

# Long-term Effects of Prenatal and Infancy Nurse Home Visitation on the Life Course of Youths

## 19-Year Follow-up of a Randomized Trial

John Eckenrode, PhD; Mary Campa, PhD; Dennis W. Luckey, PhD; Charles R. Henderson Jr, MA; Robert Cole, PhD; Harriet Kitzman, RN, PhD; Elizabeth Anson, MS; Kimberly Sidora-Arcoleo, MPH, PhD; Jane Powers, PhD; David Olds, PhD

**Objective:** To examine the effect of prenatal and infancy nurse home visitation on the life course development of 19-year-old youths whose mothers participated in the program.

**Design:** Randomized trial.

**Setting:** Semirural community in New York.

**Participants:** Three hundred ten youths from the 400 families enrolled in the Elmira Nurse-Family Partnership program.

**Intervention:** Families received a mean of 9 home visits (range, 0-16) during pregnancy and 23 (range, 0-59) from birth through the child's second birthday.

**Main Outcome Measures:** Youth self-reports of educational achievement, reproductive behaviors, welfare use, and criminal involvement.

**Results:** Relative to the comparison group, girls in the preg-

nancy and infancy nurse-visited group were less likely to have been arrested (10% vs 30%; relative risk [RR], 0.33; 95% confidence interval [CI], 0.13-0.82) and convicted (4% vs 20%; 0.20; 0.05-0.85) and had fewer lifetime arrests (mean: 0.10 vs 0.54; incidence RR [IRR], 0.18; 95% CI, 0.06-0.54) and convictions (0.04 vs 0.37; 0.11; 0.02-0.51). Nurse-visited girls born to unmarried and low-income mothers had fewer children (11% vs 30%; RR, 0.35; 95% CI, 0.12-1.02) and less Medicaid use (18% vs 45%; 0.40; 0.18-0.87) than their comparison group counterparts.

**Conclusions:** Prenatal and infancy home visitation reduced the proportion of girls entering the criminal justice system. For girls born to high-risk mothers, there were additional positive program effects consistent with results from earlier phases of this trial. There were few program effects for boys.

**Trial Registration:** clinicaltrials.gov Identifier: NCT00443638

*Arch Pediatr Adolesc Med.* 2010;164(1):9-15

**Author Affiliations:** Family Life Development Center (Dr Eckenrode) and Department of Human Development (Mr Henderson and Dr Powers), Cornell University, Ithaca, New York; Department of Psychology, Skidmore College, Saratoga Springs, New York (Dr Campa); Department of Preventive Medicine and Biometrics, University of Colorado Health Sciences Center, Denver (Drs Luckey and Olds); School of Nursing, University of Rochester, Rochester, New York (Drs Cole and Kitzman and Ms Anson); and College of Nursing and Health Innovation, Arizona State University, Phoenix (Dr Sidora-Arcoleo).

**P**REVENTIVE INTERVENTIONS FOR parents of young children that improve parental competencies and the early learning environment of the child hold considerable promise as a means of reducing health and developmental problems across the life course and associated costs to government and society.<sup>1-3</sup> Randomized controlled trials of interventions that involve enriched child care and preschool education have shown consistent short-term effects on cognitive and academic performance,<sup>2</sup> although programs with fewer features of quality (eg, higher teacher to child ratios and less teacher preparation) have produced smaller effects.<sup>4</sup> Follow-up studies<sup>5-7</sup> of some programs into young adulthood have found important benefits, including increased rates of high school graduation, reductions in teen pregnancy, and fewer arrests, although some of these effects have been limited to subgroups such as females, low-birth-weight babies in higher weight ranges, and those at greater social disadvantage.

There has been much recent interest in home visitation services that focus on promoting maternal health and caregiving competencies during pregnancy and infancy.<sup>8-10</sup> The promise of these programs has been only partially fulfilled, however, given mixed results from randomized controlled trials on maternal and child outcomes.<sup>11</sup> In addition, there have been no long-term studies of children in home visitation programs when they enter late adolescence and young adulthood.

 **Journal Club slides available at [www.archpediatrics.com](http://www.archpediatrics.com)**

**For editorial comment see page 92**

A program of prenatal and infancy home visitation by nurses, known today as the Nurse-Family Partnership (NFP), in separate randomized controlled trials conducted in Elmira, New York; Memphis, Tennessee; and Denver, Colorado, has been found to im-

prove aspects of maternal and child health through child age 15 years, including prenatal health, rates and timing of subsequent pregnancies, maternal economic self-sufficiency, maternal and child involvement with the criminal justice system, child abuse and neglect, and injuries.<sup>12-15</sup>

A follow-up of the Elmira participants at child age 15 years indicated that nurse-visited youths had significantly fewer arrests, convictions, and adjudications as persons in need of supervision for incorrigible behavior.<sup>13</sup> The program did not affect less serious forms of delinquency or the 15-year-olds' sexual behavior.

The present article reports the results of a 19-year follow-up of children born to mothers in the Elmira trial and focuses on their graduation from high school, employment, sexual behavior, childbearing, substance use, and criminal behavior. Given the earlier impact of the program on maternal use of welfare, child maltreatment, childhood injuries, and criminal behavior on the part of mothers and children through child age 15 years, there was reason to expect enduring effects on youth functioning, especially their criminal behavior. The features of the child's behavior and family environment altered through age 15 years are consistent with the prevention of early-onset problem behaviors,<sup>16</sup> which are significant contributors to adult criminal behavior.<sup>17</sup> We expected fewer program effects on less serious problem behaviors.<sup>13</sup>

We also hypothesized that the program would affect other aspects of the youths' life trajectories, reflected in more high school graduations, lower rates of teen child birth, and less use of public assistance through age 19 years. Given the findings from analyses at earlier ages, we expected that these effects would be stronger for youths born to unmarried and low-income mothers.<sup>13</sup> Such effects would be consistent with improvements in nurse-visited mothers' economic circumstances and the prevention of child abuse and neglect observed for these higher-risk mothers in the 15-year follow-up study.<sup>12</sup>

## METHODS

The present study is a 19-year follow-up of youths whose mothers enrolled in the Elmira trial of the NFP, a program of prenatal and infancy home visitation by nurses. Descriptions of the program and previous assessments can be found in previous articles<sup>12,13,18-21</sup>; a summary is presented herein.

