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The Legacy for Children™ Randomized Control Trial: Effects on Cognition Through Third Grade for Young Children Experiencing Poverty

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Abstract

Objective: In an effort to promote the health and developmental outcomes of children born into poverty, the Centers for Disease Control and Prevention (CDC) conceptualized and designed the Legacy for Children™ (*Legacy*) public health prevention model. This article examines the impact of *Legacy* on children's cognitive and language development (intelligence quotient [IQ], achievement, language skills, and early reading skills) using both standardized assessments and parent-reported indictors through third grade.

Methods: Data were collected from 2001 to 2014 from 541 mother-child dyads who were recruited into the 2 concurrent randomized controlled trials of *Legacy* in Miami and Los Angels. Cognitive and/or language outcomes of children were assessed annually from age 2 to 5 years as well as during a follow-up visit in the third grade.

Results: Children experiencing *Legacy* at the Los Angeles site had significantly higher IQ and achievement scores at 2 and 6 years postintervention, equivalent to approximately one-third of an SD (4 IQ points). IQ results persisted over time, and the difference between intervention and comparison groups on achievement scores widened. There were no significant differences in cognitive outcomes in the Miami sample. There were no significant differences in language outcomes for either site.

Conclusion: *Legacy* shows evidence of effectiveness as an intervention to prevent cognitive delays among children living in poverty. The mixed findings across sites may not only reflect the

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impact of heterogeneous risk profiles noted by other intervention research programs but also warrant additional study.

Keywords

public health; prevention; poverty; cognitive; language; child development; parenting; early intervention

Focusing on early childhood development, strengthening communities, and investing in prevention is critical to achieving healthy adult outcomes.[1] This work is especially vital for over 14 million children currently living below the poverty threshold[2] because the cross-sector societal costs of child poverty have been estimated as high as $500 billion annually.[3] From a population perspective, childhood poverty's impact includes costs to the criminal justice, special education, and welfare systems[4] as well as losses to human capital and the American economy.[5] Children living in poverty are at higher risk for poor developmental outcomes compared to children not living in poverty.[6] Poverty-related impacts on cognitive and language development are associated with academic achievement and graduation struggles,[7] delinquency,[8] lower earning potential,[9] and poorer health.[10]

Indicators of early cognitive and language development are predictive of health and well-being across the life span.[10,11] Cognitive development in childhood, as measured by intelligence quotient (IQ) and achievement, are associated with a diversity of health and well-being outcomes in adolescence and adulthood, such as psychopathology,[10] criminal activity,[12] high school graduation,[13] and economic success.[5] Meta-analytic research of cohort studies of premorbid intelligence and all-cause mortality has also demonstrated that a single SD increase in intelligence in childhood and late adolescence was associated with a 23% decreased risk of mortality rate across included studies.[11] Early literacy skills, e.g., verbal and reading abilities, are related to later educational outcomes such as math and reading achievement,[14] and third grade reading skills among children in poverty are a predictor of high school graduation.[7] Further, research suggests that children's cognitive and language development is particularly susceptible to the effects of early childhood poverty, such as inefficiencies or delays in language proficiency and information processing.[5] Given the economic and social costs of failing to support early cognitive and language development for lifelong health and well-being, prevention of cognitive and language delays is paramount.

Using a public health action framework, when socioeconomic risk factors themselves cannot be changed, the greatest potential impact comes from interventions that aim to change the context so that individuals are more likely to make healthy choices by default. Implementing long-lasting protective interventions could have the greatest population impact requiring the least amount of individual effort.[15] Early education programs are examples of long-acting protective interventions, with the return on investment for early educational programs among children estimated at 16% for disadvantaged children: 4% for participants and 12% for society at large.[16] Additionally, dyadic parenting interventions early in childhood can mitigate the impact of poverty into adulthood.[8]

In an effort to invest in prevention and promote the health and developmental outcomes of children born into poverty, the Centers for Disease Control and Prevention conceptualized and designed a public health prevention program that could serve as a long-acting protective intervention for mothers and children in poverty. The program was designed so that it could be delivered through a group approach and disseminated on a large scale, if successful. This program, known as Legacy for Children™ (*Legacy*), was developed as a positive parenting program to promote child development by supporting sensitive, responsive parent-child relationships; building maternal self-efficacy; and fostering peer networks of support among mothers living in poverty.[17]

The *Legacy* prevention program broadly focuses on 5 goals: (1) promote maternal responsibility and maternal investment of time and energy in the parenting role; (2) promote responsive, sensitive mother-child relationships; (3) support mothers as guides to their children's behavioral and emotional regulation; (4) promote each mother's facilitation of their children's verbal and cognitive development; and (5) promote mothers' sense of community. *Legacy* goals are achieved through mother-only and mother/child group meetings, one-on-one sessions to reinforce curricula content, and participation in events that build community among the mothers. The *Legacy* approach is nondidactic and nonjudgmental so that the mothers can increase their self-efficacy by making meaningful, informed choices, while fostering a community of support with the other participants. Parenting self-efficacy has been associated with positive child outcomes, such as self-regulation and cognitive skills along with parenting-positive parenting practices and parent-child interactions.[18]

