

Enduring Effects of Prenatal and Infancy Home Visiting by Nurses on Maternal Life Course and Government Spending

Follow-up of a Randomized Trial Among Children at Age 12 Years

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Objective: To test, among an urban primarily African American sample, the effects of prenatal and infancy home visiting by nurses on mothers' fertility, partner relationships, and economic self-sufficiency and on government spending through age 12 years of their firstborn child.

Design: Randomized controlled trial.

Setting: Public system of obstetric and pediatric care in Memphis, Tennessee.

Participants: A total of 594 urban primarily African American economically disadvantaged mothers (among 743 who registered during pregnancy).

Intervention: Prenatal and infancy home visiting by nurses.

Main Outcome Measures: Mothers' cohabitation with and marriage to the child's biological father, intimate partner violence, duration (stability) of partner relationships, role impairment due to alcohol and other drug use, use and cost of welfare benefits, arrests, mastery, child foster care placements, and cumulative subsequent births.

Results: By the time the firstborn child was 12 years old, nurse-visited mothers compared with control subjects reported less role impairment owing to alcohol and other drug use (0.0% vs 2.5%, $P = .04$), longer partner relationships (59.58 vs 52.67 months, $P = .02$), and greater sense of mastery (101.04 vs 99.60, $P = .005$). During this 12-year period, government spent less per year on food stamps, Medicaid, and Aid to Families with Dependent Children and Temporary Assistance for Needy Families for nurse-visited than control families (\$8772 vs \$9797, $P = .02$); this represents \$12 300 in discounted savings compared with a program cost of \$11 511, both expressed in 2006 US dollars. No statistically significant program effects were noted on mothers' marriage, partnership with the child's biological father, intimate partner violence, alcohol and other drug use, arrests, incarceration, psychological distress, or reports of child foster care placements.

Conclusion: The program improved maternal life course and reduced government spending among children through age 12 years.

Trial Registration: clinicaltrials.gov Identifier: NCT00438165

Arch Pediatr Adolesc Med. 2010;164(5):419-424

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HOME VISITING BY NURSES for low-income mothers bearing their first child has been promoted as a promising strategy for improving mothers' life-course development and for reducing rates of unintended subsequent pregnancy, poverty, and government spending.¹⁻³ Many of the long-term benefits of nurse home visiting on maternal life course reported to date have been derived from an adolescent follow-up of a Nurse-Family Partnership (NFP) trial, conducted in Elmira, New

York, among a sample of primarily white race/ethnicity.^{4,5} The first NFP replication trial focused on a low-income primarily African American sample in Memphis, Tennessee⁶⁻⁹; it is important that

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enduring program effects among mothers and youth be examined. This article reports the extent to which the Memphis program improved maternal life course and reduced government spending for wel-

fare benefits through age 12 years of their firstborn child; a companion article in this issue of the *Archives*¹⁰ reports on the enduring NFP effects among children.¹¹

METHODS

We conducted a randomized controlled trial of the NFP in a public system of obstetric and pediatric care in Memphis. We enrolled 743 pregnant women. Ninety-two percent were African American, 98.1% were unmarried, 64.1% were younger than 19 years, and 85.0% were from households with incomes below the federal poverty level. We randomly assigned women to receive nurse home visiting (n=228) or comparison (control group) services (n=515).⁶ In the present phase of follow-up after the child's 12th birthday (mean [SD] age 12.95 [0.45] years), we completed interviews among 594 mothers and completed abstractions of welfare benefits, Medicaid use, and food stamp records among 613 mothers. The details of the study design, methods, and sample retention following randomization are available in other publications.^{6-9,11}

TREATMENT CONDITIONS

For 2 treatment conditions involved in the postnatal follow-up of the trial, mothers in the control group (n=515) were provided free transportation for scheduled prenatal care plus developmental screening and referral services for their child at age 6, 12, and 24 months. Mothers in the nurse-visited condition (n=228) were provided the same services as those in the control group plus prenatal and infancy home visiting through their child's second birthday. Program descriptions can be found in the accompanying article and in earlier publications.^{6-9,11-13}

