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Pediatrics 2004;114;1560-1568

DOI: 10.1542/peds.2004-0961

This information is current as of December 2, 2004

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located on the World Wide Web at:

<http://www.pediatrics.org/cgi/content/full/114/6/1560>

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American Academy of Pediatrics

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Effects of Home Visits by Paraprofessionals and by Nurses: Age 4 Follow-Up Results of a Randomized Trial

David L. Olds, PhD*; JoAnn Robinson, PhD*; Lisa Pettitt, PhD*; Dennis W. Luckey, PhD*;
John Holmberg, PsyD*; Rosanna K. Ng, MS*; Kathy Isacks, MPS*; Karen Sheff, MS*; and
Charles R. Henderson, Jr†

ABSTRACT. *Objective.* To examine the effects of prenatal and infancy home visiting by paraprofessionals and by nurses from child age 2 through age 4 years.

Methods. We conducted, in public and private care settings in Denver, Colorado, a randomized, controlled trial with 3 arms, ie, control, paraprofessional visits, and nurse visits. Home visits were provided from pregnancy through child age 2 years. We invited 1178 consecutive, low-income, pregnant women with no previous live births to participate, and we randomized 735; 85% were unmarried, 47% Mexican American, 35% white non-Mexican American, 15% black, and 3% American Indian/Asian. Outcomes consisted of maternal reports of subsequent pregnancies, participation in education and work, use of welfare, marriage, cohabitation, experience of domestic violence, mental health, substance use, and sense of mastery; observations of mother-child interaction and the home environment; tests of children's language and executive functioning; and mothers' reports of children's externalizing behavior problems.

Results. Two years after the program ended, women who were visited by paraprofessionals, compared with control subjects, were less likely to be married (32.2% vs 44.0%) and to live with the biological father of the child (32.7% vs 43.1%) but worked more (15.13 months vs 13.38 months) and reported a greater sense of mastery and better mental health (standardized scores [mean = 100, SD = 10] of 101.25 vs 99.31 and 101.21 vs 99.16, respectively). Paraprofessional-visited women had fewer subsequent miscarriages (6.6% vs 12.3%) and low birth weight newborns (2.8% vs 7.7%). Mothers and children who were visited by paraprofessionals, compared with control subjects, displayed greater sensitivity and responsiveness toward one another (standardized score [mean = 100, SD = 10] of 100.92 vs 98.66) and, in cases in which the mothers had low levels of psychologic resources at registration, had home environments that were more supportive of children's early learning (score of 24.63 vs 23.35). Nurse-visited women reported greater intervals between the births of their first and second children (24.51 months vs 20.39 months) and less domestic violence (6.9% vs 13.6%) and enrolled their children

less frequently in preschool, Head Start, or licensed day care than did control subjects. Nurse-visited children whose mothers had low levels of psychologic resources at registration, compared with control group counterparts, demonstrated home environments that were more supportive of children's early learning (score of 24.61 vs 23.35), more advanced language (score of 91.39 vs 86.73), superior executive functioning (score of 100.16 vs 95.48), and better behavioral adaptation during testing (score of 100.41 vs 96.66). There were no statistically significant effects of either nurse or paraprofessional visits on the number of subsequent pregnancies, women's educational achievement, use of substances, use of welfare, or children's externalizing behavior problems.

Conclusions. Paraprofessional-visited mothers began to experience benefits from the program 2 years after the program ended at child age 2 years, but their first-born children were not statistically distinguishable from their control group counterparts. Nurse-visited mothers and children continued to benefit from the program 2 years after it ended. The impact of the nurse-delivered program on children was concentrated on children born to mothers with low levels of psychologic resources. *Pediatrics* 2004;114:1560–1568; nurse, home visits, pregnancy, welfare, child development.

Our team has been conducting a 3-armed, randomized, controlled trial of prenatal and infancy home visiting by paraprofessionals and by nurses (control, paraprofessional home visits, and nurse home visits), to determine visitors' influences on maternal and child health¹ when both types of visitors follow a program model found to be effective when delivered by nurses in 2 earlier trials.^{2–11} The primary question addressed in this trial was whether the sporadic weak effects typically found for paraprofessional home visiting^{12–15} could be improved if paraprofessionals were provided with well-developed program guidelines and thorough training and supervision in a program model grounded in epidemiology and theory.¹⁶

The nurse arm of the trial was included to facilitate interpretation of paraprofessional findings and to determine whether nurses could achieve effects on maternal and child outcomes comparable to those found in the earlier trials^{2–11} when serving a different population, in a different context and at a different time in our nation's economic and social history.

Although paraprofessionals can have a range of formal preparations for their roles, we chose to ex-

From the *Prevention Research Center for Family and Child Health, University of Colorado Health Sciences Center, Denver, Colorado; and †Department of Human Development, Cornell University, Ithaca, New York. Accepted for publication May 12, 2004.

doi:10.1542/peds.2004-0961

No conflict of interest declared.

Reprint requests to (D.L.O.) University of Colorado Health Sciences Center, 1825 Marion St, Suite 200, Denver, CO 80218. E-mail: olds.david@tchden.org

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amine paraprofessional visitors who share many social characteristics with the families they serve, because many think that shared social characteristics increase visitors' ability to empathize with their clients, who, in turn, are more likely to trust those similar to them.^{17,18} This segment of the paraprofessional population is important to test, because use of community health workers with limited educational backgrounds is a common element in many home visiting programs,¹⁹⁻²¹ although some programs have begun to increase visitors' educational qualifications.