At the time the *Legacy* program was conceptualized, programs that used a combination approach of providing intensive educational intervention directly to the child in a child care setting with supplemental parenting groups and intervention components that address health or nutritional care dominated the early childhood field (e.g., Refs. 19,20). Research on these programs has demonstrated improved cognitive, language, and long-term educational outcomes ranging from school achievement and high school graduation to college attendance.[20,21] However, extensive center-based care is a resource-intensive program (e.g., staffing qualification and level of effort, staff-participant ratio, materials, and space costs) and may be difficult to take to scale in communities.[22] Longitudinal research that has emerged more recently has demonstrated that targeting parenting alone during early childhood can impact adult IQ, school achievement, and grade retention.[8] Effective approaches include services to the parent individually[8] or in more cost-effective group settings.[23] This research supports the strategy of focusing on parenting groups as a means of improving the health and developmental outcomes of children born into poverty.

Legacy was rigorously evaluated among its target population of low-income mothers and their young children[17] and has demonstrated lower levels of parent-reported behavioral concerns and social-emotional problems among children of participants randomized to the intervention arm of the study in the Miami site through child age of 5 years.[24] In addition, children of participants randomized to the intervention arm in the Los Angeles (LA) site demonstrated lower levels of hyperactivity at child age of 5 years.[24]

The present study extends our understanding of the program's effects by examining the impact of *Legacy* on children's cognitive and language development (IQ, achievement, language skills, and early reading skills) using both standardized assessments and parent-reported indictors through third grade. The inclusion of standardized assessments in addition to parent report measures in the current analyses allows for a fuller examination of *Legacy* impacts while addressing some of the limitations of parent report.

METHODS

Intervention

The *Legacy* prevention program has been evaluated with a set of randomized controlled trials (ClinicalTrials.gov registry #: NCT00164697) at 2 intervention sites (LA and Miami). The 2 sites developed and implemented their own curricula around the 5 *Legacy* goals and core model components. The resulting interventions differed as a result of each site's community, demographic and cultural characteristics, and intervention delivery factors informed by a full-length pilot assessment. Miami offered weekly parent group sessions from the target child's birth to age 5 years; LA held 5 prenatal sessions and 9 blocks of 10-week sessions starting prenatally and ending when the child was 3 years old. The developmentally sequenced *Legacy* curricula cover themes such as discipline, attachment, developmental milestones, parenting stress management, establishment of goals and dreams for their children, and early literacy. See the article by Perou et al.[17] for a more complete description of the program's theoretical underpinnings and intervention curricula.

Study Population

Data were collected from 2009 to 2014 from 541 mother-child dyads who were recruited into the 2 concurrent trials of *Legacy for Children*™ at the University of Miami (n =277) and at the University of California Los Angeles (n = 264). Demographic characteristics of the *Legacy* intervention and sample population have been reported elsewhere.[17] Eligibility criteria for both sites included that the mother's age was 18 years or older and that she was comfortable speaking English, that she resided within the intervention catchment area, that she had received at least some prenatal care during her pregnancy with the target child, that she had custody of the target child, and that her income was below 200% of the federal poverty line at the time of recruitment. In Miami, mothers who were eligible for Medicaid, food stamps, or Temporary Assistance for Needy Families were recruited from 2 hospitals within 72 hours of delivery of the target child. In Los Angeles (LA), expectant mothers were recruited prenatally from Women, Infants and Children clinics. Participants were randomized at a 3 (intervention) to 2 (comparison) ratio in order to guard against differential attrition from the treatment group.

Measures

As part of the study, mothers were assessed at baseline (prenatally in LA and within 6 weeks of target child's birth in Miami), and mothers and children were reassessed when the target child was 6 months, 1, 2, 3, 4, and 5 years old as well as during a follow-up conducted in third or fourth grade (median age 9 yrs: Miami =113 months and LA =111 months; hereafter referred to as the third grade assessment). The cognitive and language outcomes included in

the current study were measured through direct assessment of the child as well as computer-assisted interviews of the mother. Assessors were naive to intervention status and had limited contact with intervention staff. Participation rates at each assessment time point ranged from 96% (at baseline) to 65% (at 5 yrs) in Miami and 93% (at baseline) to 61% (at 5 yrs) in LA; participation for the follow-up assessment in third grade was 64% in Miami and 61% in LA. See the CONSORT flowchart, Figure 1, for a complete description of retention and attrition information. An assessment at every time point was completed by 44.3% of mothers in Miami and 39.5% of mothers in LA. At least one cognitive or language assessment was completed by 92.3% of children in Miami and 86.2% of children in LA. Mothers and children received transportation to the assessment visit, and the mothers received $100 at each assessment for their time and effort (assessment time averaged 2.5 hrs). Full institutional review board approval was obtained from the both university sites, the assessment contractors' firms, and CDC.

