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Prenatal and Infancy Home Visitation by Nurses: Recent Findings

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Abstract

This article describes a 20-year program of research on the Nurse Home Visitation Program, a model in which nurses visit mothers beginning during pregnancy and continuing through their children's second birthdays to improve pregnancy outcomes, to promote children's health and development, and to strengthen families' economic self-sufficiency.

The results of two randomized trials (one in Elmira, New York, and the second in Memphis, Tennessee) are summarized, and an ongoing trial in Denver, Colorado, is briefly described. Results of the Elmira and Memphis trials suggest the following: The program benefits the neediest families (low-income unmarried women) but provides little benefit for the broader population. Among low-income unmarried women, the program helps reduce rates of childhood injuries and ingestions that may be associated with child abuse and neglect, and helps mothers defer subsequent pregnancies and move into the workforce. Long-term follow-up of families in Elmira indicates that nurse-visited mothers were less likely to abuse or neglect their children or to have rapid successive pregnancies. Having fewer children enabled women to find work, become economically self-sufficient, and eventually avoid substance abuse and criminal behavior. Their children benefitted too. By the time the children were 15 years of age, they had had fewer arrests and convictions, smoked and drank less, and had had fewer sexual partners. The program produced few effects on children's development or on birth outcomes, except for children born to women who smoked cigarettes when they registered during pregnancy. The positive effects of the program on child abuse and injuries to children were most pronounced among mothers who, at registration, had the lowest psychological resources (defined as high levels of mental health symptoms, limited intellectual functioning, and little belief in their control of their lives).

Generally, effects in Elmira were of greater magnitude and covered a broader range of outcomes than in Memphis, perhaps because of differences between the populations studied, community contexts, or a higher rate of turnover among home visitors in Memphis than in Elmira.

The article concludes that the use of nurses as home visitors is key; that services should be targeted to the neediest populations, rather than being offered on a universal basis; that clinically tested methods of changing health and behavioral risks should be incorporated into program protocols; and that services must be implemented with fidelity to the model tested if program benefits found in scientifically controlled studies are to be reproduced as the program is replicated in new communities.

Many of the most pervasive and intractable problems faced by young children and parents in America today can be traced to adverse maternal health-related behaviors during pregnancy, compromised care of the child, and stressful conditions in families' homes that interfere with parental and family functioning. These problems include infant mortality, preterm delivery, low birth weight, and neurodevelopmental impairments in young children resulting from poor prenatal health;^{1,2} child abuse and neglect, as well as accidental childhood injuries resulting from dysfunctional caregiving;³ youth violence resulting from a combination of neurodevelopmental impairment and harsh and neglectful caregiving;⁴⁻⁶ and diminished economic self-sufficiency of parents resulting from closely spaced pregnancies, educational failure, and sporadic workforce participation.⁷

A series of papers has been published on a randomized trial of prenatal and infancy home visitation by nurses in Elmira, New York, that was designed to reduce these problems through the improvement of maternal health and behavior. The study enrolled 400 women who had had no previous live births, 85% of whom were either unmarried, adolescent, or poor. Early results through the children's fourth birthdays showed significant promise for the program, and were reviewed in a 1993 article in this journal.⁸ Compared with counterparts randomly assigned to receive comparison services, women who were nurse-visited experienced greater informal and formal social support, smoked fewer cigarettes, had better diets, and exhibited fewer kidney infections by the end of pregnancy. Babies born to nurse-visited women identified as smokers were less likely to be born prematurely (that is, before 37 weeks of gestation).⁹ The program was helpful in reducing abuse and neglect among poor unmarried mothers, and in reducing visits to the emergency department for injuries among all children, irrespective of risk.¹⁰ Four years after delivery of their first children, nurse-visited women who were low income and unmarried at registration were found to have had fewer subsequent pregnancies and greater participation in the workforce.¹¹ An economic evaluation of the program from the standpoint of savings to government showed that for low-income women (and especially those who were low income and unmarried), the discounted cost savings to government exceeded the cost of the program before the children were four years of age.¹² (See Appendix C in this journal issue for a summary of these results.)

Given these findings, there was pressure to expand the program broadly. We chose instead to address four fundamental questions through continued research before offering the program for public investment: (1) Would the results found early in the lives of the children in Elmira endure after the

program ended? (2) Were the positive findings from the Elmira program limited to the population studied (primarily whites living in a central New York county) or would they apply to a wider range of communities and populations? (3) Could community health workers achieve results similar to those achieved by nurse home visitors, despite limited evidence of effectiveness for paraprofessional visitors?⁸ (4) If the program were found to have solid evidentiary foundations, could polished program protocols and methods of training nurse home visitors be developed so new programs based upon this model would be able to reliably reproduce the essential elements of the program tested in the randomized trials?

Two new randomized trials were launched. The first followed 1,139 families in Memphis, Tennessee, and was designed to replicate the findings from Elmira with a primarily African-American population. The second new trial followed 735 families in Denver, Colorado, and compared the program's effects when it was delivered by nurses with its effects when delivered by paraprofessional community health visitors. Results from the Denver trial will be available in late 1999.

This article summarizes findings from the Elmira trial that have been published since the review article appeared in this journal in 1993, as well as results from the Memphis study. The article begins with an outline of the epidemiological and theoretical foundations of the program and its content and methods.