### SETTING, PARTICIPANTS, AND RANDOMIZATION

Mothers of the 19-year-old youths were recruited during their pregnancies from a free antepartum clinic sponsored by the county health department and the offices of private obstetricians. We actively recruited nulliparous women who were less than 25 weeks pregnant and who were young (<19 years old), unmarried, or of low socioeconomic status (SES). Nulliparous women without these risk characteristics were permitted to enroll. Between April 1, 1978, and September 30, 1980, 500 women were invited to participate, and 400 enrolled. Eighty-five percent of the enrolled participants were young, unmarried, or from low-SES households (A. Hollingshead, PhD, unpublished data, 1976). After completing informed consent forms and baseline interviews, women were stratified by sociodemographic characteristics and were randomized to 1 of 4 treatment conditions (see the following subsec-

tion). Approvals have been granted by institutional review boards at Cornell University, Ithaca, NY; the University of Rochester, Rochester, NY; and the University of Colorado, Denver.

## TREATMENT CONDITIONS

Families in treatment group 1 (n=94) were provided sensory and developmental screening for the child at 12 and 24 months of age. Based on the results of these screenings, the children were referred for clinical evaluation and treatment when needed. Families in treatment group 2 (n=90) were provided these same screening services plus free transportation for prenatal and well-child care through the child's second birthday. There were no differences between treatment groups 1 and 2 in their use of prenatal and well-child care, and these groups were combined to form a single comparison group. Families in treatment group 3 (n=100) were provided the same screening and transportation services offered in treatment group 2 but were also provided a nurse who visited them at home during pregnancy. Families in treatment group 4 (n=116) were provided the same services as treatment group 3 except that the nurse continued visits through the child's second birthday.

## PROGRAM PLAN AND IMPLEMENTATION

At the home visits, the nurses had 3 goals: (1) to improve pregnancy outcomes 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 improve families' economic self-sufficiency by helping parents make appropriate choices regarding family planning, finishing their education, and finding work. In the service of these goals, nurses linked families with needed services and attempted to involve fathers, family members, and friends in the pregnancy, birth, and early care of the child. Nurses completed a mean of 9 visits (range, 0-16) during pregnancy and 23 (range, 0-59) from birth to the child's second birthday.

## OVERVIEW OF THE FOLLOW-UP STUDY

The present phase is a longitudinal follow-up of the children from the 400 randomized families when the children were 19 years of age. The 19-year assessments were conducted on 310 youths: 78% of the sample originally randomized and 88% of cases where the child was still alive, not adopted, and not mentally disabled (**Table 1**). There were no differences in treatment grouping; the mother's race, marital status, age, educational level, or SES at intake; or the child's sex for those assessed at the 19-year follow-up compared with those for whom data were missing (data not shown). There was no indication of attrition bias.

### ASSESSMENTS AND DEFINITIONS OF VARIABLES

Youths completed a telephone interview that assessed their history of arrests and convictions, delinquent and criminal behavior, use of substances, educational achievement, pregnancies, births, and use of welfare. Those who reported being arrested were asked to provide dates for up to 6 arrests and convictions. We combined data from the present phase with those from the 15-year interview to calculate the number of arrests at particular ages. For the 15-year assessment, we recorded the number of arrests and the dates of their first and most recent arrests. All data were gathered by individuals masked to treatment.

We created variables to summarize whether the youths had been arrested or convicted in their lifetime and in the 12 months preceding the interview and whether they had used illegal drugs

**Table 1. Flow of Participants From Mother's Recruitment During Pregnancy Until Child Age 19 Years**

	Treatment Group			Total
	T <sub>1 and 2</sub> : Control	T <sub>3</sub> : Pregnancy	T <sub>4</sub> : Pregnancy and Infancy	
Recruitment and randomization, No.				
Eligible patients invited	NA	NA	NA	500
Refusals	NA	NA	NA	100
Randomized	NA	NA	NA	400
Allocated to treatment	184	100	116	400
Program implementation, mean (range), No.				
Prenatal home visits	NA	8.6 (0-16)	8.6 (0-16)	8.6 (0-16)
Postnatal home visits	NA	NA	22.8 (0-59)	22.8 (0-59)
Intervening years, No.				
Fetal, infant, or child deaths	11	7	9	27
Adoptions <sup>a</sup>	7	6	3	16
Refused follow-up <sup>b</sup>	2	1	2	5
19-y follow-up				
Available for 19-year follow-up, No.	164	86	102	352
Missing or hard to reach, No.	21	6	7	34
Mentally disabled, No. <sup>c</sup>	1	1	2	4
Refused to participate, No. <sup>d</sup>	2	0	2	4
Completed youth interview, No.	140	79	91	310
Randomized, %	76	79	78	78
Alive, not adopted or mentally disabled, %	85	92	89	88

Abbreviation: NA, not applicable.

<sup>a</sup>There were 2 adoptions in which interviews were conducted with the child but not with the mother. They are not shown in this table.

<sup>b</sup>Intervening refusals include 4 guardian refusals at or before the 15-year follow-up; none of these youths was approached for the 19-year follow-up.

<sup>c</sup>Youths were classified as mentally disabled if their guardians indicated that they were disabled to the point of not being able to speak or respond to questions at the time of the 15-year follow-up. Their status was confirmed at the time of the 19-year interview.