Although the curricula were delivered in English, some children spoke primarily Spanish or Haitian-Creole, particularly at the younger assessment ages. Twenty-five children in Miami and 92 children in LA completed at least one assessment in Spanish, and some assessment items were translated into Haitian-Creole for 7 children in Miami. Children who were bilingual or monolingual non-English speaking were assessed by bilingual staff. Bilingual ability increased over time for foreign language speakers. By third grade, all child assessments were conducted in English. There was no racial or gender bias in the selection of participants.

Congnitive Measures

Children's cognitive development was assessed directly using the following developmentally appropriate measures: Kaufman Assessment Battery for Children-II (KABC)[25] at ages 3 and 5 years and at third grade (Y*3*, Y*5*, and third grade, respectively) and WoodcockJohnson (WJ) III Tests of Achievement[26] at Y*5* and third grade. See Table 4 for a summary of cognitive and language measures and assessment time points.

All the cognitive composite scores are standardized to a mean of 100 and SD of *15*. The KABC measures are widely used,[27] norm-referenced instruments designed to assess cognitive ability[25] with utility for bilingual children. The WJ Tests of Achievement are a comprehensive set of norm-referenced tests for measuring academic achievement. The WJ Tests of Achievement have good reliability and validity[28] and have been used in other large studies with low-income children, such as the Head Start Family and Child Experiences Survey.[29] The WJ Achievement subscales administered in this sample were Letter-Word Identification (Y*5* and third grade), Spelling(y*5*)and Passage Comprehension (third grade) to measure reading skills and Applied Problems (Y*5* and third grade) and Calculations (third grade) to measure mathematical skills.

Language Measures

Child language development was assessed directly with the Preschool Language Scale-4 (PLS)[30] at Y2 and Y4, with the Test of Early Reading Ability-3 (TERA)[31] at Y4, and through maternal report on the Adaptive Language Inventory (ALI)[32] at Y*5*. The PLS is a

normreferenced instrument designed to assess expressive and receptive language skills; the PLS includes 2 subscales, Auditory Comprehension and Expressive Communication, as well as a Total Language score. The TERA is an assessment that measures young children's ability to attribute meaning to printed symbols, knowledge of the alphabet, and understanding of the conventions of print. The TERA has concurrent validity with other measures of reading achievement and verbal intelligence quotient (IQ) tests.[31] The PLS and TERA subscale scores are standardized to a mean of 100 and a SD of *15*. The ALI is a rating scale to assess children's use of narrative and discourse skills. Mothers were interviewed on items that addressed the following domains: Comprehension, Expression, Rephrase, Listening, Spontaneity, and Fluency. Total scores for each of these domains range from 4 to 20 for Comprehension, Expression, and Rephrase and from 2 to 10 for Listening, Spontaneity, and Fluency. Alphas for the ALI scales ranged from 0.67 to 0.89 for this sample, indicating moderate to high internal consistency. Language was not separately assessed at the third grade follow-up assessment.

Analysis Plan

Cognitive and language outcomes at each time point were compared using *t*-tests by intervention status using a conservative intent-to-treat model,[33] in which all participants randomized to the intervention were considered part of the intervention group. Generalized linear regression models were adjusted for the following key variables associated with child cognitive outcomes in the poverty literature and shown to be significantly associated with outcomes of interest in this sample: maternal IQ (using the Kaufman Brief Intelligence Test[34]), maternal race/ethnicity, maternal age, and child sex. For assessments that were administered multiple times during the intervention (i.e., KABC, WJ, and PLS), repeated-measures mixed linear models were built using maximum likelihood estimation and an autoregressive covariance structure to measure the effect of the intervention over time. Repeated-measure mixed linear models were also used to test the interaction terms to determine whether the effect of the intervention differed over time. All statistical analyses were completed using SAS v.9.3.

RESULTS

Demographics

Data were analyzed from 2012 to 2017. Baseline demographics for the entire sample by site and intervention status using χ^2 and *t*-tests have been reported elsewhere.[17] Although there were baseline differences across sites in maternal age, ethnicity, maternal education, marital status, non-English language spoken in the home, employment, and home ownership, there were no significant demographic differences between treatment and comparison groups at either site.[17]

Table 1 shows the demographic breakdown of the *Legacy* participants included in the current analyses (i.e., with at least one cognitive or language outcome assessment), stratified by site. Similar to the overall sample, mothers in this subsample were predominantly young (mean age was 22.9 yrs in Miami [SD =4.4] and 25.4 yrs in LA [SD=5.4]) and had very low income (54% made less than $20,000 per year at baseline). Mothers in LA were mostly

black (46%) or Hispanic (46%), while the majority of the sample in Miami was black (70%). There were no statistically significant differences by intervention status in either site for any of the noted demographic characteristics (data not shown). There were no statistically significant differences in demographic factors for those who completed all cognitive/language assessments at all time points compared to those who only completed some cognitive/language assessments in both sites. There were no statistically significant differences by demographic subgroup comparing those who completed at least one cognitive/language assessment to those who did not, except for race/ethnicity within Miami (differences found in smallest subgroups—mothers who were white and of other race; data not shown). Please see Table 5 for participation rate and mean age at each cognitive and language assessment time point by site. Mean maternal Kaufman Brief Intelligence Test scores at the 6-month assessment were 79.9 (SD=14.1) in Miami and 84.0 (SD =13.3) in LA.

