0·40)	0·0001
Land owned, hectares	1·49	1·68	1·56	0·27
Asset index value†	−0·39 (0·60)	−0·39 (0·67)	−0·39 (0·63)	1·00
Characteristics (dichotomous)				
Ethnic origin (head of household speaks indigenous language)	729 (42%)	520 (47%)	1249 (44%)	0·36
Piped water on family land	484 (28%)	320 (29%)	804 (28%)	0·83
Own at least one draught animal	547 (32%)	390 (35%)	937 (33%)	0·24
Own other animals (to sell or to sell animal products)	1370 (79%)	888 (81%)	2258 (80%)	0·64
Electricity in home	1086 (63%)	619 (56%)	1705 (60%)	0·18
Households in early intervention group	1052 (61%)	684 (62%)	1736 (61%)	0·58
Qualifying children in early intervention group	1093 (61%)	721 (62%)	1814 (61%)	0·72

Data are mean (SD) or n (%), and are stratified by whether children were included in the 10-year follow-up analysis (2007). NH=number of households. Sample size varies slightly according to characteristic measured. *p values are for cluster-adjusted *t* test (continuous variables) or χ^2 (dichotomous variables) tests of independence. †Calculated with principal components analysis (PCA), which is a statistical technique for data transformation from a large collection of possibly correlated variables into a small number of variables, or principal components. Generally, the first principal component accounts for the largest amount of variability in the data. The PCA generated here included the following components: baseline (1997) household ownership of blender, refrigerator, gas heater, hot-water heater, radio, stereo, television, video washer fan, car, and van. The first principal component was retained and included in these analyses. ‡Baseline data refer to information collected in 1997.

Table 1: **Comparison of baseline‡ characteristics of households with eligible children in 2003**

Statistical analysis

All statistical analyses were calculated with STATA (version 10.0). Standardised height-for-age *Z* scores and percentiles were calculated with publicly available software from WHO.[28] We included indicator variables for each state in all models. We first investigated what proportion of the sample was available for the 8–10-year follow-up and whether these households or children differed from those that were not identified during the follow-up with cluster-adjusted *t* tests or χ^2 tests of independence. To identify a treatment effect we used cluster-adjusted *t* tests and multiple regressions to

	Randomised treatment assignment		p value*
	Early (NC=1093)	Late (NC=700)	
Child characteristics			
Girl	537 (49%)	340 (49%)	0·82
Cohort age			0·82
Oldest	360 (33%)	231 (33%)	
Middle	333 (31%)	204 (29%)	
Youngest	400 (37%)	265 (38%)	
Parental characteristics			
Father present	889 (81%)	583 (83%)	0·43
Father has some primary education	897 (82%)	557 (80%)	0·49
Mother has some primary education	859 (79%)	566 (81%)	0·44
Ethnic origin (head of household speaks indigenous language)	460 (42%)	299 (43%)	0·93
Household characteristics			
Number of people in household	6·34 (2·48)	6·33 (2·37)	0·97
Household composition			
Male			
Children (0–5 years)	0·95 (0·87)	0·94 (0·85)	0·82
Children (6–17 years)	1·01 (1·11)	0·97 (1·11)	0·45
Working-aged adults (18–49 years)	1·07 (0·47)	1·03 (0·45)	0·20
Older adults (>50 years)	0·14 (0·35)	0·14 (0·35)	0·90
Female			
Children (0–5 years)	0·88 (0·86)	0·96 (0·88)	0·10
Children (6–17 years)	1·05 (1·17)	1·04 (1·14)	0·88
Working-aged adults (18–49 years)	1·09 (0·49)	1·12 (0·49)	0·33
Older adults (>50 years)	0·15 (0·37)	0·13 (0·34)	0·38
Land owned (baseline) (hectares)	1·50 (2·45)	1·56 (2·62)	0·79
Asset index value (baseline)†‡	−0·41 (0·56)	−0·35 (0·63)	0·32
Piped water on family land	347 (32%)	156 (22%)	0·088
Own at least one draught animal	349 (32%)	220 (31%)	0·89
Own other animals (to sell or to sell animal products)	874 (80%)	552 (79%)	0·69
Had electricity in home	673 (62%)	461 (66%)	0·45