<sup>d</sup>The 19-year follow-up refusals include 3 guardian refusals.

or engaged in binge drinking (>4 drinks in a row) during the 6 months preceding the interview. Count variables were created to assess the number of arrests and convictions. Following the National Youth Survey,<sup>22</sup> variables were constructed to indicate whether the youth had engaged in the following criminal behaviors during the year preceding the 19-year interview: felony assault (aggravated assault, sexual assault, or gang fights), fraud, minor assault (hit parents, teachers, or students), minor theft (stole something worth <\$50 or joyriding), illegal services (prostitution or sold marijuana or other drugs), vandalism or damaged property, and public disorder (panhandling or been loud, rowdy, or drunk in public). The incidences of robbery and felony theft were too low to serve as valid outcomes.

Variables also were created to summarize whether the youth had graduated from high school, was currently economically productive (ie, in school, the military, or job training or working full time at the time of the interview), had become or made a girl pregnant or become a parent, and used welfare, food stamps, or Medicaid. We also included a count of the youth's number of sexual partners in the past year and continuous measures of the frequency of birth control and condom use (on scales ranging from 1[never] to 7[always]).

We identified primary outcomes based on findings from earlier phases of this trial and from the literature on youth development and antisocial behavior. We included as primary outcomes variables that reflect arrests and convictions, self-reported violent behavior (eg, felony assault), high school graduation, teen childbearing, use of welfare, and current involvement in school, work, the military, or job training. We present secondary outcomes, such as self-reported minor delinquency, to provide the reader with a complete picture of program impact.

## STATISTICAL MODELS AND METHODS

Analyses were conducted on all cases where outcome data were available, irrespective of the home-visited families' degree of pro-

gram participation. A core statistical model was derived for the analysis similar to that used in earlier phases of this research. It consisted of a 3 × 2 × 2 factorial structure plus 2 covariates. The classification factors were treatment group (1 and 2 vs 3 vs 4), risk (unmarried and from low-SES families at registration vs married or higher SES), and the youth's sex. All interactions among the factors were included in the model. The youth's race/ethnicity (white vs nonwhite) and the mother's educational level at intake were included in the model without interactions.

Quantitative variables were examined in the general linear model. For dichotomous outcomes, we used the generalized linear model with a log link and binomial error distribution; for count data, we assumed a log link and negative binomial distribution. For dichotomous and count outcomes where fewer than 70 values were nonzero, we used simpler models due to concerns about the stability of treatment effect estimates.<sup>23</sup> Models for these outcomes included family risk, the mother's educational level at intake, and the youth's sex and race as classification factors without interactions.

The Cox proportional hazards method for survival analysis was used to estimate the hazard of first arrest for those in the comparison and nurse-visited groups.<sup>24</sup> These models included family risk, the mother's educational level at intake, and the youth's sex and race as factors, again without interactions. Growth curves for arrests across time were estimated for treatment groups by the youth's sex in a generalized mixed model with cubic age regressions, with log link and negative binomial error.

All of the treatment contrasts focused on the comparison of combined treatment groups 1 and 2 (the comparison group) with treatment group 4 (the pregnancy and infancy nurse-visited group) because we hypothesized that the greatest treatment effect would be exerted by the combination of prenatal and postnatal home visits.<sup>18,19</sup> The results for the group that received prenatal home visitation only (treatment group 3) are included to examine whether that group, as predicted, had intermediate levels of functioning.

Differential treatment effects based on the youth's sex and family risk are presented in the text where these factors interacted with treatment condition. Findings are reported as adjusted percentages or means controlling for the effects of the covariates. Risk ratios (RRs) are provided for dichotomous outcomes, incidence RRs (IRRs) for count outcomes, and mean differences for continuous outcomes; 95% confidence intervals (CIs) are also shown.

## RESULTS

The treatment groups were essentially equivalent on background characteristics for the entire sample registered in the trial<sup>12,13,18-21</sup> and for the sample assessed at 19-year fol-

**Table 2. Equivalence of Treatment Conditions on Background Characteristics Measured at Registration for 310 Young Adults Assessed at 19-Year Follow-up**

	Treatment Group		
	T <sub>1</sub> and 2: Control (n=140)	T <sub>3</sub> : Pregnancy (n=79)	T <sub>4</sub> : Pregnancy and Infancy (n=91)
Characteristics of mothers			
Unmarried, %	63	61	66
White race, %	90	89	83
Age, mean (SD), y	19.26 (2.90)	19.63 (3.17)	19.13 (3.35)
Education, mean (SD), y	11.25 (1.48)	11.59 (1.64)	11.11 (1.58)
Characteristics of families			
Low-SES household, %	58	61	58
Characteristics of respondents			
Male sex, %	48	43	51
White race, %	78	77	77
Age, mean (SD), y	19.66 (0.55)	19.61 (0.54)	19.67 (0.62)

Abbreviation: SES, socioeconomic status.

low-up (**Table 2**). **Table 3** shows that among the 19-year-old youths, those visited by nurses during pregnancy and infancy were less likely to have ever been arrested or convicted than were those in the comparison group. Youths in the nurse-visited group also had fewer lifetime arrests and convictions than did those in the comparison group. Examination of treatment differences separately for boys and girls suggests that these effects were limited to girls. Specifically, nurse-visited girls (n=44) were less likely to be arrested (10% vs 30%; RR, 0.33; 95% CI, 0.13-0.82) and convicted (4% vs 20%; 0.20; 0.05-0.85) than were girls in the comparison group (n=73). There were no significant differences between nurse-visited boys (n=47) and comparison boys (n=67) in the lifetime likelihood of being arrested (46% vs 47%) or convicted (35% vs 39%). The intervention effect on number of arrests and convictions also varied by sex. Analysis of simple effects indicated that nurse-visited girls had fewer mean lifetime arrests (0.10 vs 0.54; IRR, 0.18; 95% CI, 0.06-0.54) and convictions (0.04 vs 0.37; 0.11; 0.02-0.51) than did girls in the comparison group; nurse-visited and comparison boys had similar rates of mean lifetime arrests (1.39 vs 1.37) and convictions (0.97 vs 0.91).