Cognitive Outcomes

Table 2 shows the comparison by intervention status of unadjusted and adjusted cognitive mean scores at each time point. There were no statistically significant cognitive findings in the Miami sample. In LA, the unadjusted mean Kaufman Assessment Battery for Children-II scores were higher for the intervention group than the comparison group at both the end of the intervention (Y3; 4.4 points, $p < 0.05$) and approximately 6 years postintervention (third grade; 4.9 points, $p < 0.05$). Repeated-measures analysis indicated a statistically significant difference in the impact of intervention over time, with a smaller mean score difference at Y5 (2 yrs postintervention) compared to Y3 or third grade (*time* × *intervention* interaction, $p < 0.05$). Also in LA, children in the intervention group had higher unadjusted scores on 2 Woodcock-Johnson (WJ) tests at the third grade follow-up: Letter-Word (104.1 vs 97.5, $p < 0.01$) and Applied Problems (96.8 vs 92.5, $p < 0.05$). Repeatedmeasures analysis of WJ tests administered in both Y5 and third grade showed a statistically significant widening in the difference between intervention and comparison groups over time for the Letter-Word test (*time* × *intervention* interaction, $p < 0.05$).

When adjusted for demographic variables, the results in the LA sample remained significant. In addition, the adjusted scores indicated that children in the intervention group had higher adjusted scores on the following WJ tests: Spelling in Y5 (101.7 vs 96.8, $p < 0.05$) and Passage Comprehension in third grade (92.3 vs 87.3, $p < 0.05$) in the LA sample. In the LA sample, adjusted repeated-measures analysis of WJ tests administered in both Y5 and third grade also showed a statistically significant widening in the difference between intervention and comparison groups from Applied Problems tests (*time* × *intervention* interaction, $p < 0.05$ for both models).

Language Outcomes

Unadjusted language mean scores and adjusted language mean scores are shown in Table 3. There were no significant findings for the unadjusted language outcomes. Children in the intervention group in LA had higher adjusted Test of Early Reading Ability-3 Reading Quotient Scores than children in the comparison group (84.0 vs 80.5, $p < 0.05$) measured at Y4. There were no other significant findings for the language outcomes.

DISCUSSION

The current study demonstrates that children of mothers participating in the LA site of the Legacy for Children™ prevention program had significantly higher intelligence quotient (IQ) and achievement scores, by approximately one-third of an SD, at 2 and 6 years postintervention. Repeated-measures analyses indicated that IQ results persisted over time and the difference between intervention and comparison groups on achievement scores widened over time. For children experiencing poverty early in development, shifting these cognitive developmental trajectories could have long-term implications for individual and societal factors, such as educational attainment[7] and earning potential,[35] crime and delinquency,[12,16] and public health.[10,11]

Recent reports have called for comprehensive public health models that focus on nurturing, caregiving environments, are prevention-focused, and can be tested and disseminated in communities.[23] The *Legacy* model for promoting child development is consistent with this approach. The results of this study complement and extend the previously reported socioemotional and behavioral findings through child age of *5* years[24] across both *Legacy* sites (Table 4). The cognitive findings in the current study were based on standardized test scores and examine results through third grade. Taken together, this pattern of effects supports an impact of the *Legacy* program on developmental outcomes across the 2 sites.

Although both sites recruited samples of low-income mothers and followed the same *Legacy* model, only the *Legacy* LA sample demonstrated significant improvement in cognitive outcomes. Both sites demonstrated similar adherence and fidelity to the *Legacy* model with respect to the model elements and core intervention activities (data not shown). Site differences found in other early childhood interventions (e.g., Infant Health and Development Project, Abecedarian, Nurse Family Partnership) have been associated with heterogeneity of risk conditions in their samples.[36,37] The mothers in the *Legacy* Miami sample were less resourced (e.g., younger, less educated, higher percentage in the lowest income categories) than the *Legacy* LA mothers, which might explain larger effects on cognitive outcomes in the site 2 sample. However, socioemotional and behavioral outcomes were significant for both sites but more consistently so in Miami.[24] Previous research has shown that socioeconomic status impacts child's cognitive and socioemotional development through different mechanisms.[38] For example, data from Gershoff et al.[39] suggest that poverty impacts child cognitive and socioemotional outcomes through distinct parenting pathways. Those authors concluded that the impact of income on child's cognitive outcomes was mostly mediated through parental investment such that increased income allows parents to provide more enriching and stimulating environments and experiences for their children. In contrast, the relationship between child's socioemotional development and material hardship was mediated through parental stress and decreased positive parenting behaviors. This may explain *Legacy*'s site and outcome differences. If participation in *Legacy* reduces parenting stress and increases positive parenting behaviors in even very low resourced mothers, then one would expect to see child's socioemotional and behavioral differences at both sites as we have documented here and previously.[24] *Legacy* may be sufficient to change mother's motivation to provide enriching environments but not their financial or other time

availability to do so. An in-depth analysis of proposed mediators is currently underway to help us better understand mechanisms for these site-specific intervention outcomes.