In an earlier phase of this trial (from pregnancy through child age 2 years), we found that paraprofessional home visitors produced small effects that were approximately one-half the size of those produced by nurses and were rarely clinically or statistically significant.¹ Nurses produced effects consistent with previous trials of the program, including beneficial effects on women's use of tobacco during pregnancy, maternal life course (fertility and workforce participation), and emotional, language, and cognitive development of infants born to mothers with low levels of psychologic resources.¹ The current work was conducted to determine whether beneficial effects of paraprofessionals eventually would emerge and whether the beneficial effects of nurses would endure during the 2-year period after the end of visitation at child age 2 years.

We hypothesized that nurse visitors would produce results like those in previous trials. Given the weak results from previous trials of paraprofessional home visitor programs¹²⁻¹⁵ and the earlier phase of this trial,¹ we expected the paraprofessional-control differences to be relatively small. The impact of the nurse home visitor program on caregiving and child outcomes was greater for cases in which mothers had low levels of psychologic resources (limited intellectual functioning, mental health, and sense of control over life circumstances) in both earlier trials^{3,10,16} and the earlier phase of this trial,¹ and we hypothesized corresponding effects in the current phase of this trial for both types of visitors.

Participants

The current study consisted of a follow-up study of mothers and children in their homes near the child's fourth birthday, 2 years after the end of the program at child age 2 years. The major features of the design have been reported earlier¹ but are summarized here.

Between March 1994 and June 1995, 1178 consecutive women from 21 antepartum clinics serving low-income women in Denver were invited to participate in the study. Women were recruited if they had no previous live births and either qualified for Medicaid or had no private insurance. Medicaid eligibility in Colorado at the time was extended to women who were at 133% of the federal poverty level. The numbers of women invited to participate, randomized, and assessed at the 48-month follow-up time are summarized in Table 1.

Statistical Power and Assignment Ratios

Sample size was based on 0.80 power when using $\alpha = .05$ for 2-tailed tests and assuming effects of 0.30 SD between each visited group and the control group when the trial was first designed. This resulted in 600 subjects divided evenly among 3 treatment groups. Allowing for a 20% attrition rate, an initial projected sample size of 750 was determined, and we enrolled 735 subjects. We also were interested in detecting effects limited to one-half of the total sample at higher risk (such as mothers with low levels of psychologic resources). For these comparisons, we had power to detect differences of 0.42 SD. Because of constraints in sample size and costs, the study was not designed for direct comparisons between paraprofessionals and nurses. Because >600 participants were retained in the current follow-up assessment, the original power calculations hold for analyses reported below.

Randomization

After completion of baseline interviews, identifying information on participants was sent to the data operations office (located apart from the interviewers' office), where it was entered into a computer program that randomized individual women to treatment conditions.²² Randomization was conducted within strata from a model with 3 classification factors, ie, maternal race/ethnicity (Mexican American, white non-Mexican American, black, or American Indian/Asian), maternal gestational age at enrollment (<32 vs ≥ 32 weeks), and geographic region of residence (4 regions). Women assigned to 1 of the 2 home visitor groups were assigned randomly to home visitors responsible for their geographic region.

Treatment Conditions

Women in treatment 1 ($n = 255$) were provided with free developmental screening and referral for their children at 6, 12, 15, 21, and 24 months of age. Women in treatment 2 ($n = 245$) were provided with the screenings offered in treatment 1 plus parapro-

TABLE 1. Denver Sample Composition With Time, According to Treatment, Through Age 4 Years

	Treatment Group			Total
	Control	Paraprofessional	Nurse	
No. eligible invited to participate				1178
No. of refusals				244
No. of passive refusals				199
No. randomized				735
No. allocated to treatment	255	245	235	735
No. of fetal demises	9	7	10	26
No. of infant deaths	2	1	1	4
No. of adoptions	6	3	1	10
No. available for 4-y follow-up interviews	238	234	223	695
No. completed 4-y interviews	220	211	204	635
% of randomized	86	86	87	86
% of alive or not adopted	92	90	92	91
No. completed 4-y child assessments	211	198	196	605
% of randomized	83	81	83	82
% of alive or not adopted	89	85	88	87

professional home visiting during pregnancy and the child's first 2 years of life. Women in treatment 3 ($n = 235$) were provided with the screening offered in treatment 1 plus nurse home visiting during pregnancy and the child's first 2 years.

Design and Implementation of Home Visiting Programs

A description of the nurse and paraprofessional programs and a comparison of their implementations are provided elsewhere.²³ Both programs were based on the original nurse-delivered program conducted in Elmira, New York, and updated and augmented in Memphis, Tennessee.¹⁶ The Denver program incorporated a greater focus on infants' affective development and on parent-infant communication of emotion.²⁴ The home visiting program has 3 broad goals, ie, (1) to improve maternal and fetal health during pregnancy by helping women improve their health-related behaviors; (2) to improve children's health and development by helping parents provide more competent care; and (3) to enhance mothers' personal development by promoting planning of future pregnancies and helping women continue their educations and find work. The visitors helped women accomplish these goals by promoting the adaptive behaviors specified above, by helping them improve their relationships with key family members and friends (especially their mothers and boyfriends), and by promoting women's use of needed health and human services.¹⁶

Nurse home visitors were required to have a BSN degree and experience in community or maternal and child health nursing, whereas paraprofessionals were expected to have a high school education, no college preparation in the helping professions, and strong "people skills." Preference in hiring was given to paraprofessionals who had previously worked in human services. Program protocols were adapted to accommodate nonnurses by altering such things as the way maternal and child health problems were addressed. Both visitor types received 1 month of extensive training before working with families in the study.