Data are n (%) or mean (SD). Characteristics stratified by randomised treatment assignment to early (April, 1998) or late (October, 1999). NC=number of children. Oldest=date of birth from March to August, 1997. Middle=date of birth from September, 1997, to February, 1998. Youngest=date of birth from March to October, 1998. *p values are for cluster-adjusted *t* test (continuous variables) or χ^2 (dichotomous variables) tests of independence. †Calculated with principal components analysis (PCA), which is a statistical technique for data transformation from a large collection of possibly correlated variables into a small number of variables, or principal components. Generally, the first principal component accounts for the largest amount of variability in the data. The PCA generated included the following components: baseline (1997) household ownership of blender, refrigerator, gas heater, hot water heater, radio, stereo, television, video washer fan, car, and van. The first principal component was retained and included in the analyses. ‡Baseline data refer to information collected in 1997.

Table 2: **Comparison of baseline‡ characteristics of children from households in the 10-year follow-up analysis**

compare children in households whose communities were randomised into early treatment with those randomised into late treatment—with and without covariates. Sex was then included as an interaction term with both independent variables.

Our second objective was tested as a statistical interaction between time of treatment (early or late) and education as a dichotomous variable (whether the mother had attended primary school compared with not having attended primary school), and then repeated with an interaction term between time of treatment and household assets and housing as a dichotomous variable (above or below median score), controlling for covariates. We created a variable representing cumulative cash transfer to test whether receiving an increased amount of money was associated with improvements in child outcomes, while controlling for the wide range of individual, household, and community variables. The variation in cumulative cash transfers came from the interaction of randomly assigned timing of initial programme enrolment, and baseline household demographic structure (webappendix p 1).

We reported primary results for the cash transfer effect as effect size for each outcome associated with an increase in cash transfers of 10 000 Mexican pesos (US$926 at 2007 exchange rates), representing a mean increase of 0·38SD of the mean (46 393 pesos) in cumulative cash transfers for families included in this analysis. This method differed slightly from that previously reported[17] because we did not limit the sample to only children whose households had been exposed to the programme over the child's entire lifetime. However, we included the treatment variable in our analyses, controlling for the length of time that the child was enrolled. We also controlled directly for the number of household members and proportion of children in each age category at baseline to ensure that the cumulative cash transfer variable was not confounded with family composition effects. To test whether present—rather than baseline—socioeconomic status was associated with our outcome measures, we replicated our analyses with present household size, demographic structure, and some measures of household wealth that were available in 2007 (assets and access to water).

To check robustness of our data imputation method, we replicated our analyses with an imputation method in which missing data were imputed stochastically rather than deterministically, and ran the regressions on two separate datasets with the new imputation. To test robustness of our statistical analyses for children who were not included in the 2007 follow-up (censored), we calculated an inverse probability of censored weights (IPCW) analysis. In this analysis, the first stage predicts the probability of being included in the analysis sample by use of logistic regression on child, household, and community variables. In the second stage, we calculated regressions on our outcome measures with the inverse of the probability of being included to up-weight children who were most similar to the excluded children, effectively adjusting our model to account for children who were missing.

Role of the funding source

The sponsors of the study financed the design and data collection for the Oportunidades assessmenr, including the Encuesta de Evaluación d les Hogatres Rurales 2007 (Encel 2007) and contributed to the design of the

Encel 2007 and the assessment research questions. The sponsors of the study had no role in data analysis, data interpretation, or writing of the report. All authors had full access to all data in the study and take responsibility for the integrity of the data and accuracy of the data analysis. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Figure 1 shows the study profile. We identified no significant differences between households of children included in the 10-year follow-up and those not included for most variables (table 1). Households in the analysis group were slightly smaller than were those in groups not included in the analysis, because they had fewer children aged 6–17 years and fewer adults. Groups were well balanced for children included at the 10-year follow-up according to all measured variables (table 2).

10 years after the programme started, we identified no differences between early and late groups for mean height-for-age *Z* score, body-mass index (BMI)-for-age *Z* score, or cognitive or language assessment scores (table 3). However, we noted that maternal-reported behavioural problems differed between groups—children randomly assigned to early treatment had fewer behavioural problems than did those randomly assigned to late treatment (table 3). Estimation of effects of programme participation (treatment effect) on behavioural problems was significant with the inclusion of age and sex indicator variables and a wide range of parental and household covariates (table 4). We identified no significant interactions between treatment group and sex (data not shown). All findings remained the same when we used alternative imputation techniques, with IPCW analyses, or when controlling for present rather than baseline socioeconomic status (data not shown).