Examination of age at first arrest in the proportional hazards model indicated that nurse-visited youths had a smaller risk of first arrest than did youths in the comparison group (hazard ratio [HR], 0.63; 95% CI, 0.40-0.99). Consistent with the binomial arrest results, this effect varied by sex. Nurse-visited girls had a smaller risk of first arrest than did comparison girls (HR, 0.27; 95% CI, 0.10-0.72) (**Figure 1**). Nurse-visited and comparison boys were similar in their risk of first arrest (HR, 0.85; 95% CI, 0.50-1.46) (**Figure 2**).

**Table 3. Adjusted Estimates of Program Effects on Youth Life Course: Crime and Drug Use<sup>a</sup>**

	Treatment Group, %			Contrast	
	T <sub>1</sub> and 2: Control (n=140)	T <sub>3</sub> : Pregnancy (n=79)	T <sub>4</sub> : Pregnancy and Infancy (n=91)	T <sub>1</sub> and 2 vs T <sub>3</sub>	T <sub>1</sub> and 2 vs T <sub>4</sub>
				RR (95% CI)	RR (95% CI)
Arrested, lifetime	37.4	30.0	21.3	0.80 (0.53-1.22)	0.57 (0.35-0.93)
Convicted, lifetime	27.8	22.7	11.8	0.82 (0.49-1.37)	0.42 (0.20-0.90)
Arrested, past year	5.5	11.5	8.2	2.07 (0.88-4.85)	1.48 (0.62-3.51)
Convicted, past year	4.4	10.4	7.5	2.35 (0.91-6.05)	1.69 (0.65-4.41)
Felony assault <sup>b</sup>	7.4	3.3	2.7	0.45 (0.15-1.31)	0.37 (0.12-1.10)
Illicit drug use <sup>b</sup>	51.9	52.6	48.7	1.01 (0.77-1.33)	0.94 (0.72-1.22)
Binge drinking <sup>c</sup>	31.8	35.8	28.4	1.13 (0.75-1.70)	0.88 (0.58-1.36)
Minor assault <sup>b</sup>	26.3	27.3	23.2	1.04 (0.64-1.67)	0.88 (0.54-1.44)
Minor theft <sup>b</sup>	10.9	8.8	7.5	0.81 (0.37-1.79)	0.69 (0.32-1.52)
Fraud <sup>b</sup>	4.4	5.1	1.5	1.15 (0.35-3.75)	0.35 (0.08-1.61)
Illegal services <sup>b</sup>	6.8	6.1	4.0	0.89 (0.39-2.06)	0.60 (0.24-1.45)
Vandalism <sup>b</sup>	7.4	5.1	6.7	0.68 (0.25-1.86)	0.91 (0.40-2.09)
Public disorder <sup>b</sup>	25.9	30.2	31.9	1.17 (0.74-1.85)	1.12 (0.80-1.89)
	<b>Mean<sup>d</sup></b>	<b>Mean</b>	<b>Mean</b>	<b>IRR (95% CI)</b>	<b>IRR (95% CI)</b>
No. of arrests, lifetime	0.86	0.52	0.37	0.61 (0.35-1.04)	0.43 (0.23-0.80)
No. of convictions, lifetime	0.58	0.33	0.20	0.57 (0.31-1.06)	0.34 (0.15-0.79)
No. of arrests, past year	0.06	0.11	0.10	1.68 (0.65-4.38)	1.52 (0.61-3.79)
No. of convictions, past year	0.05	0.10	0.09	2.06 (0.73-5.83)	1.87 (0.69-5.04)

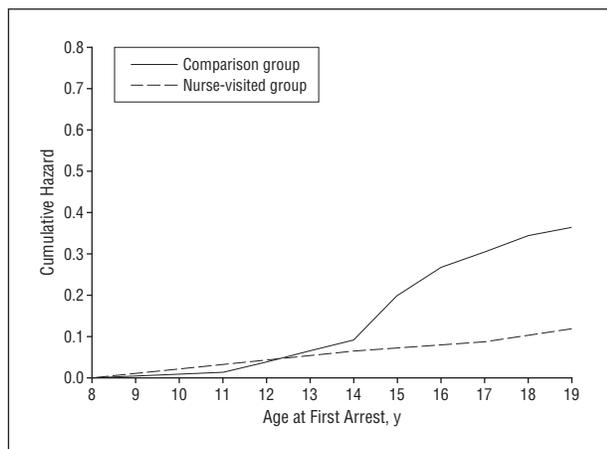
Abbreviations: CI, confidence interval; IRR, incidence risk ratio; RR, risk ratio.

<sup>a</sup>Estimates were adjusted for family risk, the mother's educational level at intake, the youth's race and sex, and interactions among treatment, risk, and sex.

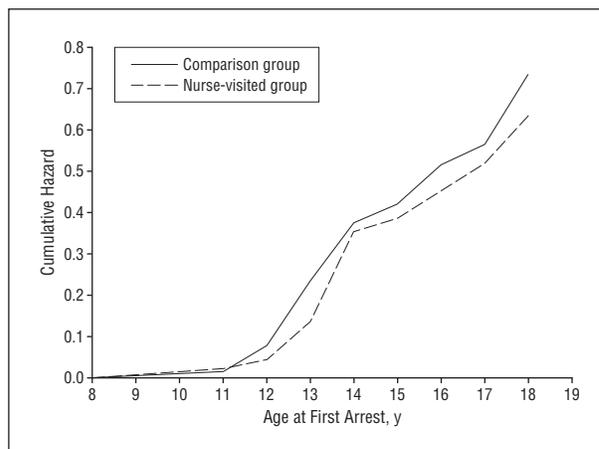
<sup>b</sup>Variable measured in the year before interview.