DATA GATHERING AND MATERNAL OUTCOMES

Interviews and assessments were conducted by staff members masked to mothers' treatment assignments. Descriptions of baseline and intervening data can be found in earlier publications.⁶⁻⁹

Primary outcomes were those for which there were significant treatment-control differences in other trials of the NFP or at earlier phases of the present trial. They were based on interviews with mothers and on reviews of Tennessee state administrative records. Data for the present study were derived primarily from the intake and 12-year assessments, although data from previous assessments^{6-9,11} were integrated with the present data to create longitudinal data sets for examination of program effects over time. Secondary outcomes are presented elsewhere.¹⁴ Primary maternal life-course outcomes were the following: (1) the mother's being partnered with or married to the child's biologic father at the 12-year interview; (2) any physical intimate partner violence reported by the mother between the child's 9th-year and 12th-year interviews¹⁵; (3) duration (in months) of the mother's relationship with her current partner (assessed at the 6-, 9-, and 12-year interviews); (4) whether the mother reported having used (a) 3 or more alcoholic drinks 3 or more times per month in the last year, (b) marijuana, or (c) cocaine since the last interview at age 9 years of the child; (5) any impairment in role functioning¹⁶ (at work, with friends, or with family members) reported by the mother due to her use of alcohol and other drug use since the last interview at age 9 years of the child; (6) mother's symptoms of psychological distress (borderline or clinical vs normal)¹⁷; (7) the mother's sense of mastery reported from age 6 months to age 12 years of the child¹⁸; (8) cumulative subsequent births (an index of the cumulative number of subsequent births by year, which reflects the number and timing of subsequent births); (9) num-

ber of times the mother reported being arrested from birth through age 12 years of the first child; (10) whether the mother reported being jailed through age 12 years of the child; (11) number of the mother's children who had been placed in foster or relative care based on maternal report; (12) number of months per year of using food stamps, Medicaid, and Aid to Families with Dependent Children and Temporary Assistance for Needy Families from birth through age 12 years of the first child (data were derived primarily from reviews of Tennessee state administrative records and were supplemented with interview data to account for time living outside of Tennessee); and (13) government spending (in US dollars) for each of 3 forms of welfare benefits for each year from birth through age 12 years of the first child. Cost data were discounted at 3%, and adjusted to 2006 US dollars.

STATISTICAL MODELS AND ANALYSIS

Data analyses are reported on all randomized mothers insofar as outcome data were available. The core statistical model consisted of a 2-level treatment variable, a 2-level maternal psychological resources variable, their interaction, and 2 covariates (household poverty and maternal child-rearing beliefs associated with maltreatment). We used reduced versions of the core model when outcomes were sparse. For quantitative outcomes on which we had multiple assessments for each mother (eg, the number of months of using welfare benefits per year), we analyzed the data in mixed models that included, in addition to the core model terms, mothers as levels of a random variable, a fixed repeated-measures classification variable for time of assessment, and all interactions of time with the other fixed classification variables.

The key tests focused on the treatment effects averaged over all other fixed classification variables, including those within subjects. We show the least-squares (adjusted) means over time. For repeated outcomes, we report results averaged over the entire period for which we have data, as well as the interval between age 10 years and age 12 years of the firstborn child. To illustrate program effects on government spending over time, we plot point estimates with standard errors for the nurse-visited and control groups for every year following the birth of the child. As a means of comparing treatment differences on quantitative outcomes, we also give the effects in standard deviation units (ie, the mean differences divided by the pooled standard deviation), which sometimes are referred to as effect size (ES).

RESULTS

As summarized in **Table 1**, by the time the firstborn child was 12 years old, nurse-visited mothers compared with control subjects reported less role impairment due to alcohol and other drug use (0.0% vs 2.5%, $P=.04$), as well as longer partner relationships (ES, 0.18; $P=.02$) and greater sense of mastery (ES, 0.14; $P=.005$) from age 6 months to age 12 years of the child. During the 12-year period following the birth of the first child, nurse-visited mothers with higher psychological resources compared with control subjects had fewer cumulative subsequent births (ES, -0.22; $P=.04$) (data not shown). No statistically significant program effects were noted on mothers' marriage or partnership with the child's biologic father, intimate partner violence, alcohol and other drug use, arrests, incarceration, psychological distress, or reports of child foster care placements.