Maternal education significantly modified the treatment effect (early *vs* late) on height-for-age *Z* scores (figure 2). We identified a treatment effect equivalent to about 1·5 cm of height (β 0·23 [0·023–0·44) p=0·029) in children aged 10 years whose mothers had received no formal education, whereas no treatment effect was noted for children of mothers who had received some formal education (0·011 [–0·10 to 0·13] p=0·85). In the analysis including a treatment by maternal education interaction term, significant factors were the treatment variable (β 0·23, 95% CI 0·024 to 0·44, p=0·029), whether the

	Randomised treatment assignment				p value*
	Early		Late		
	n	Mean (SD)	n	Mean (SD)	
Height-for-age *Z* score	1036	–1·12 (0·96)	674	–1·14 (0·97)	0·88
Body-mass index for age *Z* score	1033	0·14 (0·99)	672	0·17 (1·06)	0·58
Verbal assessment score†	1020	98·8 (13·8)	641	98·4 (14·6)	0·90
Cognitive assessment score†	1021	98·8 (12·9)	640	100·2 (13·2)	0·26
Behaviour problems score‡, standardised	1064	–0·09 (0·97)	687	0·13 (1·03)	0·0024

Comparisons of children included in the 10-year follow-up analysis, stratified by randomised assignment to early (April, 1998) or late (October, 1999) treatment groups. *p values are for cluster-adjusted *t* tests. †Scores from the Wechsler abbreviated scale of intelligence; age-adjusted *Z* scores were used in analysis. ‡From the strengths and difficulties scale and standardised score used in analysis.

Table 3: **Comparison of mean height-for-age and BMI-for-age *Z* scores, and cognitive, language, and behaviour scores**

	Early *vs* late treatment, β (95% CI), p value	Cumulative cash transfers, β (95% CI)*, p value	Significant covariates, Variable (direction of effect)
Height-for-age *Z* score (n=1710)	0·05 (–0·05 to 0·16), 0·31	0·03 (0·01 to 0·05), <0·01	Female (–), youngest birth cohort (–), household size (–), indigenous language spoken (–), access to water (+), access to electricity (+), maternal primary education (+)
Body-mass index for age *Z* score (n=1705)	–0·04 (–0·16 to 0·08), 0·52	0·00 (–0·02 to 0·02), 1·00	Female (–), asset index (+), girls aged 0–5 years in household (–)
Verbal assessment score† (n=1661)	1·13 (–1·06 to 3·32), 0·31	0·73 (0·48 to 0·99), <0·01	Household size (–), asset index (+), working-age males in household (+), adult females in household (+), maternal primary education (+)
Cognitive assessment score† (n=1661)	–1·19 (–3·26 to 0·89), 0·26	0·47 (0·19 to 0·74), <0·01	Household size (–), asset index (+), maternal primary education (+)
Behaviour problems score‡ (n=1751)	–0·14(-0·27 to –0·01), 0·03	–0·03 (–0·05 to –0·01) <0·01	Indigenous language spoken (–), elderly men in household (+)

Coefficients for treatment and cumulative cash effects were estimated (β) while controlling for individual characteristics (6-month birth cohort and child sex), parental characteristics (maternal and paternal educational attainment, presence of father in the home) and baseline characteristics (from 1997) of households, including whether an indigenous language was spoken at home, access to piped water, access to electricity, hectares of land owned, ownership of draught animals, ownership of other animals for commerce, asset index, and demographic composition of household (eg, number of children and adults of various age groups); and indicator variables representing different Mexican states were included in the model. SEs were adjusted for community clustering. +=positive effect. –=negative effect. β=effect size of treatment or cumulative cash on growth, cognition, and behavioural problems, adjusted for covariates. *Transfer coefficients reported as effect size for every outcome associated with an increase in cash transfers of 10 000 pesos (about US$926). †Scores are from the Wechsler abbreviated scale of intelligence; age-standardised *Z* scores used in analysis. ‡From the strengths and difficulties scale; age-standardised *Z* score used in analysis. §Five separate regressions were completed—one for each outcome measure.