A Research-Based and Theory-Driven Model

The program tested in this series of randomized trials was firmly grounded in epidemiology and theories of child development and behavioral change.^{13,14}

Research-Based

Research guided decisions about the families to be served and the content of the program. All of the studies examined program impact for women who had had no previous live births, and each focused recruitment on women who were low income, unmarried, and adolescent, although any woman bearing a first child was allowed to register in the Elmira trial. Women with these characteristics were recruited because the problems the program was designed to address (for example, poor birth outcomes, child abuse and neglect, and diminished economic self-sufficiency of parents) are concentrated in these populations.^{7,15,16} In addition, program benefits in Elmira were greater for the higher-risk families, so the subsequent Memphis and Denver trials focused recruitment more exclusively on those with overlapping risks (that is, being

both unmarried and from a low-income family).

All three of the trials focused on women who had had no previous live births, because it was hypothesized that such women would be more receptive to home visitation services concerning pregnancy and child rearing, given their heightened sense of vulnerability, than would women who had already given birth. Moreover, as parents learned parenting and other skills through the program, they would be better able to care for subsequent children, and the program might have an even greater positive effect. Finally, if the program helped parents plan subsequent births, then it would be easier for parents to finish their education and find work because of fewer problems with child care,⁷ and the children would benefit from more focused parental nurturing and guidance.¹⁷

The content of the program was also research based. The program sought to modify specific risk factors associated with the negative outcomes it sought to address: poor birth outcomes, child abuse and neglect, welfare dependence, and poor maternal life course.

Modifiable Risk Factors for Poor Birth Outcomes (Low Birth Weight, Preterm Delivery, and Fetal Impairment)

Prenatal exposure to tobacco, alcohol, or illegal drugs is an established risk factor for poor fetal growth¹ and, to a lesser extent, preterm birth¹ and neurodevelopmental impairment (such as attention deficit disorder or poor cognitive and language development).^{2,18-21} In all three trials (Elmira, Memphis, and Denver) the home visitors therefore sought to reduce mothers' use of these substances.

The prenatal protocols also addressed other factors that increase the risk of low birth weight, preterm delivery, and poor child development: inadequate weight gain;²² inadequate diet;²² inadequate use of office-based prenatal care;²³ and obstetric complications, such as genitourinary tract infections and hypertensive disorders (high blood pressure).²³

Modifiable Risk Factors for Child Abuse and Neglect and Injuries to Children

Mothers' psychological immaturity and mental health problems can reduce their ability to care for their infants.²⁴ Parents who grew up in households with punitive, rejecting, abusive, or neglectful caregiving are at heightened risk.³ In addition, unemployment,²⁵ poor housing and household conditions,²⁵ marital discord,²⁶ and isolation from supportive family members and friends²⁷ are all associated with higher rates of abuse and neglect, perhaps because they create stressful conditions in the household that interfere with parents' ability to care for their children. Children with attention deficit hyperactivity disorder may be at increased risk for becoming seriously injured.²⁸ The program therefore contained specific strategies to reduce these risks.

Modifiable Risk Factors for Welfare Dependence and Compromised Maternal Life Course Development

One of the major risk factors for compromised maternal educational achievement and workforce participation is rapid successive pregnancies, particularly among unmarried women.⁷ Such pregnancies often occur when women have limited aspirations in the areas of education and work,⁷ as well as a limited belief in their ability to control their life circumstances and, in particular, their con-

traceptive practices.²⁹ The nurses therefore helped women envision futures consistent with the women's values; helped women evaluate different contraceptive methods, child care options, and career choices; and helped women develop concrete plans for achieving their goals.

Modifiable Risk Factors for Early-Onset Antisocial Behavior

Many of the aforementioned factors are risk factors for early-onset antisocial behavior,³⁰ a type of disruptive behavior that frequently characterizes children who grow up to become violent adolescents and sometimes chronic offenders.⁴⁻⁶ For example, children who develop early-onset disorder are more likely to have subtle neurodevelopmental deficits (sometimes resulting from poor prenatal health)^{2,19,20} combined with abusive and rejecting care early in life.⁴⁻⁶ They are more likely to come from large families with closely spaced children,¹⁷ in which parents

The program was grounded in theories that suggest that behavior change is a function of families' social context as well as individuals' beliefs, motivations, and emotions.