<sup>c</sup>Variable measured in the 6 months before interview.

<sup>d</sup>Outcomes were analyzed using the generalized linear model with log link and negative binomial error.



**Figure 1.** Cox proportional hazard curves showing the hazard of first arrest for girls in the comparison (n=73) and nurse-visited (n=43) groups.

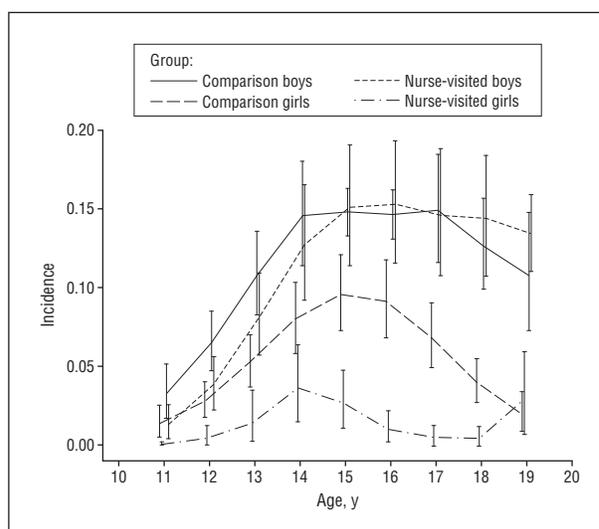


**Figure 2.** Cox proportional hazard curves showing the hazard of first arrest for boys in the comparison (n=67) and nurse-visited (n=47) groups.

It is instructive to examine the types of arrests being reported for girls in the present study. In the comparison group, 23 females were arrested by age 19 years. Of those, almost half (n=11) involved violence or the threat of violence (eg, assault, harassment, domestic violence, and armed robbery). Of nurse-visited girls, 5 were arrested by age 19 years, and of the 3 for which we have data on reason for the arrest, none involved violence. Although not definitive, this pattern is consistent with the idea that the program is preventing more serious and more violent forms of antisocial behavior in the females in the study.

**Figure 3** shows the fitted curves of the counts of arrests by child age, sex, and treatment condition and emphasizes that program impact on the number of arrests was limited to girls and that the treatment-control difference in girls was concentrated in mid-adolescence. The rate of arrests in control group girls declined during the latter half of adolescence to a rate comparable with that of their nurse-visited counterparts. The rate of arrests was higher in boys than in girls and remained high throughout all of adolescence once it reached its peak in mid-adolescence. There were no other program effects on the youths' self-reported criminal behavior or their use of alcohol or illegal drugs. There were no overall treatment effects on high school graduation, economic productivity, number of sexual partners, use of birth control, teen pregnancy or childbearing, and use of welfare, food stamps, or Medicaid (**Table 4**).

There was some indication that the program affected the fertility behaviors of youths born to high-risk mothers. Specifically, youths born to high-risk mothers in the intervention group reported higher rates of condom use (n=38; mean, 4.13) than did similar youths in the comparison group (n=58; mean, 3.11; mean difference, 1.01; 95% CI, 0.07-1.96). Boys in the intervention group born to high-risk mothers (n=18), however, reported a greater number of sexual partners (mean, 3.07) than did similar boys in the comparison group (n=23; mean, 1.53; IRR, 2.00; 95% CI, 1.16-3.45). Finally, girls in the intervention group born to high-risk mothers (n=20) were less likely to use Medicaid than were their counterparts in the comparison group (n=35; 18% vs 45%; RR, 0.40; 95% CI, 0.18-0.87), a difference largely attributable to high-



**Figure 3.** Estimates of 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 SD.

risk intervention girls' reduced childbearing rate compared with that of high-risk girls in the comparison group (11% vs 30%; RR, 0.35; 95% CI, 0.12-1.02).

#### COMMENT

The program produced enduring effects on girls' involvement with the criminal justice system but, except for youths born to high-risk women, with no other effects on their life course. Girls in the nurse-visited group had almost no increase in the likelihood of a first arrest across time, whereas the likelihood of a first arrest increased steadily for girls in the comparison group after age 14 years. For boys, the likelihood of an arrest increased substantially for the intervention and control groups after age 12 years, and there were no significant treatment-control differences in arrests for boys through age 19 years. Although the pattern of results shown in Figure 3 is consistent with the intervention effects on arrests and con-

**Table 4. Adjusted Estimates of Program Effects on Youth Life Course: Education, Work, Fertility, and Welfare Use<sup>a</sup>**

	Treatment Group, %			Contrast	
	T <sub>1 and 2</sub> : Control (n=140)	T <sub>3</sub> : Pregnancy (n=79)	T <sub>4</sub> : Pregnancy and Infancy (n=91)	T <sub>1 and 2</sub> vs T <sub>3</sub>	T <sub>1 and 2</sub> vs T <sub>4</sub>
				RR (95% CI)	RR (95% CI)
Graduated from high school	74.5	81.6	70.6	1.09 (0.93 to 1.28)	0.95 (0.78 to 1.15)
Economically productive	68.3	72.7	71.4	1.06 (0.89 to 1.27)	1.05 (0.88 to 1.25)
Ever been pregnant/made a girl pregnant	30.9	32.4	31.6	1.05 (0.68 to 1.63)	1.02 (0.70 to 1.49)
Ever fathered a child/given birth	20.7	18.1	21.2	0.88 (0.45 to 1.70)	1.02 (0.63 to 1.68)
Ever used AFDC	1.9	5.6	2.9	2.84 (1.14 to 7.05)	1.46 (0.55 to 3.88)
Ever used food stamps	5.9	6.5	6.1	1.11 (0.48 to 2.54)	1.04 (0.50 to 2.17)
Ever used Medicaid	12.4	19.8	11.4	1.60 (0.75 to 3.40)	0.92 (0.39 to 2.19)
	<b>Mean</b>	<b>Mean</b>	<b>Mean</b>	<b>IRR (95% CI)</b>	<b>IRR (95% CI)</b>
No. of sex partners, past year <sup>b</sup>	1.55	1.68	1.73	1.08 (0.82 to 1.43)	1.12 (0.87 to 1.45)
	<b>Mean</b>	<b>Mean</b>	<b>Mean</b>	<b>Mean Difference (95% CI)</b>	<b>Mean Difference (95% CI)</b>
Frequency of birth control use	4.6	4.9	4.7	0.32 (-0.24 to 0.89)	0.04 (-0.49 to 0.57)
Frequency of condom use	3.3	3.7	3.9	0.35 (-0.32 to 1.02)	0.62 (-0.01 to 1.26)