Table 1. Adjusted Estimates of Program Effects on Maternal Life Course 12 Years After the Birth of a First Child^a

Variable	Study Child Age	Control Group	Nurse-Visited Group	Nurse-Visited vs Control Groups	
				P Value	Statistic (95% Confidence Interval)
Dichotomous Outcome, %					
Partnered, cohabiting, or married to child's biological father ^b	12 y	6.7	9.7	.20	1.51 (0.81 to 2.81)
Intimate partner violence	9 to 12 y	21.3	22.2	.81	1.06 (0.67 to 1.67)
Alcohol or other drug use ^c	12 y	10.4	9.6	.76	0.91 (0.50 to 1.66)
Role impairment due to alcohol or other drug use ^{c,d,e}	12 y	2.5	0.0	.04	...
Mother jailed	0-12 y	13.2	12.8	.90	0.97 (0.57 to 1.63)
Symptoms of psychological distress, borderline or clinical vs normal	12 y	17.1	18.4	.75	1.09 (0.64 to 1.85)
Quantitative Outcome, Mean (SE)					
Duration of current partner relationship, mo ^f	6, 9, 12 y	52.67 (1.65)	59.58 (2.47)	.02	6.91 (1.07 to 12.75)
	12 y	70.80 (2.71)	77.44 (4.08)	.18	6.64 (-2.97 to 16.25)
Time employed, mo ^f	2 to 12 y	4.64 (0.12)	4.50 (0.18)	.54	-0.13 (-0.56 to 0.30)
	10 to 12 y	7.77 (0.22)	7.10 (0.32)	.09	-0.66 (-1.42 to 0.10)
Cumulative subsequent births ^{f,g}	0 to 12 y	1.15 (0.04)	1.07 (0.06)	.23	-0.08 (-0.21 to 0.05)
	10 to 12 y	1.83 (0.06)	1.80 (0.09)	.76	-0.03 (-0.26 to 0.19)
Maternal mastery ^h	6 mo to 12 y	99.60 (0.28)	101.04 (0.43)	.005	1.44 (0.43 to 2.45)
	12 y	99.56 (0.46)	101.07 (0.68)	.07	1.50 (-0.12 to 3.13)
Low-Frequency Count Outcome, Incidence					
Maternal arrests	0 to 12 y	0.36	0.49	.15	1.36 (0.90 to 2.07)
Child foster care placements ^d	0 to 12 y	0.04	0.12	.08	3.33 (0.86 to 12.88)

^aModel for outcomes included a treatment variable and a maternal psychological resources variable, their interaction, and 2 covariates (household poverty and maternal child-rearing beliefs associated with maltreatment) unless noted otherwise. The statistics are odds ratios for dichotomous outcomes, mean differences for quantitative outcomes, and incidence ratios for low-frequency count outcomes. *P* values are based on likelihood ratio test, whereas confidence intervals are estimated using Wald test.

^bModel included a treatment variable, a maternal psychological resources variable, and household poverty but no interactions.

^cModerate or heavy alcohol, marijuana, or cocaine use since the last interview.

^dModel included a treatment variable only.

^eFisher exact test (treatment variable only).

^fRepeated-measures analysis.

^gAn index that reflects the number and timing of subsequent births.

^hStandardized to mean (SD), 100 (10).

As summarized in **Table 2**, during the 12-year period, nurse-visited mothers used food stamps (ES, -0.13; *P* = .01) and Aid to Families with Dependent Children and Temporary Assistance for Needy Families (ES, -0.10; *P* = .05) for fewer months per year. These effects were not statistically significant for the 10-year to 12-year period or for Medicaid use averaged across the 12-year period. Nurse effects on government spending per year for these programs were significant for the 12-year period (\$8772 vs \$9797 in 2006 US dollars, *P* = .02). The **Figure** shows that the nurse effects on government spending for welfare benefits were constant over the 12-year period.