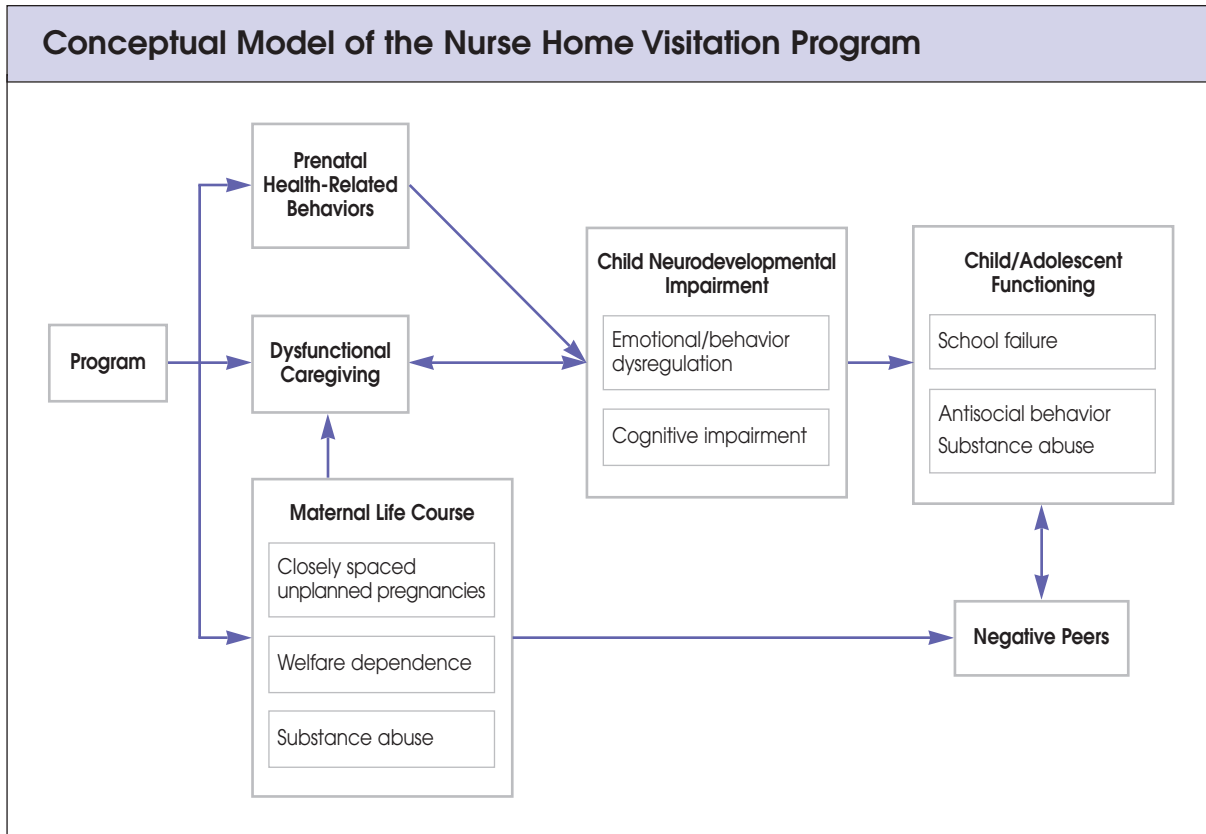
are involved in substance abuse and criminal behavior.⁴ As Figure 1 illustrates, diverse influences converge to produce childhood-onset conduct disorder. As data from the Elmira and Memphis studies show, this home visitation program reduced several of these risk factors, and in Elmira led to reductions in antisocial behavior among the children born to low-income unmarried mothers who participated in the program.³¹

Theory-Driven

The program was grounded in theories of human ecology,³² self-efficacy,³³ and human attachment.³⁴ Together, these theories suggest that behavior change is a function of families' social context as well as individuals' beliefs, motivations, and emotions.

Human ecology theory, for example, emphasizes that children's development is influenced by how their parents care for them, which, in turn, is influenced by characteristics of their families, social networks, neighborhoods, and communities, and by

Figure 1



the interrelations among them.³² Drawing from this theory, nurses attempted to enhance the material and social environment of each family by involving other family members, including fathers, in the home visits, and by linking families with needed health and human services.

Parents help select and shape the settings in which they find themselves, however.³⁵ Self-efficacy theory provides a useful framework for understanding how women make decisions about their health-related behaviors during pregnancy, their care of their children, and their own personal development. This theory suggests that individuals choose those behaviors that they believe (1) will lead to a given outcome, and (2) they themselves can successfully carry out.³³ In other words, individuals' perceptions of self-efficacy can influence their choices and can determine how much effort they put forth in the face of obstacles.

Therefore, the curriculum was designed first to help women understand what is known about the influence of particular behaviors on their own health and on the

health and development of their babies. Second, the home visitors helped parents establish realistic goals and small, achievable objectives that, once accomplished, would increase parents' reservoir of successful experiences. These successes, in turn, would increase women's confidence in taking on larger challenges.

Finally, the program was based on attachment theory, which posits that infants are biologically predisposed to seek proximity to specific caregivers in times of stress, illness, or fatigue to promote survival.³⁴ Attachment theory also hypothesizes that children's trust in the world and their later capacity for empathy and responsiveness to their own children once they become parents are influenced by the degree to which they form attachments with caring, responsive, and sensitive adults when they are growing up.³⁶

The program therefore explicitly promoted sensitive, responsive, and engaged caregiving in the early years of a child's life.³⁷ In addition, home visitors tried to help mothers and other caregivers review their

own child-rearing histories and make decisions about how they wished to care for their children in light of the way they had been cared for as children. Finally, the visitors sought to develop empathic, trusting relationships with the mothers and other family members, because experience in such relationships was expected to help women eventually trust others and to promote more sensitive, empathic care of their children.

Program Design

The same basic program design was used in Elmira, Memphis, and Denver.

Frequency of Visitation

The frequency of home visits changed with the stages of pregnancy and could be adapted to each mother's needs. Each mother typically was enrolled through the end of the second trimester of pregnancy. Visits were scheduled once a week during the first month after enrollment, which assisted the new mother and the home visitor to establish a trusting relationship. Thereafter, visits were scheduled every other week until the birth of the baby. The nurse again visited weekly for six weeks after the baby was born, helping the new mother and newborn adjust. From the child's 2nd to 21st postnatal month, visits were scheduled twice a month. From the 21st to 24th postnatal month, visits were scheduled once a month. Assuming that the woman registered in the program at 18 weeks of gestation, the maximum number of completed home visits would be 13 during pregnancy (assuming delivery at 40 weeks of gestation) and 47 after the child's birth.