Table 4: **Separate effects of randomisation to treatment and cumulative cash transfers on growth, cognition, and behaviour problems, adjusted for covariates§**

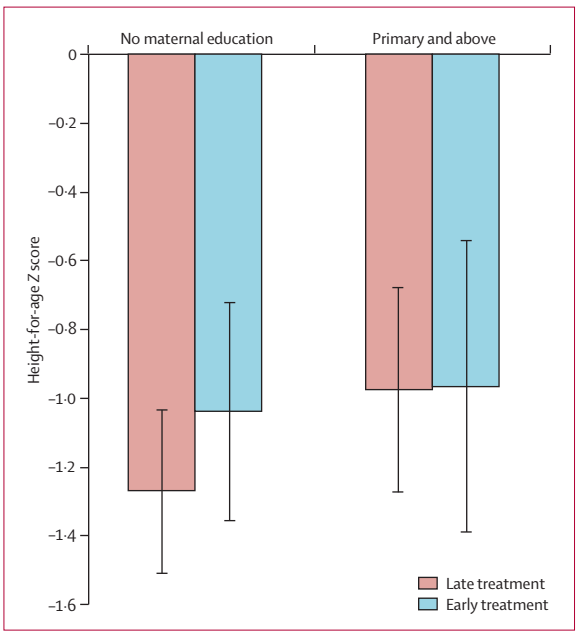

Figure 2: **Differential effect of randomised start time of Oportunidades programme on child height-for-age by maternal educational status**
Error bars are 95% CI. Early enrolment=April, 1998. Late enrolment=October, 1999. Height-for-age was calculated for 1710 children aged 8–10 years (367 communities). Mean height-for-age was estimated on the basis of the following control characteristics: median values of asset index; land ownership (1 hectare); cumulative cash transfer amount (43 000 pesos, about US$4000); household size (six people); proportion of household sex and age-groups; children whose families live in Veracruz (32% of children), do not speak an indigenous language (58%), do not have water on property (72%), do not have draught farm animals (68%), but do have electricity (63%) and other animals (80%); and where the father is present (82%) and has some primary education (81%). Results were adjusted for community clustering (367 communities, 1710 children).

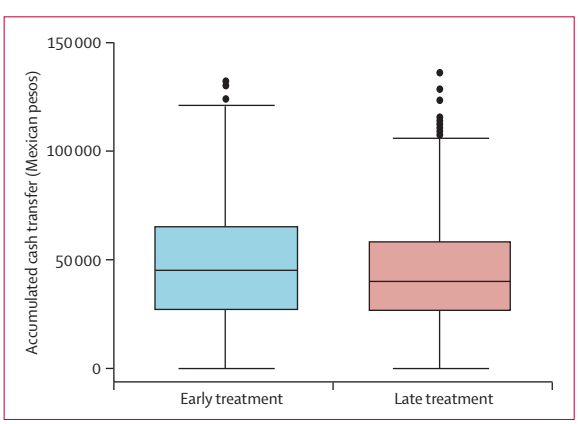

Figure 3: **Distribution of accumulated cash transferred to Oportunidades households**
Black circles are outliers. n=1725 households. At 2007 rates, 10 000 pesos was equivalent to US$926.

mother had attended any primary school (0·29, 0·12 to 0·47, p=0·001), and the interaction term (–0·22, –0·44 to –0·001, p=0·049). These findings remained the same when we used alternative imputation techniques but not when we used the IPCW analyses or controlled for present rather than baseline socioeconomic status (data not shown). Maternal education did not modify the effect of treatment for the other four outcome variables and the housing and assets index did not modify the treatment effect for any outcome measure (data not shown).

The median amount of cash transferred for the early treatment group was 45 450 pesos (IQR 27 170–65 485, maximum 132 235), which is $4208 ($2516–6063, $12 244) at the 2007 exchange rates). The median amount transferred for the late treatment group was 40 135 pesos (IQR 26 992–58 530, maximum 135 910), which is US$3716 ($2500–5420, $12 580) at the 2007 exchange rates (figure 3).