Abbreviations: AFDC, Aid to Families With Dependent Children; CI, confidence interval; IRR, incidence risk ratio; RR, risk ratio.

<sup>a</sup>Estimates were adjusted for family risk, the mother's educational level at intake, the youth's race and sex, and interactions among treatment, risk, and sex.

<sup>b</sup>Outcomes were analyzed using the generalized linear model with log link and negative binomial error.

victions found at age 15 years,<sup>19</sup> we had not previously found significant sex differences in these outcomes.

Girls in the nurse-visited group born to high-risk (unmarried and low-income) mothers had fewer children and were less likely to have received Medicaid than were high-risk girls in the comparison group. This pattern of effects for crime, childbirth, and use of Medicaid is consistent with earlier findings from this trial for the youths' mothers: high-risk nurse-visited mothers had fewer arrests, had fewer and more widely spaced subsequent children, and used less public assistance during the 15 years after the birth of the first child than did their comparison counterparts.<sup>12</sup>

We intend to examine in future studies possible explanations for the coherence of intervention effects between mothers and daughters but not sons. We are particularly interested in the extent to which the program's effect on earlier risks (eg, child maltreatment, maternal arrests, and maternal use of welfare) predicts adolescent criminality equally for boys and girls. Given that this same program has been tested in other trials, we will have an opportunity to examine the extent to which the moderation of treatment effects on antisocial behavior by the child's sex occurs in other populations and contexts.<sup>14,15</sup>

We did not find that the intervention affected rates of high school graduation by age 19 years. Nineteen-year-old youths may simply be too young to observe patterns of educational achievement that include college attendance, or the program may not have affected educational outcomes for this population of youths in this semirural setting. Other early intervention programs serving different populations have not consistently shown program effects on these outcomes. For example, at age 23 years, there were no program effects of the Perry Preschool Program on high school graduation rates.<sup>5</sup> Although the 21-year follow-up of the Abecedarian Program reported positive program effects on years of school completed,<sup>6</sup> the Infant Health and Development Pro-

gram, at age 18 years, found no program effects on high school dropout rates.<sup>7</sup> We are conducting an adolescent follow-up of primarily black youths who participated in the Memphis trial of the NFP, which will give us additional insight into the long-term effects of the program on such educational outcomes and on criminal behavior, antisocial behavior, and economic productivity for youths whose families have lived in substantially different contexts than those in the Elmira NFP trial.

These findings must be tempered with recognition of their limitations. The most obvious is that the data were based on youth reports, which may be subject to treatment-related reporting bias. Although we do not have administrative data with which we can compare youth self-reports of arrests and convictions because youth arrest records are sealed, program effects on maternal arrests through child age 15 years were stronger when based on New York State criminal justice records than when they were based on self-report.<sup>12</sup> Mothers would be more prone to treatment-related reporting bias than would their children, however, given that the program ended when the children were 2 years old. Another limitation is the lack of racial diversity in the sample, which did not permit the examination of racial or ethnic differences in treatment effects. This was one of the principle rationales for the more recent replications of the Elmira trial in Memphis and Denver.

Overall, these findings suggest that the NFP program has the potential to produce lasting changes in criminal offending trajectories, early childbearing, and economic outcomes for girls born to low-resource mothers. Given that other long-term follow-up studies of model early-childhood interventions for infants and preschoolers have reported continued treatment effects with older adolescents and young adults, the impact of well-designed and implemented early interventions on crime reduction is promising.<sup>25-27</sup> These findings also emphasize the need to direct more scientific attention to girls

in observational and interventional research on criminal behavior and delinquency.<sup>28</sup>

Age 19 years is too young to observe intervention effects on more established adult patterns of criminal behavior or to document accurately educational attainment, economic productivity, or longer-term patterns of childbearing. The follow-up study of the Elmira sample at age 27 years will give us a much clearer picture of the effect of the program on these and other indicators of young adult functioning.

**Accepted for Publication:** June 15, 2009.

**Correspondence:** John Eckenrode, PhD, Family Life Development Center, Cornell University, Beebe Hall, Ithaca, NY 14853 (jje1@cornell.edu).

**Author Contributions:** Drs Eckenrode, Campa, Luckey, and Olds and Mr Henderson had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Eckenrode, Henderson, Cole, Kitzman, Powers, and Olds. *Acquisition of data:* Eckenrode, Kitzman, Anson, Sidora-Arcoleo, and Powers. *Analysis and interpretation of data:* Eckenrode, Campa, Luckey, Henderson, Cole, Kitzman, Anson, Sidora-Arcoleo, Powers, and Olds. *Drafting of the manuscript:* Eckenrode, Campa, Henderson, Powers, and Olds. *Critical revision of the manuscript for important intellectual content:* Eckenrode, Campa, Luckey, Henderson, Cole, Kitzman, Anson, Sidora-Arcoleo, and Olds. *Statistical analysis:* Eckenrode, Campa, Luckey, Henderson, and Sidora-Arcoleo. *Obtained funding:* Eckenrode, Henderson, Cole, and Olds. *Administrative, technical, and material support:* Cole, Kitzman, Anson, and Powers. *Study supervision:* Eckenrode.