In Elmira and Memphis, the nurses completed an average of 9 (with a range of 0 to 16) and 7 (with a range of 0 to 18) visits during pregnancy, respectively; and 23 (with a range of 0 to 59) and 26 (with a range of 0 to 71) visits from birth to the children's second birthdays, respectively.³⁸ (See Appendix C in this journal issue for additional detail.) The number of visits received varied greatly among participating families. Analyses revealed that the nurses completed substantially more visits with women who had fewer coping resources (defined as limited belief in their control over their life circumstances in Elmira, and as limited intellectual functioning, high levels of mental health symptoms, and limited control beliefs in Memphis),

probably because the nurses recognized these women's greater need for help.³⁹

Nurses as Home Visitors

Nurses were selected to be the home visitors because of their formal training in women's and children's health and their competence in managing the complex clinical situations often presented by at-risk families. Nurses' ability to competently address mothers' and family members' concerns about the complications of pregnancy, labor, and delivery, and about the physical health of the infants, was thought to provide nurses with increased credibility and persuasive power in the eyes of family members. Moreover,

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through their ability to teach mothers and family members to identify emerging health problems and to use the health care system, nurses enhanced their clinical effect through the early detection and treatment of disorders. Each nurse carried a caseload of 20 to 25 families. In Memphis and Denver, nurse home visitors received regular clinical supervision from master's-prepared nurses, but in Elmira they were supervised by an associate's degree-level nurse who had extensive experience in community and newborn nursing.

Program Content

During the home visits, each of which lasted 75 to 90 minutes, the nurses carried out three major activities: (1) they promoted improvements in women's (and other family members') behavior thought to affect pregnancy outcomes, the health and development of the children, and parents' life course; (2) they helped women build supportive relationships with family members and friends; and (3) they linked women and their family members with other needed health and human services.

The nurses followed detailed visit-by-visit program protocols whose content reflected

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the challenges parents were likely to confront during specific stages of pregnancy and the first two years of the children's lives. Specific assessments were made of maternal, child, and family functioning corresponding to those stages, and specific interventions were recommended to address issues identified through the assessments.

During pregnancy, the nurses helped women complete 24-hour diet histories on a regular basis and plot weight gains at every visit; they also assessed the women's cigarette smoking and use of alcohol and illegal drugs and facilitated reductions in the use of these substances through behavioral change strategies. They taught women to identify the signs and symptoms of pregnancy complications, encouraged women to inform the office-based staff about those conditions, and facilitated compliance with treatment. They gave particular attention to urinary tract infections, sexually transmitted diseases, and hypertensive disorders (condi-

tions associated with poor birth outcomes). They coordinated care with physicians and nurses in the office and measured blood pressure when needed.

After delivery, the nurses helped mothers and other caregivers improve the physical and emotional care of their children. They taught parents to observe the signs of illness, to take temperatures, and to communicate with office staff about their children's illnesses before seeking care. Curricula promoted parent-child interaction by facilitating parents' understanding of their infants' and toddlers' communicative signals, enhancing parents' interest in playing with their children in ways that promoted emotional and cognitive development, and creating households that were safer for children.

The nurses also helped women clarify their goals and solve problems that might interfere with continuing their education, finding work, and planning future pregnancies.¹⁴

Overview of Research Designs, Methods, and Findings

In each of the three studies, women were randomized to receive either home visitation services during pregnancy and the first two years of their children's lives or comparison services. While the nature of the home visitation services was essentially the same in each of the trials, as described previously, the comparison services were slightly different. The designs and methods employed in the Elmira and Memphis trials are outlined in the following section and listed in Table 1. In addition, a summary of the effects of the program on major outcomes for the two trials is presented in Box 1. (See Appendix C in this journal issue for more detail.)

Elmira Design and Methods

The first study was conducted in a small, semirural county of approximately 100,000 residents in the Appalachian region of New York State.

Elmira Sample

Pregnant women were actively recruited for the study through their sources of prenatal care if, at intake, they had had no previous live births, were at less than 26 weeks of ges-

Table 1

Study Design and Sample Size of the Elmira, NY, and Memphis, TN, Nurse Home Visitation Program Trials		
Elmira		
Experimental Conditions	Sample Size (Initially)	Sample Size (15-Year Follow-Up)^o
Group 1 Sensory and developmental screenings for children at 12 and 24 months	94	72
Group 2 Sensory and developmental screenings for children at 12 and 24 months Free transportation for prenatal and well-child care through 24 months	90	76
Group 3 Sensory and developmental screenings for children at 12 and 24 months Free transportation for prenatal and well-child care through 24 months Home visits by nurse during pregnancy	100	79
Group 4 Sensory and developmental screenings for children at 12 and 24 months Free transportation for prenatal and well-child care through 24 months Home visits by nurse during pregnancy and until child's second birthday	116	97
Memphis		
Experimental Conditions	Sample Size (Initially)	Sample Size (24-Month Interviews)^b
Group 1 Free transportation for prenatal care appointments	166	NA
Group 2 Free transportation for prenatal care appointments Developmental screening and referral services for children at 6, 12, and 24 months	515	465
Group 3 Free transportation for prenatal care appointments Developmental screening and referral services for children at 6, 12, and 24 months Home visits by nurse during pregnancy; one visit in hospital after childbirth; one visit at home after birth	230	NA
Group 4 Free transportation for prenatal care appointments Developmental screening and referral services for children at 6, 12, and 24 months Home visits by nurse during pregnancy and until child's second birthday	228	206
^o 28 cases were unavailable for follow-up because of fetal, infant, child, or maternal death. ^b 42 cases in Groups 2 and 4 were unavailable for postnatal follow-up because of fetal or infant death.		