Each visitor managed caseloads of ~25 families. Paraprofessionals had twice the level of supervision (2 supervisors for 10 visitors), compared with nurses (1 supervisor for 10 visitors). Nurses had greater staff retention. All 10 nurses remained with the program for its duration, whereas 7 of the original paraprofessionals did; replacements were hired for paraprofessionals who left.

Paraprofessionals completed an average of 6.3 home visits (range: 0-21 visits) during pregnancy and 16 visits (range: 0-78 visits) during infancy. Nurses completed an average of 6.5 home visits (range: 0-17 visits) during pregnancy and 21 visits (range: 0-71 visits) during infancy. The paraprofessional-nurse difference in completed infancy home visits was significant ($P < .001$). On average, paraprofessionals had more scheduled visits in which families were not at home or did not answer the door (8 vs 5 visits, $P < .001$), but they had longer visits when they were completed (eg, 78 vs 72 minutes during infancy, $P < .001$). By the end of the program, 48% of the paraprofessional-visited families had discontinued the program, compared with 38% of the families visited by nurses ($P = .04$).²³

Masking

Data were gathered by staff members masked with respect to participants' treatment assignments.

Assessments and Definitions of Variables

Interviews with participating women were conducted by research staff members at the time of registration (before their assignment to treatments), at the 28th and 36th weeks of pregnancy, and at the 6th, 12th, 15th, 21st, 24th, and 48th months of the child's life. The children's mean age at the current follow-up assessment was 49.8 months (SD: 2.0 months).

A variable was created to index women's psychologic resources measured at registration, with procedures similar to those used in an earlier trial in Memphis.^{10,11} The variable was based on summed z scores for the women's intelligence,²⁵ mental health,²⁶ and sense of mastery.²⁷ The psychologic resource variable was dichotomized at values that corresponded to the 50th percentile of the raw scores included in this index for the Memphis sample.¹¹ This procedure produced a classification variable comparable to that created in Memphis, which split the Denver sample into low-functioning (40% of the sample) and high-functioning (60% of the sample) groups.

At the 48-month in-home assessment, mothers reported the number and outcomes of subsequent pregnancies (miscarriages, abortions, low birth weight newborns, or neonatal intensive care unit admissions), their educational achievements, the number of months they had participated in the workforce, their use of welfare services (Temporary Assistance for Needy Families, Medicaid, or food stamps), whether they had been married or cohabiting, and, for women who lived with a partner during the 2-year period before the interview, whether they had experienced physical violence (eg, being slapped, kicked, choked, or threatened with a knife or gun)²⁸ during 2-year and 6-month periods preceding the interview. Women reported on their use of alcohol, marijuana, and other illegal drugs and the extent to which use of those substances interfered with their daily functioning. Use of illegal drugs other than marijuana occurred too infrequently to serve as a valid outcome. Moderate to heavy drinking was classified as ≥ 3 days of drinking in the past 14 days in which women drank an average of ≥ 3 alcoholic beverages per day. Women also reported on whether their children had been enrolled in preschool, Head Start, or licensed day care.

Mothers reported on their children's externalizing behavior problems (rule-breaking and aggressive behavior).²⁹ They were observed with their children in a free-play session and their interactions were coded.³⁰ The behaviors of mothers and children were subjected to principal-components analysis and aggregated to a single factor, termed sensitive/responsive interaction (Cronbach's $\alpha = .67$).

Home environments were assessed for their support of early learning with the Home Observation for Measurement of the Environment inventory.³¹ The children were assessed in their homes with Preschool Language Scales-3³² and with a series of cognitive tasks focusing primarily on the children's capacity for sustained attention³³ and inhibitory control (fine-motor control was assessed with the tap test, gross-motor control was assessed with the Walk-a-Line test, and inhibition of prepotent responses was assessed with the day-night test).³⁴⁻³⁶ Principal-components analysis of attention and inhibitory control tasks produced a single composite index, which we labeled executive functions (Cronbach's $\alpha = .60$). Examiners rated children's behavior during testing to assess children's ability to regulate their behavior and emotions.³³ Principal-components analysis of these behaviors produced 2 scales, ie, behavioral adaptation (attention, activity level, organization of behavior/impulse control, and sociability, Cronbach's $\alpha = .96$) and emotional regulation (anxiety, energy and feelings, regulation of mood, and sensory reactivity, Cronbach's $\alpha = .92$). These analyses substantially duplicated the published 2-factor structure for the broadband subscales, which were converted into standard scores according to published normative values.³³

Statistical Models and Methods of Analysis

Data analyses were conducted with all cases for which outcome data were available, irrespective of the degree to which families participated in the programs. The primary statistical model consisted of a single classification factor for treatments (3 levels) and 6 covariates included to control for potential nonequivalence among treatment groups at intake, ie, maternal psychologic resources, whether the mother registered in the study after 28 weeks of gestation, maternal age, housing density, mother's conflict with her partner, and mother's conflict with her mother. Paraprofessional-visited families had higher incomes than did nurse-visited families, but missing data on household income for ~10% of the sample (often teens living at home) precluded its use as a covariate. Covariates were included whenever the probability for any treatment comparison was $< .10$ for that variable. All covariates were examined for homogeneity of regressions.³⁷ Results reported below were similar for models with and without covariates. Results are shown for models with covariates, to reduce possible concern about bias. Planned comparisons focused on the test of nurse versus control and paraprofessional versus control. For mother-child interaction, home environment, and child outcomes, separate treatment group comparisons were performed for the group defined by mothers having low psychologic resources.