Despite the many strengths of the *Legacy* program and its evaluation design, the current study is not without limitations. As the *Legacy* curricula and implementations were developed separately for their communities in adherence to the core *Legacy* model components and intervention goals, site and intervention attributes are confounded. The interventions differ in multiple factors, such as curricula length, age range, and implementation approach; therefore, we cannot disentangle whether outcome differences are related to the curriculum, implementation, or site characteristics. Future analyses will explore subgroups at each site to better understand for whom and how the program works, which will lead to better targeting and tailoring services for families. Continued analysis and longitudinal follow-up may help determine how the cognitive differences translate into outcomes over time given the cross-site socioemotional outcomes through age *5* years[24] and the close connection between cognitive and socioemotional development early in childhood.[40]

Legacy was designed to address a need in the early intervention field for a rigorously evaluated public health preventive strategy for children in poverty that could be widely disseminated if effective. Previous early childhood educational programs have been limited in producing long-term impacts with wider dissemination, based in part on a lack of quality assurance when moving from research to practice[22] and a lack of attention to scalability and dissemination from program design.[41] Integrated within the *Legacy* curricula are monitoring tools that ensure continuous quality improvement, fidelity implementation, and comparability of results. The *Legacy* program combines a statistically conservative intent-to-treat research design with attention to practical purpose. Even at the early stages of study design, factors that would facilitate community-based dissemination and implementation were included: plans for longitudinal cost analyses, a mix of qualitative and quantitative analyses, and a model responsive to community context.

As a first step toward wider community-based dissemination of *Legacy*, CDC is working with federal (Administration for Children and Families' Head Start program, Health Services and Resources Administration's Healthy Start program, Substance Abuse and Mental Health Administration's Project Linking Actions for Unmet Needs in Children's Health and private [American Academy of Pediatrics, Association of University Centers on Disability] organizations on the sustainability of *Legacy* and a Spanish translation and adaptation of the curricula).[42] Preliminary results indicate that *Legacy* facilitates patient/parent engagement within the clinical practice and early educational settings.[43] These complementary projects were designed to identify implementation drivers and barriers to *Legacy* dissemination within diverse community settings.

Socioeconomic disparities in developmental outcomes emerge early and widen over time; therefore, intervention as early as possible may yield the greatest payoffs.[1,5,6] Offering a broad array of integrated service options to ensure children and families have access to appropriate prevention and intervention services based on their specific needs is important.[1] The needs of children and families in poverty are varied; our results and previous research

suggests that intervention effects may differ by risk characteristics in the poverty sample and outcome type.[23] The *Legacy* program is currently taking measured steps toward community-based dissemination within a variety of programmatic infrastructures including clinical care settings. Public health prevention can have widespread impacts on individual and societal levels, particularly through the use of long-lasting protective interventions that can be integrated into service systems families already access.[23] Primary care may be a particularly promising home for evidence-based, parent-focused intervention programs.[6] This study contributes to the evidence base of the Legacy program, which collectively suggests that the program may serve as a long-lasting protective intervention. The findings of the current study suggest that *Legacy* may prevent cognitive delays and improve the socioemotional and behavioral outcomes of children living in poverty.