Box 1

Summary of Selected Outcomes of the Elmira, NY, and Memphis, TN, Nurse Home Visitation Program Trials^a

Pregnancy Outcomes

Elmira

- Decrease in cigarette smoking
- Improved diet
- Decrease in preterm delivery for smokers
- Increased birth weight for children of women less than 17 years old
- Increased use of community services

Memphis

- No difference in use of prenatal care, length of gestation, preterm delivery, or birth weight
- Decrease in pregnancy-induced hypertension
- Decrease in vaginal yeast infections
- Increased use of community services

Dysfunctional Care of Children

Elmira

- Fewer emergency health care visits and fewer verified child abuse and neglect reports for children of low-income unmarried women, and for women identified as having low psychological resources^b

Memphis

- Fewer health care visits (outpatient and hospitalization) for injuries and ingestions, particularly for the children of women with low psychological resources
- Better mother-child interactions among women with low psychological resources

Child Development

Elmira

- Better cognitive development of children of smokers
- No difference in cognitive development of children of low-income unmarried women

Memphis

- No difference in cognitive development or behavioral problems

Maternal Life Course

Elmira

- Fewer subsequent pregnancies and births, increased time between first and second children, fewer months on welfare, and fewer arrests for low-income unmarried women
- Adolescent children of low-income unmarried women who had received nurse visits reported fewer arrests, fewer lifetime sex partners, and less tobacco and alcohol use

Memphis

- Fewer subsequent pregnancies and births
- No difference in educational achievement or length of employment

^a Outcomes are for home-visited women and their children in contrast with the study's comparison group(s).

^b In Elmira, low psychological resources meant that women had limited belief in their control over their lives; in Memphis, it meant that they had a combination of poor mental health, limited intellectual functioning, and limited belief in their control over their lives.

tation, and had any of the following characteristics that predispose infants to health and developmental problems: (1) an age of less than 19 years, (2) single-parent status, or (3) low socioeconomic status. Any woman who asked to participate was enrolled, however, regardless of her age, marital status, or income, if she had had no previous live births.

Five hundred women were invited to participate and 400 enrolled, 85% of whom were either low income, unmarried, or younger than 19 years of age at registration; none had had a previous live birth. Eighty-nine percent of the sample were white. There were no sociodemographic differences between those who enrolled and those who declined, although participation was higher among African Americans. The sample was stratified on the basis of maternal race, marital status, and geographic region of residence and then randomly assigned to four treatment groups.

Elmira Treatment Conditions

As listed in Table 1 and detailed elsewhere,^{9-11,31,40} families in Group 1 were provided sensory and developmental screenings for their children at 12 and 24 months of age. Children were referred for further clinical evaluation and treatment when needed. Families in Group 2 were provided the same screening services plus free transportation for prenatal and well-child care through the children's second birthdays. Families in Group 3 were provided the screening and transportation services plus nurses who visited them at home during pregnancy. Families in Group 4 were provided the screening and transportation services plus nurses who visited them from pregnancy through the children's second birthdays. Families in Groups 1 and 2 made equally good use of prenatal and well-child care and were therefore combined into a single comparison group against which Groups 3 and 4 were contrasted to estimate the influence of prenatal home visitation on pregnancy outcomes (Group 3 plus Group 4), and the influence of prenatal plus infancy home visitation on postnatal outcomes (Group 4).

Elmira Outcome Assessments

Assessments of outcomes were made by individuals who were not aware of the women's and children's treatment assignments. Data

were derived from interviews, observations of parenting and conditions in the homes, and reviews of medical and social service records from pregnancy through the children's 15th birthdays. (A list of some of the key measures used in Elmira and Memphis appears in Table 1 in the article by Gomby on pages 32-38 in this journal issue.)

Elmira Analyses

All analyses were based upon an intention-to-treat approach; that is, families were kept in their original groups for the analyses no matter how few home visits they received. Through the fourth year of the children's lives, results were reported for white families only; results for the 46 African-American families were analyzed separately because the sample size was too small to permit some of the analyses.⁴¹ Thereafter, results were reported for both whites and blacks combined, in part because the influence of maternal race on maternal and child outcomes diminished at older ages.^{31,40}

For each outcome, analyses were conducted that simultaneously focused on the effects of the program on all families as well as on those subgroups of families hypothesized to benefit the most from the program by virtue of being at greater risk, such as

With some exceptions, most of the positive effects of the program were concentrated in those higher-risk subgroups.

low-income unmarried women and their children, and children born to women who smoked cigarettes during pregnancy. With some exceptions, which will be noted, most of the positive effects of the program were concentrated in those higher-risk subgroups.

In addition, because it had been hypothesized that the effects of the program would be greater for women with fewer resources to cope with adversity, analyses were conducted to test whether women with less belief in their ability to control their own lives benefitted more from the program.

Elmira Results

At randomization, the treatment groups in the Elmira trial were essentially equivalent

in terms of all background characteristics examined. At the 15-year follow-up, assessments were completed for 324 women—81% of the women originally randomized, and 87% of those cases for whom there was no fetal, maternal, or child death. The groups remained essentially equivalent in terms of background characteristics for those individuals for whom the 15-year follow-up assessments were completed.