To determine whether program effects were moderated by women's ethnicity, we examined models that also included a classification factor for ethnicity (Mexican American, black, or white). After finding that program effects were essentially equivalent for each ethnic group, we dropped ethnicity from the final

model. The model for child outcomes also considered the gender of the child as a classification factor with and without interactions, but this factor was not included after it was determined that the gender of the child did not interact with treatments and that adjustment of estimates for gender had little bearing on estimates or conclusions.

Continuous dependent variables were analyzed with the general linear model, and dichotomous outcomes were analyzed with the logistic-linear model. Timing of subsequent births was examined with proportional-hazards analysis³⁸ with the primary model specified above, with tests performed for the planned treatment comparisons; distributions of the data met the proportionality assumption for proportional-hazards analysis. Outcomes related to subsequent pregnancies and births for mothers might be correlated. For dichotomous correlated outcomes, we used generalized estimating equations^{39,40} with a logit link function and assumption of an exchangeable (compound symmetry) correlation structure. The tables show exact probability levels for comparisons of the 2 visited groups with the control group (2-tailed tests).

RESULTS

Sample Retention

As indicated in Table 1, rates of completed assessments at 48 months were high and equivalent across treatment conditions. Interviews were conducted with mothers in 86% of the cases randomized and 91% of those in which the child was alive and not adopted. Direct assessments of children were completed in 82% of the cases randomized and 87% of those in which the child was alive and not adopted.

Equivalence of Treatment Conditions

Across treatment conditions, participants were similar with respect to key background characteristics in cases in which the 48-month follow-up assessments were conducted, both for the sample overall and for the group defined by mothers having low psychologic resources (Table 2). Differences that existed for any treatment comparison at $P < .10$, for either the whole sample or the low-resource group (maternal psychologic resources, registration in the study after 28 weeks of gestation, maternal age, housing density, mother's conflict with her partner, and mother's conflict with her mother), were handled with covariate adjustments as described above. Although household income favored the paraprofessional-visited group, it was not included as a covariate because of unacceptably high rates of missing data on that variable.

Paraprofessional Effects

Maternal Life Course

Table 3 shows, that 2 years after the end of the program, women visited by paraprofessionals, compared with control subjects, were less likely to be married (32.2% vs 44.0%, $P = .02$) and to live with the child's biological father (32.7% vs 43.1%, $P = .03$), but they worked more between child age 2 and age 4 (15.13 vs 13.38 months, $P = .04$) and had a greater sense of mastery (score of 101.25 vs 99.31, $P = .03$) and better mental health (score of 101.21 vs 99.16, $P = .03$). Although there were no statistically significant paraprofessional effects on rates or timing of subsequent pregnancies and births, when a subsequent birth did occur, paraprofessional-visited women were less likely than control subjects to have a low birth weight newborn (2.8% vs 7.7%, $P = .03$).

There were no statistically significant paraprofessional effects on women's educational achievement, use of welfare, use of marijuana or alcohol, behavior problems attributable to substance use, or experience of domestic violence.

Home Environments, Mother-Child Interaction, and Child Development

Table 4 shows that paraprofessional-visited mother-child pairs, compared with control subjects, displayed more sensitive and responsive interactions during the free-play session (score of 100.92 vs 98.66, $P = .03$). Families in which mothers had low psychologic resources at registration, compared with control group counterparts, had home environments more supportive of early learning (score of 24.63 vs 23.35, $P = .03$). There were no statistically significant paraprofessional program effects on children's language, executive functioning, emotional regulation, or behavioral adaptation, or on mothers' reports of externalizing behavior problems.

Nurse Effects

Maternal Life Course

Table 3 shows that nurse-visited women, compared with control subjects, had greater intervals between the births of their first and second children when a second birth occurred (24.51 vs 20.39 months, $P = .01$). Figure 1 shows the timing of subsequent births in a survival analysis; the nurse and control lines are different ($P = .03$). Nurse-visited women also reported less domestic violence from partners during the 6-month interval before the 4-year interview (6.9% vs 13.6%, $P = .05$). Nurse-visited mothers reported enrolling their children less frequently in preschool, Head Start, or licensed day care ($P = .03$). There were no statistically significant nurse effects on women's educational achievement, employment, use of welfare, mental health, mastery, use of marijuana or alcohol, behavior problems attributable to substance use, marriage, or living with a partner or father of the child.

Home Environments, Mother-Child Interaction, and Child Development

Table 4 shows that nurse-visited children born to mothers with low psychologic resources, compared with control group counterparts, had home environments more conducive to early learning (score of 24.61 vs 23.35, $P = .03$), better language development (score of 91.39 vs 86.73, $P = .04$), superior executive functioning (score of 100.16 vs 95.48, $P = .004$), and better behavioral adaptation during testing (score of 100.41 vs 96.66, $P = .04$). There were no statistically significant nurse effects on sensitive-responsive mother-child interaction, children's emotional regulation, or externalizing behavior problems.