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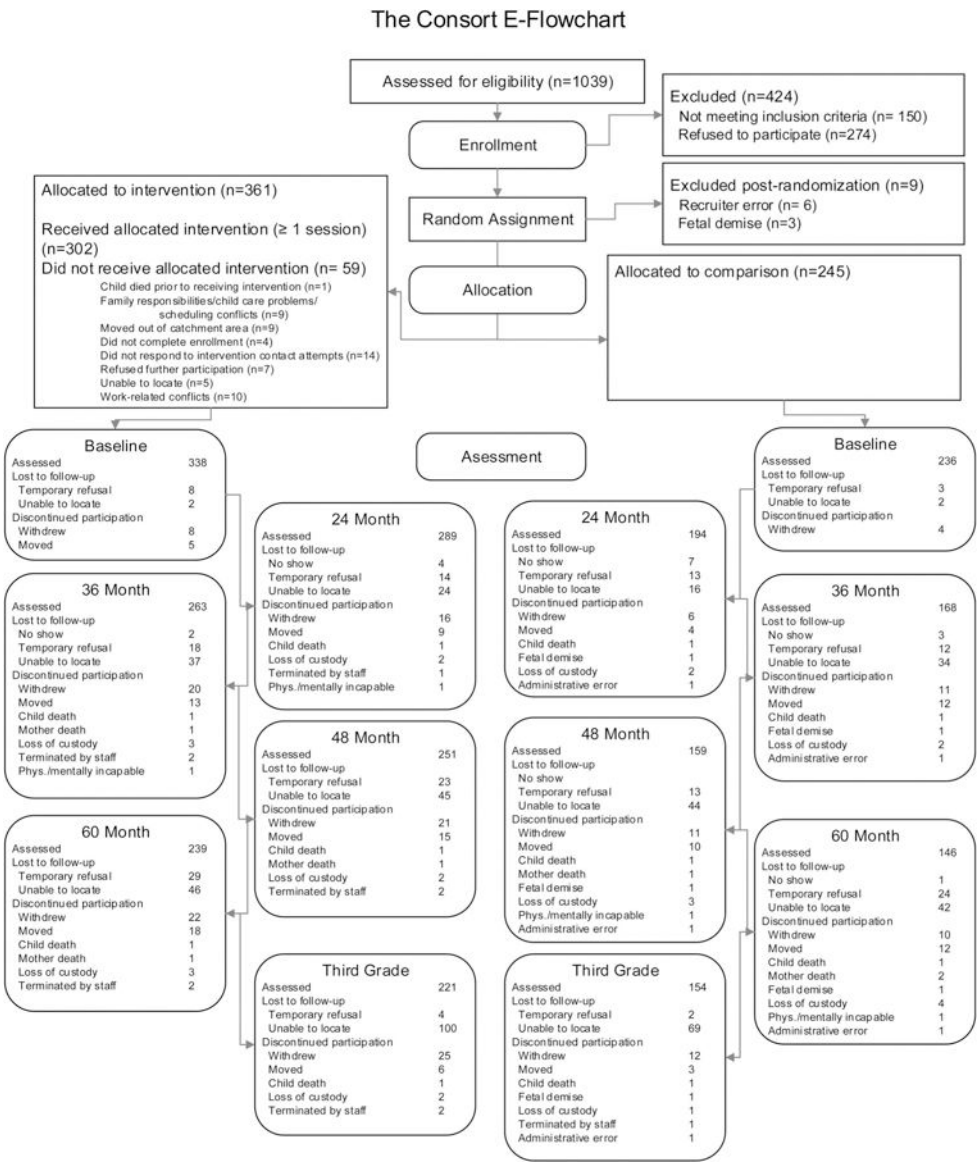

Figure 1.

Consort diagram participant flowchart for Legacy for Children™ program through third grade assessment.

Table 1.

Baseline Demographics of Mothers with Legacy Children with at Least One Cognitive/Language Outcome, N = 541

	Miami		Los Angeles	
	N	**%**	**N**	**%**
Intervention Status				
Intervention	165	59.6	154	58.3
Comparison	112	40.4	110	41.7
Sex				
Male child	131	47.3	137	52.1
Female child	146	52.7	126	47.9
Race/Ethnicity				
Hispanic	24	8.7	120	45.5
Black	195	70.4	120	45.5
White	3	1.1	15	5.7
Haitian	47	17.0	0	0.0
Other	8	2.9	9	3.4
Education				
Less than HS diploma	76	27.6	53	20.3
HS Diploma/GED	169	61.5	150	57.5
Voc. tech/associate's degree	26	9.5	41	15.7
College degree +	4	1.5	17	6.5
Income level				
<$20,000	149	59.4	119	49.4
$20,000–29,999	46	18.3	58	24.1
$30,000–39,999	26	10.4	31	12.9
$40,000–49,999	18	7.2	17	7.1
$50,000+	12	4.8	16	6.6
Language spoken in home				
English spoken primarily in home	181	65.8	128	49.0
Other language	94	34.2	133	51.0
Employment level				
Works full-time	32	11.6	24	9.2
Works part-time	28	10.2	58	22.2
Not working	215	78.2	179	68.6
	Mean	**SD**	**Mean**	**SD**
Maternal IQ (KBIT)	79.9	14.1	84.0	13.3
Child age at third grade assessment (mo)	114.2	7.7	111.4	5.3

GED, high school equivalency diploma; HS, high school; IQ, intelligence quotient; KBIT, Kaufman Brief Intelligence Test.

Table 2.