At the 10-year follow-up assessment, the amount of cumulative cash that had been transferred to the households during participation in the programme was significantly and positively associated with children having high verbal and cognitive scores, and a reduced number of maternal-reported behavioural problems (figure 4). Cumulative cash transferred to the households was also significantly positively associated with height-for-age *Z* scores in all households (figure 4). For children from households with mothers who had received primary education or above (compared with children whose mothers had no education), the effect was shifted upwards by about 0·3 *Z* score (equivalent to 1·9 cm for a child aged 10 years).

These findings remained significant when we controlled for individual, parental, and household characteristics, state of residence, and treatment group (table 4). An increase of 10 000 pesos ($926) transferred to the families—an increase of roughly 0·38SD of the mean cumulative cash transfers for families included in this analysis—was associated with an increased height-for-age *Z* score. This difference is equivalent to 0·2 cm for every additional 10 000 pesos received for a child aged 10 years. We identified no association between an increased amount of cash and BMI-for-age (table 4). All findings remained the same when we used alternative imputation techniques, IPCW analyses, or controlled for present rather than baseline socioeconomic status.

Discussion

Our results show that an additional 18 months of inclusion in the Oportunidades programme in very early childhood reduced the number of socioemotional problems reported in children aged 8–10 years. We identified no significant treatment effects between early and late treatment groups for height-for-age, BMI-for-age, and cognitive or language development. However, our results show a significant, independent, positive association between cumulative cash transfers and height, cognition, and vocabulary score, and a negative association with behavioural problems, agreeing with the results we reported for these children when they were aged 3–5 years.[17] Variation in cumulative cash

transfers came from interactions between randomly assigned timing of initial programme enrolment and baseline household demographic structure.

The greatest change in height for age, independent of the cash transfer given to the family, was identified in children of women with no formal education, according with other studies showing an effect of Oportunidades on height for age in vulnerable subgroups only.[8,9] For these children, the fortified food that was distributed by the programme might have filled gaps in dietary intake, and health and nutrition education and growth monitoring might have resulted in improved care and feeding practices in the home and early identification and treatment of infectious disease.

Early programme participation was also associated with lower rates of behavioural problems in all children in the treatment group when compared with the control group—these results are consistent with those previously reported in these children.[16] Our findings might be related to reductions in economic stress perceived by the family, improved school attendance, or promotion of parental mental health and family relationships.

Factors that relate to the child's home or child-care environment probably explain the finding that the cash transfer component of the programme was positively associated with improved growth, improved scores on measures of child cognition and language, and behaviour at age 8–10 years.[29] Alternatively, having increased financial resources might allow parents to provide an improved environment for their children (eg, housing, electricity, gas stove, or telephone), or to purchase of goods that could directly affect child growth and development, such as animal-source foods.[30,31] Gertler and colleagues[32] have reported that Oportunidades households invest the cash that they receive in large working animals (eg, cows, sheep, donkeys, mules, horses, and oxen), which might then become sources of protein and fat. Increased cumulative cash transfers could also be linked to improvements in child outcomes indirectly via the psychological wellbeing of family members, which could then affect subjective feelings of financial strain and deprivation.[31]

Several reasons might explain why we did not identify any significant long-term effects of the programme on cognition and language. First, the tests that were used might have had limitations—the Wechsler abbreviated scale of intelligence is a short form of the Wechsler intelligence scales test and might not have been sensitive enough to detect differences. Second, 18 months of exposure might not have been long enough to effect much change, although the programme occurred early in the children's lives. Third, the iron in the supplementation in the initial fortified food was not readily bioavailable,[8] and the supplement might have been shared between many family members. Finally, the cash transferred to the families in the two groups could have equalised the effects of the programme over time—ie, the amount of cash received by the households in the early and late groups after 8–10 years were very similar, and its benefits to both groups might have outweighed the initial 18-month advantage of exposure to programme benefits.