DISCUSSION

Paraprofessional Findings

Two years after the program ended, paraprofessional-visited women, compared with control subjects, had lower rates of marriage and cohabitation

TABLE 2. Background Characteristics at Intake for Clients Who Completed 4-Year Maternal Assessments

Background Variable	Sample	Proportion, %					
		Control (N = 220)*		Paraprofessional (N = 211)		Nurse (N = 204)	
Married	Whole	16.4		12.8		15.2	
	Low-resource	13.9		9.2		8.6	
Black	Whole	14.1		16.6		15.2	
	Low-resource	16.7		18.4		19.8	
Mexican American	Whole	47.7		47.4		44.6	
	Low-resource	58.3		49.0		51.9	
Monolingual Spanish	Whole	4.1		4.3		3.9	
	Low-resource	2.8		2.0		2.5	
Anglo (non-Hispanic)	Whole	35.0		33.6		37.3	
	Low-resource	23.6		28.6		25.9	
Drank alcohol in past 14 D†	Whole	5.9		6.2		6.9	
	Low-resource	4.2		6.1		9.9	
Cigarette smoker‡	Whole	26.8		21.8		27.9	
	Low-resource	25.0		25.5		32.1	
Used marijuana in past 14 D†	Whole	9.5		9.5		9.8	
	Low-resource	8.3		13.3		12.3	
Cocaine user‡	Whole	1.4		2.9		1.0	
	Low-resource	0		5.2		1.3	
Registered after 28 wk of gestation	Whole	16.8		10.4		13.2	
	Low-resource	15.3		9.2		19.8	
Any domestic violence in past 6 mo	Whole	16.4		19.0		13.7	
	Low-resource	18.0		31.9		22.8	
		Mean	SD	Mean	SD	Mean	SD
Maternal age, y	Whole	19.81	4.09	19.46	3.79	20.14	4.05
	Low-resource	19.65	4.30	19.03	4.00	19.43	3.86
Gestational age at randomization, wk	Whole	18.88	7.52	18.69	7.30	18.81	7.28
	Low-resource	18.24	7.72	17.60	6.76	19.26	7.89
Psychologic resources index§	Whole	100.86	10.33	99.38	9.08	100.70	9.93
	Low-resource	89.16	6.75	91.45	4.96	90.49	5.01
Highest grade completed, mother	Whole	11.30	1.89	11.07	1.86	11.19	2.07
	Low-resource	10.72	1.73	10.62	1.86	10.51	2.11
Annual household income¶	Whole	13 071	11 604	13 566	13 649	12 792	11 804
	Low-resource	10 077	10 875	11 989	13 338	8724	8523
% of census tract below poverty	Whole	10.97	13.95	20.75	13.40	20.13	15.30
	Low-resource	22.69	15.27	21.90	13.77	22.31	14.55
Housing density	Whole	0.83	0.49	0.95	0.56	0.83	0.47
	Low-resource	0.90	0.55	1.02	0.61	0.87	0.51
Conflict with mother§	Whole	100.44	10.84	99.18	8.66	100.38	10.34
	Low-resource	104.85	13.14	100.57	9.89	100.97	11.14
Conflict with partner§	Whole	101.16	11.25	99.31	9.08	99.46	9.39
	Low-resource	102.58	12.73	101.60	11.52	100.79	11.64
Attitudes toward childrearing predictive of child abuse#	Whole	100.18	10.61	100.45	9.86	99.34	9.48
	Low-resource	105.42	10.24	103.59	9.13	103.55	7.67

* Low-resource group sample sizes: control: 72; paraprofessional: 98; nurse: 81.

† Self-report.

‡ Either self-report or urine assay.

§ Scales standardized to mean of 100 and SD of 10.

|| Scale consists of summed z scores of mental health inventory, mastery, and intellectual functioning.

¶ Reported total annual household income.

Bavolek Adult/Adolescent Parenting Inventory (mean = 100; SD = 10).

with the child's father, greater participation in the workforce, and better sense of mastery, mental health, and mother-child interaction. Although the difference in interbirth intervals shown in Table 3 was relatively small and not statistically significant, the survival analysis shown in Fig 1 suggests that paraprofessional-visited women had a clinically but not statistically significant reduction in the timing of subsequent live births. When paraprofessional-visited women did get pregnant or give birth to a subsequent child, they were less likely to miscarry or to deliver a low birth weight newborn. Mothers with low psychologic resources who were visited by paraprofessionals provided home environments that were more supportive of early learning. Although

paraprofessionals produced positive effects on sensitive mother-child interaction and home environments, they produced no statistically significant effects on child outcomes. Paraprofessional effects on the language, executive functioning, and behavioral adaptation of children born to low-resource mothers were clinically important (in the 0.23- to 0.29-SD range), however. Taken as a whole, the effects of the paraprofessionals on maternal outcomes at child age 4 years increase the possibility that more effects on child outcomes may emerge at later times.