Unadjusted and Adjusted Cognitive Mean Scores of *Legacy* Children and Comparison Children Through Third Grade

	Miami			LA		
	Intervention	Comparison		Intervention	Comparison	
	Mean (SE)	Mean (SE)	*p*	Mean (SE)	Mean (SE)	*p*
Unadjusted mean scores						
Y3 KABC	75.6 (1.3)	76.5 (1.8)	NS	**83.7 (1.2)**	**79.3 (1.4)**	*
Y5 KABC	85.5 (1.1)	88.1 (1.4)	NS	87.6 (1.2)	86.6 (1.5)	NS
Third grade KABC	86.5 (1.3)	87.4 (1.3)	NS	**94.6 (1.2)**	**89.7 (1.6)**	*
Y5 WJ letter-word	100.4 (1.2)	103.3 (1.7)	NS	103.4 (1.5)	101.1 (2.0)	NS
Y5 WJ spelling	94.8 (1.5)	96.1 (1.6)	NS	101.1 (1.5)	97.0 (1.7)	†
Y5 WJ applied problems	87.7 (1.2)	89.0 (1.7)	NS	91.6 (1.4)	89.3 (1.7)	NS
Third grade WJ letter word	98.2 (1.4)	98.0 (1.8)	NS	**104.1 (1.2)**	**97.5 (1.9)**	**
Third grade WJ passage comprehension	86.1 (1.2)	87.1 (1.8)	NS	92.3 (1.0)	88.5 (1.8)	†
Third grade WJ calculations	98.6 (1.4)	99.8 (1.9)	NS	107.2 (1.5)	104.2 (2.5)	NS
Third grade WJ applied problems	90.6 (1.4)	93.3 (1.7)	NS	**96.8 (1.1)**	**92.5 (1.7)**	*
Adjusted mean scores[a]						
Y3 KABC	77.4 (1.6)	79.3 (2.0)	NS	**85.9 (1.5)**	**80.2 (1.7)**	**
Y5 KABC	86.5 (1.3)	89.0 (1.7)	NS	88.3 (1.6)	87.3 (1.8)	NS
Third grade KABC	87.8 (1.5)	89.4 (1.8)	NS	**95.0 (1.7)**	**89.6 (1.8)**	*
Y5 WJ letter-word	101.2 (1.5)	104.5 (1.9)	†	103.1 (2.0)	100.2 (2.3)	NS
Y5 WJ spelling	96.7 (1.7)	98.9 (2.1)	NS	**101.7 (1.9)**	**96.8 (2.3)**	*
Y5 WJ applied problems	88.3 (1.5)	90.0 (1.9)	NS	92.7 (1.8)	89.3 (2.1)	NS
Third grade WJ letter word	99.6 (1.9)	99.9 (2.1)	NS	**105.0 (1.8)**	**97.4 (1.9)**	***
Third grade WJ passage comprehension	87.2 (1.7)	88.4 (1.9)	NS	**92.3 (1.6)**	**87.3 (1.7)**	*
Third grade WJ calculations	99.6 (2.0)	101.5 (2.2)	NS	106.0 (2.2)	103.3 (2.4)	NS
Third grade WJ applied problems	91.5 (1.8)	94.7 (2.0)	NS	**96.8 (1.7)**	**92.3 (1.8)**	*

Boldface indicates statistical significance

† ($p < 0.10$

* $p < 0.05$

**$p < 0.01$

***$p < 0.001$).

[a]Adjusted for maternal age, maternal race/ethnicity, child sex, and maternal IQ. KABC, Kaufman Assessment Battery for Children-II; NS, not significant; WJ, Woodcock-Johnson III tests of achievement.

Table 3.

Unadjusted and Adjusted Language Mean Scores of *Legacy* and Comparison Children Through Age 5 Years

	Miami			LA		
	Intervention	Comparison		Intervention	Comparison	
	Mean (SE)	Mean (SE)	*p*	Mean (SE)	Mean (SE)	*p*
Unadjusted mean scores						
Y2 Preschool Language Scale						
Auditory	83.0 (1.1)	84.8 (1.2)	NS	84.3 (1.0)	85.9 (1.4)	NS
Expression	100.3 (0.9)	99.0 (1.1)	NS	94.1 (1.0)	92.8 (1.3)	NS
Standard score	90.8 (1.0)	91.2 (1.1)	NS	88.2 (1.0)	88.3 (1.4)	NS
Y4 Preschool Language Scale						
Auditory	86.3 (1.0)	86.9 (1.3)	NS	88.7 (1.2)	87.4 (1.4)	NS
Expression	88.2 (0.9)	89.0 (1.4)	NS	90.7 (1.1)	89.3 (1.5)	NS
Standard score	86.1 (1.0)	86.7 (1.4)	NS	88.8 (1.2)	87.3 (1.5)	NS
Y4 TERA reading quotient	77.8 (0.7)	78.8 (1.1)	NS	82.3 (0.9)	79.6 (1.1)	†
Y5 Adaptive Language Inventory						
Comprehension	10.5 (0.2)	10.7 (0.3)	NS	10.8 (0.2)	10.7 (0.3)	NS
Expression	18.9 (0.4)	19.1 (0.5)	NS	19.1 (0.4)	18.5 (0.5)	NS
Rephrase	11.9 (0.2)	12.0 (0.3)	NS	12.1 (0.2)	11.9 (0.3)	NS
Listening	7.6 (0.1)	7.8 (0.2)	NS	7.8 (0.1)	7.5 (0.2)	NS
Spontaneity	7.8 (0.2)	7.9 (0.2)	NS	8.0 (0.2)	7.5 (0.2)	*†*
Fluency	15.1 (0.3)	14.9 (0.4)	NS	15.3 (0.3)	15.3 (0.4)	NS
Total	71.8 (1.2)	72.5 (1.6)	NS	72.9 (1.3)	71.2 (1.7)	NS
Adjusted mean scores[a]						
Y2 Preschool Language Scale						
Auditory	83.4 (1.3)	85.8 (1.6)	NS	85.0 (1.3)	86.2 (1.5)	NS
Expression	99.8 (1.1)	99.0 (1.3)	NS	94.2 (1.3)	92.2 (1.4)	NS
Standard score	90.9 (1.2)	91.8 (1.4)	NS	88.7 (1.3)	88.1 (1.5)	NS
Y4 Preschool Language Scale						
Auditory	85.3 (1.3)	85.7 (1.6)	NS	89.8 (1.5)	88.2 (1.7)	NS
Expression	88.1 (1.2)	88.8 (1.5)	NS	92.8 (1.5)	90.8 (1.7)	NS