COMMENT

The program produced enduring effects on important aspects of maternal life course and government spending through age 12 years of the firstborn child. Given that the program cost about \$11 511 in 2006 US dollars after adjustment for the employment cost index,^{19,20} the \$12 300 discounted savings (in 2006 US dollars) in welfare benefits recovered the cost of the program from the standpoint of government. Other benefits to government and society have not been monetized.

These life-course findings are consistent with an earlier trial of this program begun in 1977, which found long-term effects on maternal life course, including less role impairment owing to alcohol and other drug use and reduced use of welfare benefits.⁴ The Denver, Colorado, trial of the NFP, initiated during the economic boom of the 1990s, after welfare benefits reform, and with a less impoverished sample, found low use of welfare benefits and no program effects on these outcomes, although there were effects on the timing of subsequent pregnancies and births and on earned income for nurse-visited mothers that contributed to significant cost savings.²¹⁻²³ The return on investment in Memphis needs to be interpreted in light of the extreme poverty and concentrated social disadvantage found in this trial. Overall, these findings reinforce earlier estimates of return on investment in this program.^{24,25}

The program effects are consistent with corresponding effects observed in the Elmira trial on stability of partner relationships at age 3 years of the children²⁶ and on marriage at age 15 years of the children among mothers who were unmarried and from low-income families at registration.²⁷ The consistency of effects from the Elmira and Memphis trials lends validity to these partner relationship findings, despite absence of corresponding effects in the Denver trial.^{21,22}

Table 2. Welfare Benefits Use and Government Spending (in 2006 US Dollars) for Food Stamps, Medicaid, and Aid to Families With Dependent Children and Temporary Assistance for Needy Families (AFDC-TANF) 12 Years After the Birth of a First Child

Continuous Outcome by Study Child Age, y ^a	Group, Mean (SE)		Nurse-Visited vs Control Groups	
	Control	Nurse Visited	P Value	Difference, Mean (95% Confidence Interval)
Welfare Benefits Use, mo				
Food stamps				
0-12	6.86 (0.13)	6.27 (0.19)	.01	-0.59 (-1.04 to -0.13)
10-12	5.06 (0.19)	4.46 (0.29)	.09	-0.60 (-1.28 to 0.08)
AFDC-TANF				
0-12	5.47 (0.14)	4.97 (0.21)	.05	-0.50 (-1.00 to 0.00)
10-12	3.97 (0.21)	3.75 (0.31)	.55	-0.22 (-0.95 to 0.51)
Medicaid				
0-12	8.39 (0.14)	8.08 (0.21)	.22	-0.31 (-0.81 to 0.19)
10-12	6.23 (0.22)	6.02 (0.33)	.60	-0.21 (-0.98 to 0.57)
Government Spending, \$				
Food stamps				
0-12	3222 (72)	2870 (108)	.007	-352 (-606 to -98)
10-12	2170 (100)	1882 (150)	.11	-287 (-642 to 67)
AFDC-TANF				
0-12	2782 (118)	2467 (178)	.14	-315 (-733 to 104)
10-12	2927 (216)	2711 (324)	.58	-216 (-979 to 547)
Medicaid				
0-12	3790 (71)	3438 (107)	.006	-351 (-603 to -99)
10-12	2627 (99)	2297 (149)	.07	-329 (-681 to 22)
Total				
0-12	9797 (245)	8772 (367)	.02	-1025 (-1891 to -159)
10-12	7726 (385)	6887 (577)	.23	-839 (-2199 to 521)

^aThe outcomes examined using repeated-measures analysis in the fully specified model included a treatment variable, a maternal psychological resources variable, their interaction, and 2 covariates (household poverty and maternal child-rearing beliefs associated with maltreatment).