**Financial Disclosure:** None reported.

**Funding/Support:** This research was supported by grant 801-099 from the Smith Richardson Foundation. Support for earlier phases of this trial was provided by a Senior Research Scientist Award (Dr Olds) and by grants from the Prevention Research and Behavioral Medicine Branch of the National Institute of Mental Health, the Assistant Secretary for Planning and Evaluation, Health and Human Services, the Bureau of Maternal and Child Health (Department of Health and Human Services), the Robert Wood Johnson Foundation, the W. T. Grant Foundation, the Ford Foundation, and the Commonwealth Fund. Dr Olds' Research Center at the University of Colorado has a contract with the NFP National Service Office to conduct research on improving the NFP program model.

**Disclaimer:** Dr Olds has no personal financial interest in the NFP program.

**Additional Contributions:** John Shannon, PhD, supported the program and gathered data through Comprehensive Interdisciplinary Developmental Services, Elmira; Alise Mahr, BS, and Darlene Batrone, BA, traced and interviewed the families; and Terri Moffitt, PhD, provided valuable comments on an earlier draft of the manuscript.

## REFERENCES

1. Aos S, Lieb R, Mayfield J, Miller M, Pennucci A. Benefits and costs of prevention and early intervention programs for youth. Washington State Institute for Public

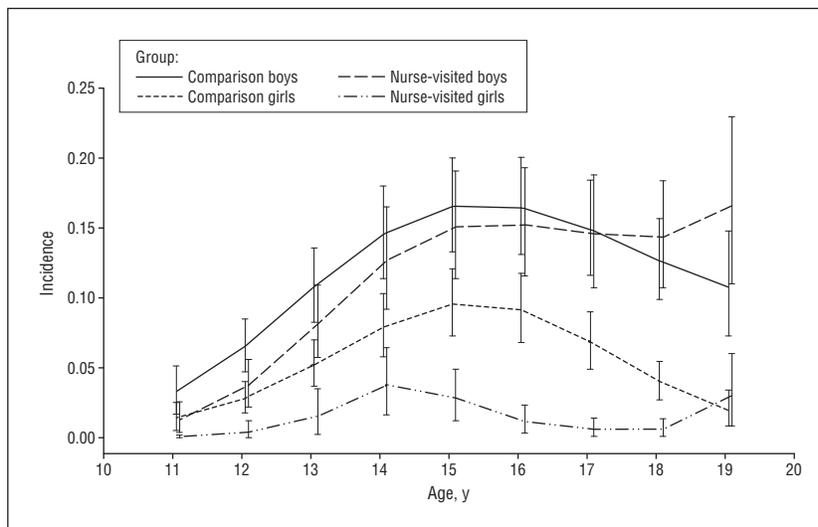
Policy Web site. <http://www.wsipp.wa.gov/rptfiles/04-07-3901.pdf>. Accessed October 14, 2009.

2. Karoly LA, Kilburn MR, Cannon JS. *Early Childhood Interventions: Proven Results, Future Promise*. Santa Monica, CA: RAND Corp; 2005.
3. Reynolds AJ, Temple JA. Cost-effective early childhood development programs from preschool to third grade. *Annu Rev Clin Psychol*. 2008;4:109-139.
4. Love JM, Kisker EE, Ross C, et al. The effectiveness of Early Head Start for 3-year-old children and their parents: Lessons for policy and programs. *Dev Psychol*. 2005;41(6):885-901.
5. Schweinhart L, Weikart D. The High/Scope Preschool curriculum comparison study through age 23. *Early Child Res Q*. 1997;12:117-143.
6. Campbell FA, Wasik BH, Pungello E, et al. Young adult outcomes of the Abecedarian and CARE early childhood educational interventions. *Early Child Res Q*. 2008;23:452-466.
7. McCormick MC, Brooks-Gunn J, Buka SL, et al. Early intervention in low birth weight premature infants: results at 18 years of age for the Infant Health and Development Program. *Pediatrics*. 2006;117(3):771-780.
8. National Commission to Prevent Infant Mortality. *Home Visiting: Opening Doors for America's Pregnant Women and Children*. Washington, DC: National Commission to Prevent Infant Mortality; 1989.
9. US Advisory Board on Child Abuse and Neglect. *Creating Caring Communities: Blueprint for an Effective Federal Policy on Child Abuse and Neglect*. Washington, DC: US Government Printing Office; 1991.
10. American Academy of Pediatrics; Council on Child and Adolescent Health. The role of home-visitation programs in improving health outcomes for children and families. *Pediatrics*. 1998;101(3, pt 1):486-489.
11. Olds DL, Sadler L, Kitzman H. Programs for parents of infants and toddlers: recent evidence from randomized trials. *J Child Psychol Psychiatry*. 2007;48(3-4):355-391.
12. Olds DL, Eckenrode J, Henderson CR Jr, et al. Long-term effects of home visitation on maternal life course and child abuse and neglect: fifteen-year follow-up of a randomized trial. *JAMA*. 1997;278(8):637-643.
13. Olds DL, Henderson C Jr, Cole R, et al. Long-term effects of nurse home visitation on children's criminal and antisocial behavior: 15-year follow-up of a randomized controlled trial. *JAMA*. 1998;280(14):1238-1244.
14. Olds DL, Kitzman H, Hanks C, et al. Effects of nurse home visiting on maternal and child functioning: age-9 follow-up of a randomized trial. *Pediatrics*. 2007;120(4):e832-e845.
15. Olds DL, Robinson J, Pettitt L, et al. Effects of home visits by paraprofessionals and by nurses: age 4 follow-up results of a randomized trial. *Pediatrics*. 2004;114(6):1560-1568.
16. Olds DL, Pettitt LM, Robinson J, et al. Reducing risks for antisocial behavior with a program of prenatal and early childhood home visitation. *J Community Psychol*. 1998;26:65-83.
17. Moffitt TE. Adolescence-limited and life-course-persistent antisocial behavior: a developmental taxonomy. *Psychol Rev*. 1993;100(4):674-701.
18. Olds DL, Henderson C Jr, Tatelbaum R, Chamberlin R. Improving the delivery of prenatal care and outcomes of pregnancy: a randomized trial of nurse home visitation. *Pediatrics*. 1986;77(1):16-28.
19. Olds DL, Henderson C Jr, Chamberlin R, Tatelbaum R. Preventing child abuse and neglect: a randomized trial of nurse home visitation. *Pediatrics*. 1986;78(1):65-78.
20. Olds DL, Henderson C Jr, Tatelbaum R. Intellectual impairment in children of women who smoke cigarettes during pregnancy. *Pediatrics*. 1994;93(2):221-227.
21. Olds DL, Henderson CR Jr, Kitzman H, et al. Prenatal and infancy home visitation by nurses: a program of research. In: Rovee-Collier C, Lipsitt LP, Hayne H, eds. *Advances in Infancy Research*. Vol 12. Stamford, CT: Ablex Publishing Corp; 1998.
22. Elliot DS, Huizinga D, Menard S. *National Youth Survey: Multiple Problem Youth: Delinquency, Substance Use, and Mental Health Problems*. New York, NY: Springer Verlag; 1989.
23. Peduzzi P, Concato J, Kemper E, Holford T, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373-1379.
24. Singer J, Willett J. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York, NY: Oxford University; 2003.
25. Tremblay RE. Prevention of youth violence: why not start at the beginning? *J Abnorm Child Psychol*. 2006;34(4):481-487.
26. Yoshikawa H. Long-term effects of early childhood programs on social outcomes and delinquency. *Future Child*. 1995;5(3):51-75.
27. Reynolds AJ, Temple JA, Ou SR, et al. Effects of a school-based, early childhood intervention on adult health and well-being: a 19-year follow-up of low-income families. *Arch Pediatr Adolesc Med*. 2007;161(8):730-739.
28. Molnar BE, Roberts AL, Browne A, Gardener H, Buka SL. What girls need: recommendations for preventing violence among urban girls in the US. *Soc Sci Med*. 2005;60(10):2191-2204.