Dysfunctional Caregiving

During the second year of life, nurse-visited children were seen in emergency departments 32% fewer times than control group children (0.74 versus 1.09 visits, $p=.01$), a difference that was explained in part by a 56% reduction in visits for injuries and ingestions (0.15 versus 0.34 visits, $p=.03$). Perhaps most important, nurse-visited children born to low-income unmarried teens had 80% fewer verified cases of child abuse and neglect

Nurse-visited children born to low-income unmarried teens had 80% fewer verified cases of child abuse and neglect during their first two years of life than did their counterparts in the control group.

during their first two years of life than did their counterparts in the control group (one case or 4% of the nurse-visited teens, versus eight cases or 19% of the control group, $p=.07$). These effects were greatest among children whose mothers had little belief in their control over their lives when they first registered for the program.¹⁰

During the two years after the program ended, its impact on health care encounters for injuries endured: irrespective of risk, children of nurse-visited women were less likely than their control group counterparts to receive emergency room treatment (a per-child average of 1.00 versus 1.53 visits, $p<.001$) and to visit physicians for injuries and ingestions (a per-child average of 0.34 versus 0.57 visits, $p=.03$).⁴² The impact of the program on state-verified cases of child abuse and neglect, on the other hand, disappeared during that two-year period,⁴² probably because of increased detection of child abuse and neglect in nurse-visited fam-

ilies and the nurses' linkage of families with needed services (including child protective services) at the end of the program, at the children's second birthdays.⁴³ When child abuse or neglect was identified in the first four years of the child's life, the nurse-visited cases were found to be less serious, again probably because of the early identification of less serious forms of maltreatment in nurse-visited families.⁴³

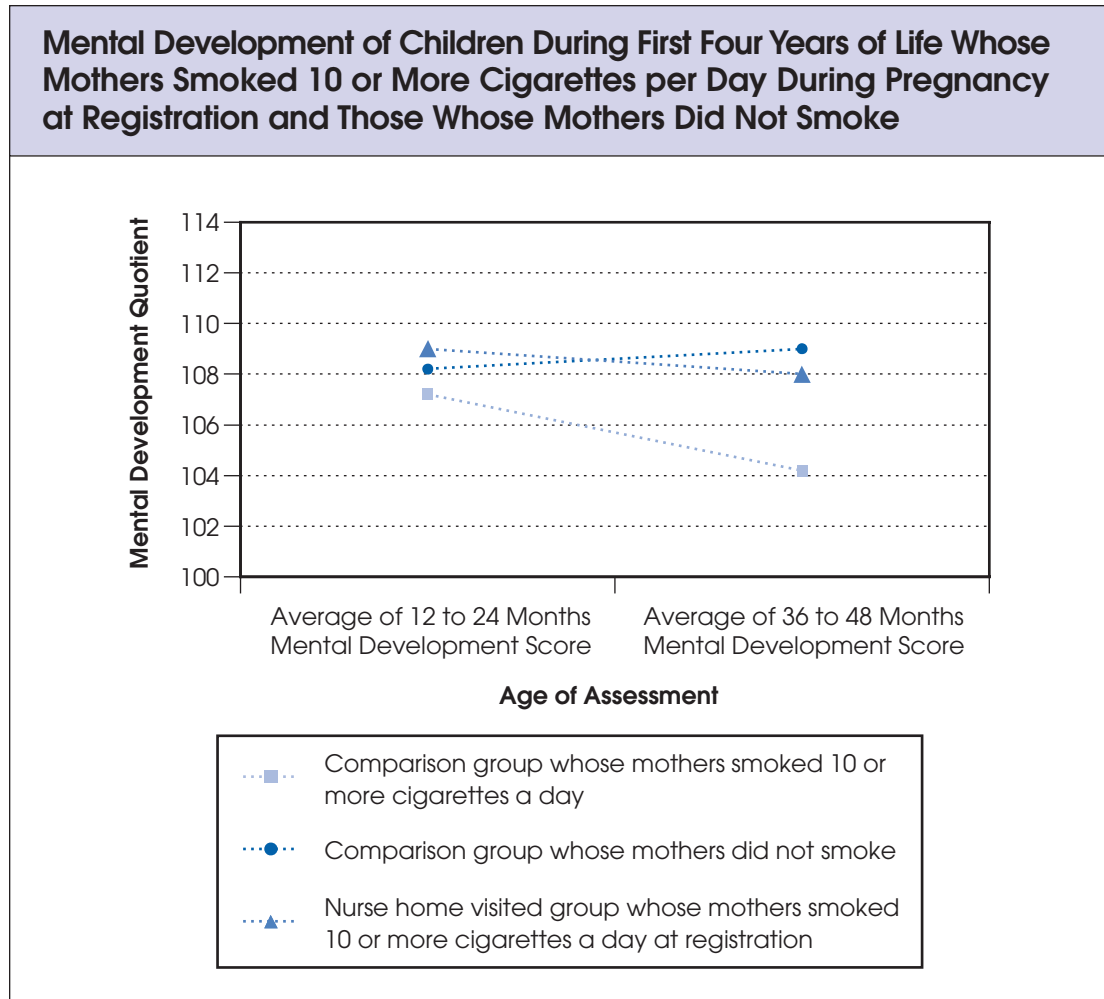
Results from a 15-year follow-up of the Elmira sample⁴⁰ indicate that the differences between Group 4 and the control group in rates of state-verified reports of child abuse and neglect grew between the children's 4th and 15th birthdays. Overall, during the 15-year period after delivery of their first children, women visited by nurses during pregnancy and infancy were identified as perpetrators of child abuse and neglect in an average of 0.29 verified reports per program participant, in contrast with 0.54 verified reports for the comparison group ($p<.001$). This difference for the entire period overrode the disappearance of program effects during the two-year period immediately following the end of the program. This program effect was greater for women who were poor and unmarried at registration (0.11 versus 0.53 reports per program participant, $p<.001$).⁴⁰