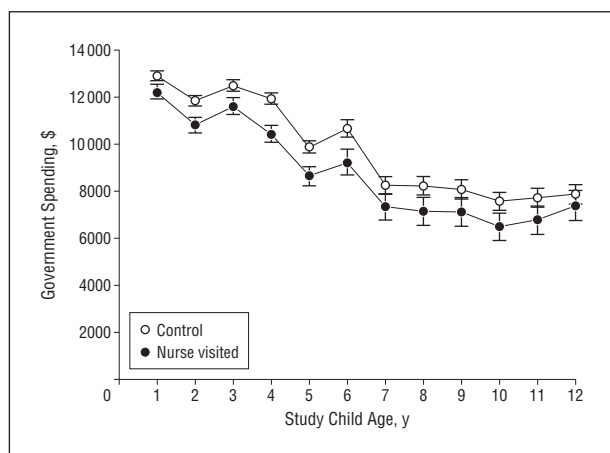


Figure. Total discounted government spending (in 2006 US dollars) per year after the birth of a first child for food stamps, Medicaid, and Aid to Families with Dependent Children and Temporary Assistance for Needy Families for nurse-visited vs control groups over time.

Some hypothesized effects did not emerge. We found no program effects on maternal involvement with the criminal justice system, child foster care or kinship care placements, or increased employment among nurse-visited mothers; in fact, the report of child foster care placements, as a trend, was higher in the nurse-visited than control families. Unlike the Elmira trial, we were unable to corroborate the child welfare benefits finding with administrative data.

We expected that the treatment-control difference in welfare benefits use and costs would be explained in part

by earlier reductions in subsequent pregnancies and births and by increased maternal employment and involvement with the children's biologic fathers.⁶⁻⁹ While we found an enduring program effect on cumulative subsequent births (among higher-resource mothers) in the present phase of follow-up, we observed no enduring program effect on maternal employment. In fact, in the 10-year to 12-year period, nurse-visited mothers, as a trend, had lower rates of employment. Although we have not conducted mediation analyses to determine the pathways through which the program reduced government spending, the decrease in closely spaced subsequent pregnancy and the increase in stability of partner relationships are prime candidates for explaining this pattern of results. Nurse-visited mothers had corresponding increases in their duration of relationships with employed partners (summed from age 6 years to age 12 years of the child, 42.88 vs 36.73 months; ES, 0.20; $P = .006$) (data not shown).

The program effects found at this phase of the trial are encouraging but must be interpreted in light of their limitations. First, some of the outcomes were assessed by maternal report, which may be subject to treatment-related reporting bias. The presence of program effects on welfare benefits and cost outcomes derived from administrative data provides some assurance that the findings based on self-report are not simply owing to nurse-visited mothers' providing more socially desirable responses. Second, nurse-visited mothers had higher rates of household poverty and worse attitudes toward child

rearing at registration than those in the control group. Although we controlled statistically for these differences, it is possible that the analysis failed to control for all excess risk. However, we were able to retain a large portion of those mothers who had enrolled in the trial during their pregnancies, which increases our confidence in the estimate of enduring program effects.

It is reasonable to ask how the completion of 1 visit a month during pregnancy and the first 2 years of the child's life might produce enduring effects on maternal and child outcomes 10 years after the program ended. It is important to note that nurses delivering this program develop relationships with first-time mothers during their pregnancies and their children's early years. Nurses guide parents as they make important choices during this fundamental life transition that shape the subsequent trajectories of their lives and those of their children. The nurses' work is designed specifically to respond to parents' sense of vulnerability and to support their desire and efforts to protect their children. The theory is that nurses help parents gradually gain a sense of mastery in overcoming challenges and position themselves to create the kind of lives they want. Although we have not conducted mediation analyses to test the role of mastery in accounting for the long-term benefits of the program, the consistency in program effects on mastery suggests that it is likely to be centrally involved.

In general, these findings support the effectiveness of the NFP. The partnership offers a means of reducing government spending and family poverty, improving children's health and development, and grounding policy based on the results of replicated randomized controlled trials.²⁸⁻³⁰

Accepted for Publication: December 2, 2009.