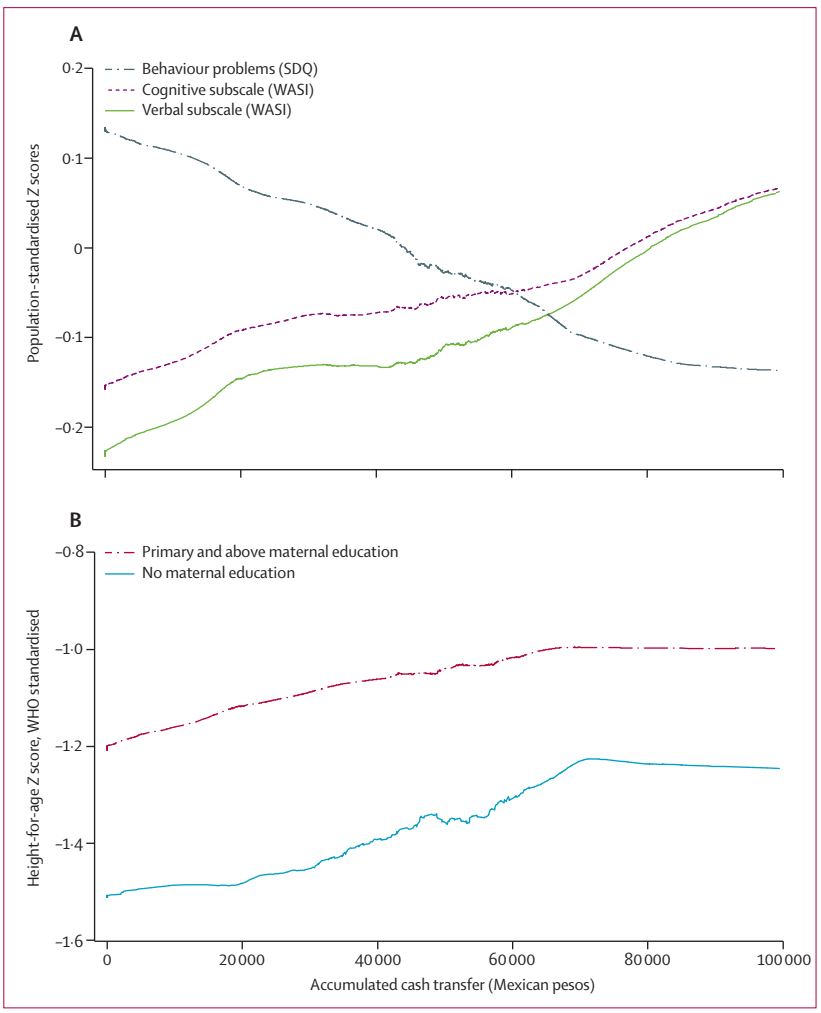

Figure 4: **Accumulated cash transfers received by household and child variables**
Child outcomes for verbal and cognitive subscales, and behaviour problems (A); WASI=Wechsler abbreviated scale of intelligence. SDQ=strengths and difficulties questionnaire.

This study had several limitations. Loss to follow-up over the 10-year study was fairly high, which is the main limitation of our study. Baseline characteristics did not differ between the study sample and the group that was not able to be studied in 2007. Our tests of robustness with IPCW techniques showed that all results were sustained apart from the treatment by maternal education interaction. A second limitation is that we had to impute some household data, but results passed checks for robustness for our imputation techniques.

Third, although the original design of the assessment was randomised and allows for direct causal inferences on programme effect,[33] at least 8 years have passed since all families were incorporated into the programme, and

many factors might affect outcomes. The design of the assessment does not allow for causal inferences related to individual components of the programme, and the effects measured for both cash and non-cash components of the study might be dependent on the integrated nature of the Oportunidades programme. To address this issue, we replicated our analyses with present socioeconomic status and results were consistent, but we did not have data for many other variables that could have allowed an improved understanding of the programme effects.[29] Fourth, the cumulative transfer amounts that the household actually receives are affected in part by the household's decision to send their children to school. For example, if a household sends their children to work instead of to school, the family would have a reduced transfer sum but an increased income from the child's work, leading to a biased estimate of the effect of the transfer on investment. Finally, we have no information about the quality of medical or preventive care received by children and thus had to assume that this care is equal across all contexts.

An inability to decipher the causal pathways by which CCTs have affected child outcomes is a key research gap.[34] Our analysis takes advantage of the detailed information available for the Oportunidades programme in Mexico and the quality of cash transfer data to explore potential mechanisms for the effects of CCTs, recognising the limitations that this approach has for causal inferences. Together, these results suggest that independent beneficial effects of programme components exist in Oportunidades other than money—especially for women with no formal education—and that the money itself also has significant effects, adding to existing evidence[35,36] for interventions in early childhood.