Prenatal Tobacco Exposure, Prenatal Home Visitation, and Development in the First Four Years of the Child's Life

At age four, there were no overall differences between nurse-visited and control group children in mental development; nor were there effects on children's mental development among children born to low-income unmarried teens.⁴²

There were, however, developmental benefits for children born to women who smoked a moderate to heavy amount (defined as 10 or more cigarettes per day) when they enrolled in the program during pregnancy. Fifty-five percent of women were smokers at enrollment, and 30% smoked a moderate to heavy amount. The children of women who were moderate to heavy smokers and who had received prenatal home visitation had significantly higher IQ scores at three and four years of age than their counterparts in the comparison group.⁴⁴

Figure 2



Source: Olds, D.L., Henderson, C.R. Jr., and Tatelbaum, R. Prevention of intellectual impairment in children of women who smoke cigarettes during pregnancy. *Pediatrics* (1994) 93:228-33; Olds, D.L., Henderson, C.R. Jr., and Tatelbaum, R. Intellectual impairment in children of women who smoke cigarettes during pregnancy. *Pediatrics* (1994) 93:221-27.

As shown in Figure 2, comparison group children born to women who smoked 10 or more cigarettes per day during pregnancy had mental development scores that declined during the first four years of life, in contrast with their counterparts in the comparison group whose mothers did not smoke during pregnancy.¹⁸ At three and four years of age, the average mental development scores of comparison group children born to women who smoked a moderate or heavy amount during pregnancy were about four points lower than those of children born to women who started pregnancy as moderate to heavy smokers but received nurse home visits during pregnancy, and five points lower than those of children born to women who did not smoke. In the nurse-visited group, children born to women who smoked 10 or more cigarettes per day at registration

during pregnancy had mental development scores in infancy, toddlerhood, and the preschool period that were the same as for those whose mothers did not smoke at all or smoked only a few cigarettes per day.⁴⁴ These beneficial effects of prenatal home visitation held for the group visited during pregnancy and infancy as well as the group visited only during pregnancy and were not explained by differences in measured aspects of the postnatal environment, such as qualities of the home environment or duration of maternal breast-feeding.⁴⁴

Maternal Life Course 15 Years After Delivery of First Child

At the 15-year follow-up, no differences were reported for the full sample for measures of maternal life course such as subsequent pregnancies or subsequent births, the number of months between the first and

second births, receipt of welfare, or months of employment.⁴⁰

Poor unmarried women, however, showed a number of enduring benefits. In contrast with their counterparts in the comparison group, those visited by nurses during both pregnancy and infancy averaged fewer subsequent pregnancies (1.5 versus 2.2, $p=.03$), fewer subsequent births (1.1 versus 1.6, $p=.02$), a longer time between the births of their first and second children (65 versus 37 months, $p=.001$), fewer months on welfare (60 versus 90 months, $p=.005$), fewer months receiving food stamps (46.7 versus 83.5, $p=.001$), fewer behavioral problems resulting from substance abuse (0.41 versus 0.73, $p=.03$), and fewer arrests (0.18 versus 0.58 arrests by self-report, $p<.001$; 0.16 versus 0.90 arrests according to New York State records, $p<.001$).⁴⁰

Antisocial Behavior Among the 15-Year-Olds

The follow-up study also assessed the children of the original participants when the children were 15 years of age.³¹ There were no differences between nurse-visited and comparison group adolescents for the whole sample, but there were differences among the children of poor unmarried women. In contrast with adolescents born to poor

use of drugs and alcohol (0.15 versus 0.34, $p=.08$).³¹ There were no program effects on other behavioral problems, such as teachers' reports of adolescents' acting out in school; suspensions; initiation of sexual intercourse; and parents' or children's reports of major acts of delinquency, minor antisocial acts, or other behavioral problems.³¹

Cost Analysis

The RAND Corporation has conducted an economic evaluation of the program that extrapolates the results of the 15-year follow-up study to estimate cost savings generated by the program.⁴⁵ While there were no net savings to government or society for serving families in which mothers were married and of higher social class, the savings to government and society for serving families in which the mothers were low income and unmarried at registration exceeded the cost of the program by a factor of four over the lifetimes of the children. Figure 3 illustrates this relationship and shows that the return on the investment was realized well before the children's fourth birthdays. The primary cost savings were found in reduced welfare and criminal-justice expenditures, and in increases in tax revenues.

Conclusion

In general, the beneficial effects of the program were greater for families at greater risk (for example, for low-income or unmarried women and for those who smoked during pregnancy). Moreover, the beneficial effects of the program on child abuse, neglect, and childhood injuries during the first two years of life were greater for mothers with little belief in their control over their life circumstances.