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Henderson, and Bondy. *Administrative, technical, and material support:* Olds, Cole, Hanks, Anson, Bondy, and Stevenson. *Study supervision:* Cole and Bondy.

Financial Disclosure: The Prevention Research Center for Family and Child Health in the Department of Pediatrics, School of Medicine, University of Colorado Denver, is directed by Dr Olds. The Prevention Research Center for Family and Child Health has a contract with the Nurse-Family Partnership National Service Office to conduct research to improve the Nurse-Family Partnership program model and its implementation. This contract covers part of the salary of Dr Olds.

Funding/Support: This project was supported by grant 1R01MH68790-01 from the National Institute of Mental Health, National Institutes of Health, and by grant 2004-52854-CO-JS0 from the Office of Juvenile Justice and Delinquency Prevention.

Additional Contributions: Evelyn Collins and Evelyne Greer traced and engaged study participants in this study. We thank the administrators of the Memphis/Shelby County Health Department; the nurse home visitors; and the families who participated in this research.

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Correction

Error in Figure 3, Text and Cited Reference. In the article titled "Long-term Effects of Prenatal and Infancy Nurse Home Visitation on the Life Course of Youths: 19-Year Follow-up of a Randomized Trial" by Eckenrode et al, published in the January issue of the *Archives* (2010;164[1]:9-15), there were several instances of misinformation. In the "Comment" section, page 14, left-hand column, complete paragraph 3, lines 9 through 11 stated, "For example, at age 23 years, there were no program effects of the Perry Preschool Program on high school graduations rates." The wrong study was referenced. The text should have read as follows: "A follow-up study of the Perry Preschool Program through age 40 years has shown significantly more program females than no-program females graduated from regular high school or adult high school or obtained General Education Development certification (88% to 46%), while there was not a program effect for males (69% to 68%)." The appropriate citation to this study (page 15, right-hand column, reference 5) should have read as follows: "Schweinhart LJ, Montie J, Xiang Z, et al. *Lifetime Effects: The HighScope Perry Preschool Study Through Age 40*. Ypsilanti, MI: HighScope Press; 2005. In addition, Figure 3 (page 13, right-hand column) incorrectly indicated that the nurse-visited and control group male children's counts of arrest cross at child age 15 years; they actually cross at age 17 years, with nurse-visited males being consistently, but nonsignificantly lower than males in the control group prior to that age. The corrected figure and its legend are reproduced here.

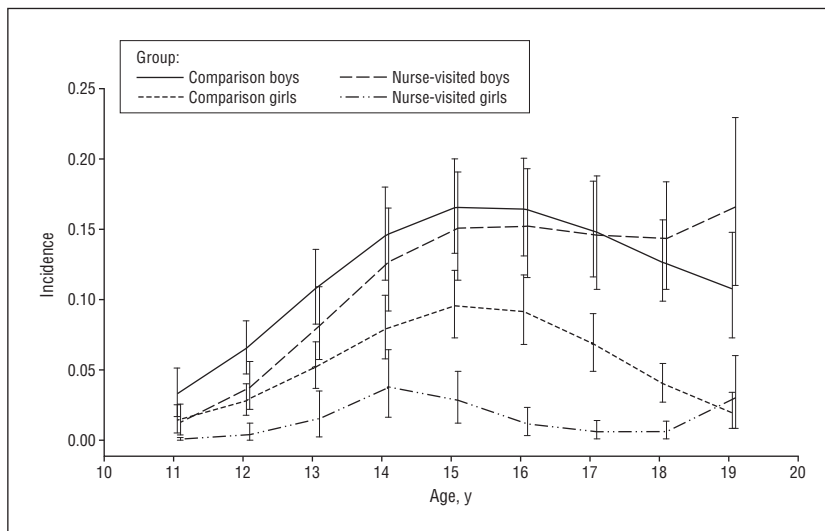


Figure 3. Estimates of the rates of arrest from cubic regressions by treatment and the youth's sex using a generalized linear model assuming a negative binomial distribution and a log link. Comparison group (n=140); the prenatal and infancy nurse-visited group (n=91). Error bars represent 1 SE.