In light of anecdotal reports that paraprofessional visitors urged women to terminate abusive relationships,⁴¹ we wondered whether the lower rates of marriage and cohabitation and higher levels of men-

TABLE 3. Adjusted Estimate of Program Effects on Maternal Life Course

	Control		Paraprofessional		Nurse		Control vs Paraprofessional		Control vs Nurse	
	LS Mean	SE	LS Mean	SE	LS Mean	SE	P Value	Effect Size*	P Value	Effect Size*
No. of subsequent pregnancies	0.88	0.06	0.88	0.06	0.85	0.06	1.00	0.00	.72	-0.04
No. of subsequent live births	0.57	0.04	0.53	0.04	0.48	0.05	.57	-0.06	.18	-0.13
Months between births of 1st and 2nd children	20.39	1.09	22.20	1.19	24.51	1.18	.27	0.14	.01	0.32
Mastery†	99.31	0.62	101.25	0.64	99.41	0.64	.03	0.20	.91	0.12
Mental health†	99.16	0.66	101.21	0.67	99.82	0.68	.03	-0.03	.49	-0.04
Months mother employed (25-48 mo)	13.38	0.59	15.13	0.61	14.42	0.61	.04	0.11	.22	0.04
Months with current partner	20.14	0.65	20.03	0.71	19.92	0.68	.91	0.07	.81	0.04
Months of AFDC (25-48 mo)	2.10	0.39	1.95	0.40	1.88	0.40	.78	0.19	.69	0.01
Months of food stamps (25-48 mo)	3.98	0.56	4.56	0.57	4.32	0.57	.47	0.21	.67	0.07
Months of Medicaid (25-48 mo)	6.98	0.68	8.08	0.70	7.34	0.70	.26	-0.02	.71	-0.03
	Proportion, %						P Value	Odds Ratio	P Value	Odds Ratio
	Control		Paraprofessional		Nurse					
Graduated from high school or earned GED diploma	76.1		81.6		80.0		.18	1.39	.35	1.26
Married	44.0		32.2		38.6		.02	0.61	.28	0.80
Lives with partner	60.6		52.0		58.1		.08	0.70	.61	0.90
Lives with father of child	43.1		32.7		41.1		.03	0.64	.69	0.92
Subsequent miscarriage‡	12.3		6.6		9.3		.04	0.50	.31	0.73
Subsequent abortion‡	5.2		6.1		4.9		.67	1.19	.89	0.94
Subsequent low birth weight newborns§	7.7		2.8		5.9		.03	0.34	.45	0.75
Subsequent NICU/Special care admissions§	8.3		4.6		5.6		.13	0.54	.27	0.66
Currently using marijuana	9.4		8.9		8.2		.87	0.94	.67	0.86
Moderate/heavy drinker (≥3 drinks ≥3 times in 14 d)	3.8		2.7		4.2		.54	0.74	.84	1.09
Behavioral problems attributable to substance use	12.3		10.3		15.2		.52	0.82	.41	1.27
Child attended Head Start, preschool, center-based day care, or government-supported family care	65.9		59.4		54.4		.21	0.76	.03	0.62
Any domestic violence										
Past 6 mo	13.6		14.2		6.9		.88	1.05	.05	0.47
Since child age 2	23.7		21.9		15.8		.72	0.90	.09	0.60

AFDC indicates Aid to Families With Dependent Children; GED, General Educational Development; NICU, neonatal intensive care unit.

* Variable standardized to mean = 100, SD = 10.

† Effect size = least-squares (LS) mean difference divided by the pooled SD of the outcome.

‡ Per subsequent pregnancy.

§ Per subsequent live birth.

TABLE 4. Program Impact on Home Environment, Mother-Child Interaction, and Child Development Outcomes

	Sample	Control		Paraprofessional		Nurse		Control vs Paraprofessional		Control vs Nurse	
		LS Mean	SE	LS Mean	SE	LS Mean	SE	P Value	Effect Size*	P Value	Effect Size*
Home total score	Whole	25.09	0.22	25.08	0.23	25.32	0.23	.96	-0.00	.47	0.07
	Low-resource	23.35	0.42	24.63	0.36	24.61	0.40	.03	0.38	.03	0.37
Sensitive/responsive interaction†	Whole	98.66	0.69	100.92	0.72	100.51	0.72	.03	0.23	.06	0.18
	Low-resource	98.07	1.37	101.16	1.16	100.35	1.25	.09	0.31	.22	0.23
Total language score	Whole	92.01	1.00	93.24	1.03	92.65	1.03	.39	0.08	.65	0.04
	Low-resource	86.73	1.69	90.09	1.42	91.39	1.56	.13	0.23	.04	0.31
Executive function composite†	Whole	99.69	0.68	99.70	0.70	100.64	0.71	1.00	0.00	.34	0.09
	Low-resource	95.48	1.17	98.40	0.99	100.16	1.09	.06	0.29	.00	0.47
Behavioral adaptation in testing	Whole	99.71	0.69	100.66	0.71	99.63	0.72	.34	0.09	.93	-0.01
	Low-resource	96.66	1.31	99.51	1.10	100.41	1.21	.10	0.28	.04	0.38
Emotional regulation in testing	Whole	99.61	0.69	100.86	0.71	99.54	0.72	.21	0.13	.95	-0.01
	Low-resource	98.42	1.23	99.29	1.03	99.54	1.13	.59	0.09	.51	0.11
Externalizing behavior problems	Whole	12.20	0.49	11.65	0.51	12.16	0.51	.44	-0.08	.96	-0.01
	Low-resource	12.95	0.99	12.91	0.84	13.16	0.93	.98	-0.00	.88	0.03

* Effect size = least-squares (LS) mean difference divided by the pooled SD of the outcome.