	Miami			LA		
	Intervention	Comparison		Intervention	Comparison	
	Mean (SE)	Mean (SE)	*p*	Mean (SE)	Mean (SE)	*p*
Standard score	85.4 (1.3)	85.8 (1.6)	NS	90.5 (1.5)	88.6 (1.7)	NS
Y4 TERA reading quotient	76.9 (1.0)	77.7 (1.1)	NS	**84.0 (1.1)**	**80.5 (1.3)**	*
Y5 Adaptive Language Inventory						
Comprehension	10.7 (0.3)	10.8 (0.4)	NS	10.9 (0.3)	10.7 (0.4)	NS
Expression	19.3 (0.5)	19.6 (0.6)	NS	19.3 (0.5)	18.5 (0.6)	NS
Rephrase	12.1 (0.3)	12.3 (0.3)	NS	12.1 (0.3)	11.7 (0.3)	NS
Listening	7.7 (0.2)	8.0 (0.2)	NS	7.7 (0.2)	7.4 (0.3)	NS
Spontaneity	7.9 (0.2)	8.1 (0.2)	NS	8.1 (0.2)	7.6 (0.3)	†
Fluency	15.3 (0.4)	15.2 (0.5)	NS	15.6 (0.4)	15.5 (0.5)	NS
Total	73.0 (1.6)	74.0 (2.0)	NS	73.6 (1.8)	71.1 (2.1)	NS

Boldface indicates statistical significance

† $p < 0.10$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$).

[a] Adjusted for maternal age, maternal race/ethnicity, child sex, and maternal IQ. NS, not significant; TERA, Test of Early Reading Ability-3.

Table 4.

Summary of Legacy for Children™ Intent-to-Treat Analyses (Including Previously Reported Findings[24])

	Assessment Time Point					
Domain/Measure	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Third Grade**
Cognitive, language/communication						
KABC II			**LA** * **ES = 0.34**		NS	**LA** * **ES = 0.38**
WJ tests of achievement—II					LA † ES 5 0.26	LA * **ES = 0.49** [a] **ES = 0.33** [b]
Preschool Language Scales—4		NS		NS		
Test of Early Reading Ability—3				LA † ES = 0.27		
Adaptive Language Inventory					NS	
Social/emotional23						
Brief infant toddler social and emotional assessment	LA † ES = −0.26					
Behavior23						
Devereux Early Childhood Assessment		**Miami** * **ES = −0.37**	NS	**Miami** * **ES = −0.51**	LA † ES = −0.49	Analysis in progress
Strengths and Difficulty Questionnaire				NS	**LA** * **ES = −0.38**	Analysis in progress

Boldface indicates statistical significance

† ($p < 0.10$

* $p < 0.05$)

please note that the difference in the direction of effect sizes is because of the cognitive/language outcomes, for which a higher score is better, while a lower score is better for the social/ emotional outcomes).

[a] ES for letter-word test.

[b] ES for applied problems. ES, effect size; KABC, Kaufman Assessment Battery for Children-II; NS, not significant; Miami, significant unadjusted intervention effects for Miami site; LA, significant unadjusted intervention effects for LA site; WJ, Woodcock-Johnson.

Table 5.

Participation Rate and Mean Age at Each Cognitive and Language Assessment Time Point by Site

	Miami		LA	
	Response Rate	**Mean Age (in mo) of Child at Completion**	**Response Rate**	**Mean Age (in mo) of Child at Completion**
Baseline	96.3% (289/300)		93.1% (284/305)	
24 mo	85.0% (255/300)	24.9	75.7% (231/305)	25.1
36 mo	75.3% (226/300)	36.9	67.2% (205/305)	36.8
48 mo	69.0% (207/300)	48.5	66.2% (202/305)	48.8
60 mo	65.0% (195/300)	60.5	62.3% (190/305)	60.9
Third grade	64.0% (192/300)	112.7	60.9% (186/305)	110.9