Contributors

All authors participated in study design; acquisition, analysis, and interpretation of data; statistical analysis; obtaining funding; and providing administrative, technical, and material support. LCF drafted the report and PJG and LMN revised it for important intellectual content.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

The Mexican Ministry of Social Development financed the design and data collection for Oportunidades assessment, including the Encuesta de Evaluación de los Hogares Rurales 2007 (Encel 2007), and provided part funding for the analysis. The Oportunidades Division of Geostatistic Information, Analysis and Evaluation contributed to the design of the Encel 2007 and the research questions. Additional funding for the previous round (2003) was received from the National Institutes of Child Health and Human Development. We thank Ann Weber for thorough and consistent research assistance; James Manley and Marta Rubio-Codina for research assistance; Lourdes Schnaas for overseeing training and quality control of the administration of the cognitive and language tests; and Juan Pablo Gutierrez, Jere Behrman, Bernardo Hernandez, Juan Rivera, Stefano Bertozzi, Rogelio Gomez-Hermosillo, Concepción Steta, Iliana Yaschine, and Citlalli Hernandez for contributing to study design and providing comments on early drafts of this report. The field operation for the Encel 2007 was designed and implemented by the Center for Evaluation Research and Surveys, National Institute of Public Health (Insituto Nacional de Salud Pública in Mexico), under the coordination of Stefano Bertozzi, Lynnette Neufeld, Juan Pablo Gutierrez, and Aurora Franco.

References

1 Grantham-McGregor S, Cheung YB, Cueto S, et al. Developmental potential in the first 5 years for children in developing countries. *Lancet* 2007; **369:** 60–70.

2 Engle PL, Black MM, Behrman JR, et al. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet* 2007; **369:** 229–42.

3 de Janvry A, Sadoulet E. Making conditional cash transfer programs more efficient: designing for maximum effect of the conditionality. *World Bank Econ Rev* 2006; **20:** 1–29.

4 Das J, Do Q-T, Özler B. Reassessing conditional cash transfer programs. *World Bank Res Obs* 2005; **20:** 57–80.

5 Lagarde M, Haines A, Palmer N. Conditional cash transfers for improving uptake of health interventions in low- and middle-income countries: a systematic review. *JAMA* 2007; **298:** 1900–10.

6 Handa S, Davis B. The experience of conditional cash transfers in Latin America and the Caribbean. *Dev Policy Rev* 2006; **24:** 513–36.

7 Gertler P. Do conditional cash transfers improve child health? Evidence from PROGRESA's controlled randomized experiment. *Am Econ Rev* 2004; **94:** 336–41.

8 Rivera JA, Sotres-Alvarez D, Habicht JP, Shamah T, Villalpando S. Impact of the Mexican program for education, health, and nutrition (Progresa) on rates of growth and anemia in infants and young children: a randomized effectiveness study. *JAMA* 2004; **291:** 2563–70.

9 Leroy JL, García-Guerra A, García R, Dominguez C, Rivera J, Neufeld LM. The Oportunidades program increases the linear growth of children enrolled at young ages in urban Mexico. *J Nutr* 2008; **138:** 793–98.

10 Maluccio JA, Flores R. Impact evaluation of a conditional cash transfer program: the Nicaraguan Red de Protección Social, research report 141. Washington DC: International Food Policy Research Institute, 2005. http://www.ifpri.org/sites/default/files/publications/pubs_pubs_abstract_141_rr141.pdf (accessed Oct 7, 2009).

11 Paxson C, Schady N. Does money matter? The effects of cash transfers on child health and development in rural Ecuador: unpublished manuscript. Princeton University and The World Bank, 2008. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=984618 (accessed Sept 23, 2009).

12 Attanasio O, Battistin E, Fitzsimons E, Mesnard A, Vera-Hernández M. How effective are conditional cash transfers? Evidence from Colombia. London: Institute for Fiscal Studies, briefing note number 54, 2005. http://www.ifs.org.uk/bns/bn54.pdf (accessed Sept 23, 2009).

13 Morris SS, Olinto P, Flores R, Nilson EA, Figueiró AC. Conditional cash transfers are associated with a small reduction in the rate of weight gain of preschool children in northeast Brazil. *J Nutr* 2004; **134:** 233–41.