† Variable standardized to mean of 100 and SD of 10.

tal health and mastery on the part of the paraprofessional-visited women might have been attributable to paraprofessional-visited women ending relation-

ships with abusive men. The absence of paraprofessional effects on domestic violence, however, reduces the plausibility of this explanation.

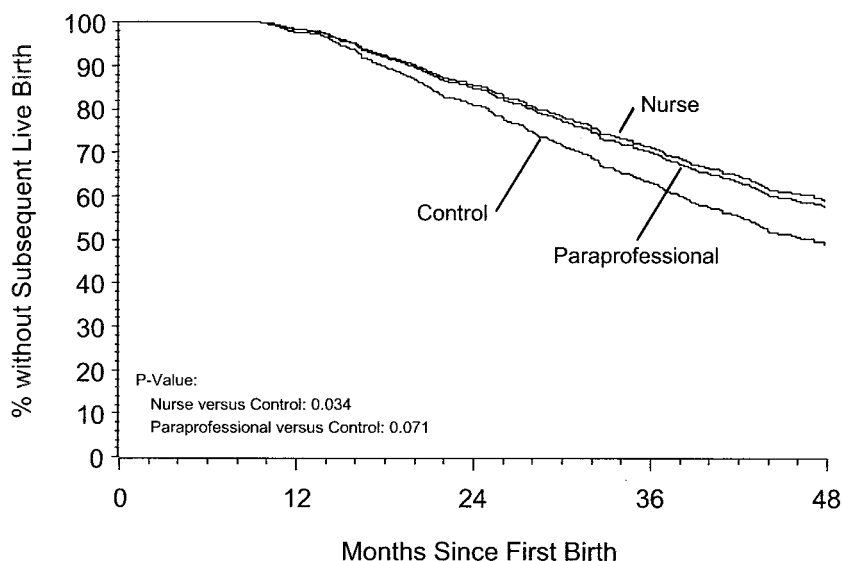


Fig 1. Proportional-hazards model for time until first subsequent live birth.

Nurse Findings

Nurse-visited women had longer intervals between the births of their first and second children, and those who were married or cohabiting experienced less domestic violence. The first finding is important because greater interbirth intervals make it easier for parents to spend time caring for their firstborn children.¹⁶ The second finding is important because few interventions have shown promise in reducing domestic violence in randomized trials,⁴² and domestic violence reduced the impact of this program on the prevention of child abuse and neglect in the Elmira trial.⁴³ Because this is the first time that domestic violence has been affected in this series of trials, it is particularly important that this finding be replicated and examined for its endurance in subsequent phases of follow-up monitoring. It is plausible, however, given nurses' increased emphasis on domestic violence in more recent trials of this program.⁴³

Despite nurse effects on the spacing of subsequent births (now observed in each of the 3 trials), there was no effect on women's use of welfare, in contrast to the Elmira and Memphis trials.^{8,11,44} This is likely attributable to welfare reform, which limits lifetime use. Findings also might have been affected by the highly favorable economic conditions in the late 1990s (when this follow-up study was conducted), which increased the availability of jobs. Although this may lead some to ask whether an investment in this program is a good use of welfare dollars, its consistent positive impact on children from at-risk families distinguishes it from the impact of welfare reform by itself on children's development, which has depended on whether families improve their economic conditions.⁴⁵ Because this home visiting program improves the conditions for family economic self-sufficiency through better pregnancy planning among unwed mothers (a goal of welfare reform) and simultaneously improves the development of children born to low-resource mothers, it is an important service to consider for families at risk of needing welfare.

Unlike nurse-visited women in the Memphis trial,⁴⁴ nurse-visited women in Denver were less likely to place their children in licensed day care, preschool, or Head Start than were their control group counterparts. Despite less frequent enrollment in these programs, nurse-visited children born to women with low psychologic resources demonstrated better language development, executive functioning, and behavioral adaptation to testing, increasing their readiness to enter elementary school.

Statistically significant effects on children's language and intellectual functioning were not observed at ages 3 and 4 in the Elmira trial of this program,⁴ although effect sizes were in the same range as observed here for children born to low-resource mothers and for the sample overall when children were 6 years of age in the Memphis trial.⁴⁴ In all trials, the effects of this program on children's health and development have been concentrated among families at greater risk because of sociodemographic factors and the mothers' having limited psychologic resources.¹⁶ The absence of program effects for children born to high-resource mothers in the current trial thus may be related to their lower sociodemographic risk, compared with their counterparts in Memphis. Compared with those in Denver, mothers in the Memphis trial were at substantially greater risk (eg, 85% living in families below the federal poverty level and 98% unmarried at registration).^{10,44} Moreover, the greater program impact on child outcomes observed for children born to low-resource mothers in Denver is consistent with recent evidence that environmental factors play a larger role in explaining children's cognitive functioning among children from impoverished environments than they do among children from more advantaged environments.⁴⁶

Why Do Paraprofessionals and Nurses Have Different Patterns of Effects?