16. Kessler RC. The National Comorbidity Survey of the United States: preliminary results and future directions. *Int Rev Psychiatry*. 1994;4:114.1-114.13.
17. Derogatis LR, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med*. 1983;13(3):595-605.
18. Pearlman LI, Schooler C. The structure of coping. *J Health Soc Behav*. 1978;19(1): 2-21.
19. Glazner J, Bondy J, Luckey D, Olds DL. *Effect of the Nurse Family Partnership on Government Expenditures for Vulnerable First-Time Mothers and Their Children in Elmira, New York, Memphis, Tennessee, and Denver, Colorado (#90XP0017): Final Report to the Administration for Children and Families*. Washington, DC: US Dept of Health and Human Services; 2004.
20. Bureau of Labor Statistics. *Employment Cost Index*. Washington, DC: US Dept of Labor. June 2009. BLS news release USDL-09-0874.
21. Olds DL, Robinson J, O'Brien R, et al. Home visiting by paraprofessionals and by nurses: a randomized, controlled trial. *Pediatrics*. 2002;110(3):486-496.
22. Olds DL, Robinson J, Pettitt L, et al. Effects of home visits by paraprofessionals and by nurses: age 4 follow-up results of a randomized trial. *Pediatrics*. 2004; 114(6):1560-1568.
23. Olds DL. *Impact of the Nurse-Family Partnership on Neighborhood Context, Government Expenditures, and Children's School Functioning: Grant 2005-MU-MU-0001*. Washington, DC: US Dept of Justice; 2009.
24. Karoly LA, Kilburn MR, Cannon JS. *Early Childhood Interventions: Proven Results, Future Promise*. Santa Monica, CA: RAND Corp; 2005.
25. Lee S, Aos S, Miller M. *Evidence-Based Programs to Prevent Children From Entering and Remaining in the Child Welfare System: Benefits and Cost for Washington*. Olympia: Washington State Institute for Public Policy; 2008. Document 08-07-3901.
26. Olds DL, Lombardi J, Birmingham MT, Henderson CR Jr. *Prenatal/Early Infancy Project: A Follow-up Evaluation at the Third and Fourth Years of Life: Final Report to the Robert Wood Johnson Foundation (Grant 3729)*. Rochester, NY: University of Rochester; 1986.
27. Pettitt L, Olds DL. *Partner and Father Involvement in the Lives of Low-Income First-Time Mothers and Their Children: Developmental Course and Impact of Maternal and Child Functioning: Final Report of Grant 90PD0232 to the Administration of Children and Families*. Washington, DC: US Dept of Health and Human Services; 2001.
28. Boonstra H. Home visiting for at-risk families: a primer on a major Obama administration initiative. *Guttmacher Policy Rev*. 2009;12(3):11-15.
29. Coalition for Evidence-Based Policy. *Early childhood home visitation program models: an objective summary of the evidence about which are effective*. April 2009. <http://www.evidencebasedpolicy.org/docs/OverviewOfEvidenceOnHomeVisitationModels409.pdf>. Accessed February 1, 2010.
30. Haskins R, Paxson C, Brooks-Gunn J. *Social science rising: a tale of evidence shaping public policy: policy brief*. Fall 2009. [http://www.princeton.edu/futureofchildren/publications/docs/19\\_02\\_PolicyBrief.pdf](http://www.princeton.edu/futureofchildren/publications/docs/19_02_PolicyBrief.pdf). Accessed February 2, 2010.

### 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.