14 Moore C. Assessing Honduras' CCT programme PRAF (Programa de Asignación Familiar): Expected and unexpected realities. Brasilia: International Poverty Center, country study, 2008. http://www.undp-povertycentre.org/pub/IPCCountryStudy15.pdf (accessed Sept 23, 2009).

15 Macours K, Schady N, Vakis R. Can conditional cash transfer programs compensate for delays in early childhood development? Working paper, 2008. http://are-251.are.berkeley.edu/Papers/macours-etal08.pdf (accessed Sept 23, 2009).

16 Ozer EJ, Fernald LC, Manley J, Gertler PJ. Effects of a conditional cash transfer program on children's behavior problems. *Pediatrics* 2009; **123:** e630–37.

17 Fernald LCH, Gertler PJ, Neufeld LM. Role of cash in conditional cash transfer programmes for child health, growth and development: an analysis of Mexico's *Oportunidades*. *Lancet* 2008; **371:** 828–37.

18 Skoufias E, Davis B, Behrman JR. An evaluation of the selection of beneficiary households in the Education, Health, and Nutrition Program (PROGRESA) of Mexico. Washington, DC. International Food Policy Research Institute, 1999. http://www.ifpri.org/sites/default/files/publications/skoufias_target.pdf (accessed Sept 23, 2009).

19 Behrman JR, Todd PE. Randomness in the experimental samples of PROGRESA (education, health and nutrition program). Washington, DC: International Food Policy Research Institute, 1999. http://www.ifpri.org/sites/default/files/publications/behrmantodd_random.pdf (accessed Sept 23, 2009).

20 Habicht, JP. Estandarización de métodos epidemiológicos cuantitativos sobre el terreno [Standardisation of quantitative epidemiological methods in the field.] *Bol Oficina Sanit Panam* 1974; **76:** 375–84 (in Spanish).

21 Lohman TG, Roche AF, Martorell R, et al. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics Books, 1988.

22 Wechsler D. Wechsler Abbreviated Scale of Intelligence (WASI). San Antonio: Pearson Education, Inc, 1999.

23 Schnaas L, Rothenberg SJ, Flores MF, et al. Reduced intellectual development in children with prenatal lead exposure. *Environ Health Perspect* 2006; **114:** 791–97.

24 Woerner W, Fleitlich-Bilyk B, Martinussen R, et al. The strengths and difficulties questionnaire overseas: evaluations and applications of the SDQ beyond Europe. *Eur Child Adolesc Psychiatry* 2004; **13** (suppl 2)**:** 47–54.

25 Fernald LCH, Kariger PK, Engle P, Raikes A. Examining child development in low-income countries: a toolkit for the assessment of children in the first five years of life. Washington, DC: The World Bank, in press.

26 Moser CON. The Asset Vulnerability Framework: reassessing urban poverty reduction strategies. *World Dev* 1998; **26:** 1–19.

27 McGee R, Brock K. From poverty assessment to policy change: processes, actors and data. Brighton: Institute of Development Studies, 2001.

28 WHO. The World Health Organization child growth standards. http://www.who.int/childgrowth/standards/en/ (accessed Sept 23, 2009).

29 Guo G, Harris KM. The mechanisms mediating the effects of poverty on children's intellectual development. *Demography* 2000; **37:** 431–47.

30 Becker GS, Tomes N. Human capital and the rise and fall of families. *J Labor Econ* 1986; **4:** 1–39.

31 Yeung WJ, Linver MR, Brooks-Gunn J. How money matters for young children's development: parental investment and family processes. *Child Dev* 2002; **73:** 1861–79.

32 Gertler PJ, Martinez S, Rubio M. Investing cash transfers to raise long term living standards. http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2006/08/10/000016406_20060810124348/Rendered/PDF/wps3994.pdf (accessed Sept 23, 2009).

33 Habicht JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. *Int J Epidemiol* 1999; **28:** 10–18.

34 Leroy JL, Ruel M, Verhofstadt E. The impact of conditional cash transfer programmes on nutrition: a review of evidence using a programme theory framework. *J Develop Effectiveness* 2009; **1:** 1–27.

35 Duncan GJ, Yeung WJ, Brooks-Gunn J, Smith JR. How much does childhood poverty affect the life chances of children? *Am Sociol Rev* 1998; **63:** 406–23.

36 Heckman J, Masterov DV. The productivity argument for investing in young children. Chicago: University of Chicago, 2005.