The presence of greater effects for paraprofessional-visited mothers than for nurse-visited women and greater effects for children in nurse-visited families

than in paraprofessional-visited families raises questions about the mechanisms through which the programs affected outcomes. Preliminary findings suggest that paraprofessional-visited women worked more because they had to, in view of their lower rates of marriage and cohabitation with the fathers of their children. Because employment is associated with mastery, their higher rates of mastery may be attributable to their higher rates of employment between 25 and 48 months. The superior mental health of paraprofessional-visited women is puzzling, however, because marriage and cohabitation are associated with better mental health. We doubt that the lower rates of miscarriage and low birth weights for subsequent births in the paraprofessional-visited group are reproducible, given that the low birth weight rate (2.8%) is lower than the goal set for the nation as a whole (5%) in Healthy People 2010.⁴⁷

We hypothesized that the program would improve children's intellectual and behavioral development in part through its combined effects on prenatal health, parental caregiving, and maternal life course.¹⁶ As hypothesized, measures of caregiving (Home Observation for Measurement of the Environment inventory and responsive mother-child interaction) were strongly related to child outcomes. Both nurse-visited and paraprofessional-visited groups experienced improvements in these putative mediators; therefore, differences in program effects on parental caregiving cannot account for the presence of nurse effects on child outcomes and the smaller effects of paraprofessionals.

In the Denver trial, we had no systematic access to all prenatal, labor, and delivery records, as we had in the 2 previous trials of this program,^{2,10} and ascertainment of prenatal influences was therefore limited. Prenatal tobacco use (reflected in urine cotinine levels) and maternal life course (in particular, interbirth intervals) were associated with child functioning results. Because nurse-visited women demonstrated improvements in both prenatal tobacco use and interbirth intervals, whereas paraprofessional-visited women improved these aspects of functioning to a lesser degree, it is likely that nurse effects on prenatal health and planning of subsequent pregnancies help explain the greater effects on child outcomes.

Limitations of Findings

These findings must be interpreted with an acknowledgment of their limitations. The first limitation is that home-visited women might have responded to questions or behaved during the assessments in ways that were promoted by the program whereas their enduring behavior in other contexts was not affected. We know, for example, that domestic violence is underreported,⁴² and reliance on maternal reports is particularly susceptible to reporting artifacts. The finding of program effects for nurse-visited but not paraprofessional-visited women decreases the likelihood that the reduction in domestic violence is simply a reflection of home-visited women giving more socially desirable answers. Moreover, some of the strongest program ef-

fects for the nurse-visited group were on outcomes based on objective measures (eg, tests of child executive and language functioning and examiner ratings of the child's behavioral adaptation during the testing session). These findings increase the likelihood that nurse effects observed in other domains also are valid.

It is possible that the better behavioral adaptation to testing and language and executive functioning of nurse-visited children born to low-resource mothers were attributable to their greater comfort with home visitors, because assessments were conducted in families' homes. The presence of program effects on all of these outcomes for nurse-visited children and none for those visited by paraprofessionals weakens this alternative explanation, however.

The superior language, cognitive, and behavioral performance of nurse-visited children born to low-resource mothers also may be a reflection of their home environments having fewer distractions, compared with their control group counterparts, because children's assessments were conducted in their homes. Both nurse- and paraprofessional-visited families had improved home environments but only nurse-visited children had better test performance. This reduces the likelihood that fewer distractions in the homes of nurse-visited children account for their superior test performance.

Because the nurse visitation program produced effects on mothers' reports of child behavior problems in the clinical or borderline range with the Total Problems Scale of the Child Behavioral Checklist in the 6-year follow-up assessment of the Memphis trial,⁴⁴ it would have been desirable to have the entire scale, rather than just the externalizing behavior problems subscale, administered to participants in the current trial. The Memphis results indicated that the nurse visitation program affected internalizing, externalizing, and other dysregulated behaviors, and we might have failed to detect corresponding effects in Denver. We used the entire scale in a recently completed follow-up study of the Denver sample at child age 6 years, which will enable us to examine the degree to which the Memphis findings on the Total Problems Scale are replicated in Denver at the same age.⁴⁸

Implications for Policy and Practice

Although the paraprofessional program produced larger effects on a wider range of outcomes in the current follow-up study than it did earlier,¹ they were isolated effects that, by themselves, do not warrant public investment in the paraprofessional version of this program. Promising findings produced in single randomized trials need to be replicated with other populations before they warrant public investment.^{15,16}

This program of home visitation by nurses has produced enduring consistent effects on the timing of subsequent pregnancies and child development, which add to the growing body of evidence for the effectiveness of the program with different populations living in different contexts and at different points in US social and economic history.¹⁶ The next

challenge is to help new communities develop this program with fidelity to the model tested, to ensure that it will produce corresponding effects in practice.⁴⁹

ACKNOWLEDGMENTS

The current phase of this research was supported with funding from the Colorado Trust (grant 99030), the Administration for Children and Families, Department of Health and Human Services (grant 90PD0232), and a Senior Research Scientist Award (grant 1-K05-MH01382-01) to D.L.O. The earlier phases of this study were supported by a grant from the Colorado Trust and the Administration for Children and Families.

We thank Mary Hasan and Robin Tutt for assistance in preparing the manuscript; Charlie Izzo for comments on the manuscript; Zhaoxing Pan for assistance in data analysis; Pilar Baca, Darlene Sampson, Diane Baird, and the nurse and paraprofessional home visitors for work with the families; and the families who participated in the research.

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**Effects of Home Visits by Paraprofessionals and by Nurses: Age 4 Follow-Up
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Rosanna K. Ng, Kathy Isacks, Karen Sheff and Charles R. Henderson, Jr

Pediatrics 2004;114:1560-1568

DOI: 10.1542/peds.2004-0961

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