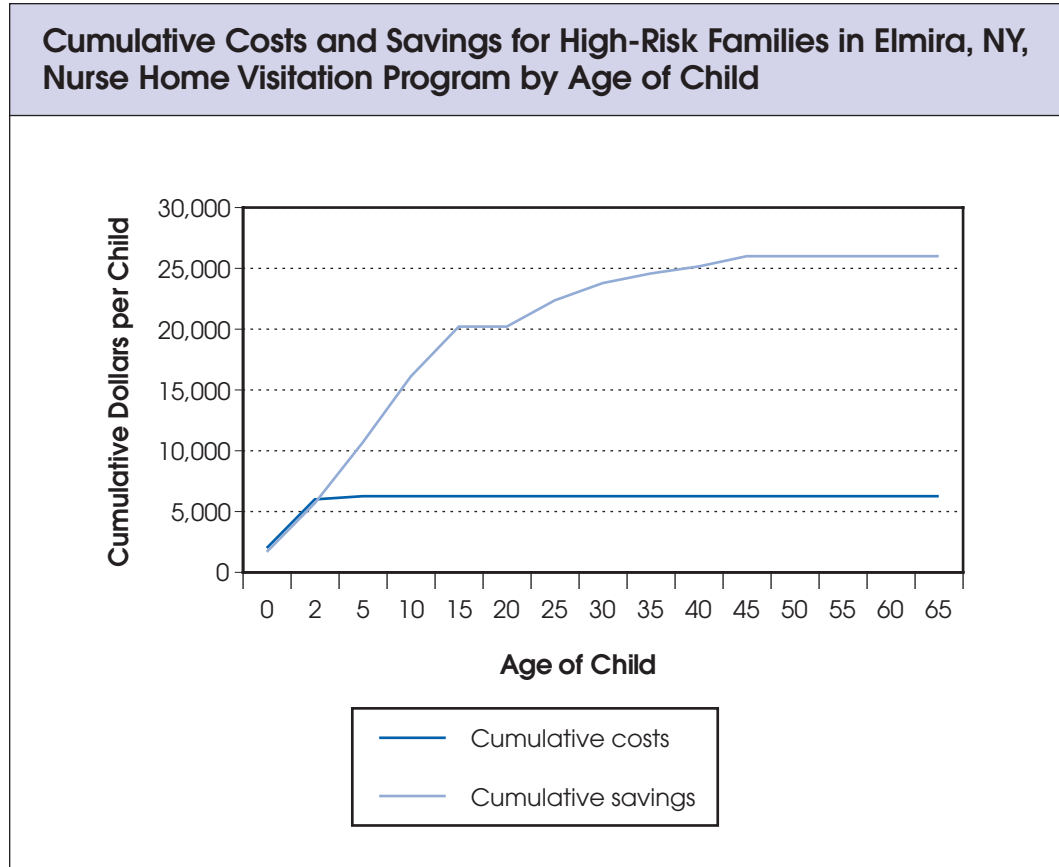
Memphis Design and Methods

The Memphis trial was designed to determine whether the encouraging results of the Elmira program could be replicated when the program was conducted through an existing health department and when it served low-income African-American women, children, and families living in a major urban area.⁴⁶ The study focused on those groups for which the effects in Elmira had been greatest, that is, low-income unmarried women (most of whom were teens) and gave greatest attention to those outcomes for which the benefits had been greatest (for example, childhood injuries and inges-

The savings to government and society for serving families in which the mothers were low income and unmarried at registration exceeded the cost of the program by a factor of four over the lives of the children.

unmarried women in the comparison group, those visited by nurses during pregnancy and infancy reported fewer instances of running away (0.24 versus 0.60, $p=.003$), fewer arrests (0.20 versus 0.45, $p=.03$), fewer convictions and violations of probation (0.09 versus 0.47, $p<.001$), fewer lifetime sex partners (0.92 versus 2.48, $p=.003$), fewer cigarettes smoked per day (1.50 versus 2.50, $p=.10$), and fewer days having consumed alcohol in the past six months (1.09 versus 2.49, $p=.03$). Parents of nurse-visited children reported that their children had fewer behavioral problems related to the

Figure 3



Source: Reprinted with permission from Karoly, L.A., Greenwood, P.W., Everingham, S.S., et al. *Investing in our children: What we know and don't know about the costs and benefits of early childhood interventions*. Santa Monica, CA: RAND Corporation, 1998.

tions, and rates of subsequent pregnancies). In addition, because results in Elmira showed a trend toward reducing hypertensive disorders of pregnancy, it was hypothesized that the program would reduce the rates of pregnancy-induced hypertension in Memphis, given the high rates of this problem among African-American pregnant women bearing first children.⁴⁷

Pretest and pilot work in Memphis revealed that the rate of state-verified cases of child abuse and neglect among low-income firstborn children in their first two years of life was too low (3% to 4%) to serve as a viable outcome measure in this setting. It was therefore hypothesized that the program would produce effects on children's health care encounters for injuries (a proxy for deficient care of the children), and that those effects would follow the pattern observed in Elmira. Women with few psychological resources (defined in Memphis as having high rates of mental health symptoms, limited intellectual functioning, and limited belief in their control over their

lives) were hypothesized to benefit the most from the program.⁴⁶

Memphis Sample

From June 1990 through August 1991, 1,290 women were invited to participate and 1,139 enrolled through the obstetrical clinic at the Regional Medical Center in Memphis. Women were recruited if they were less than 29 weeks of gestation, and if they had had no previous live births, no specific chronic illnesses thought to contribute to fetal growth retardation or preterm delivery, and at least two of the following risk conditions: (1) unmarried, (2) less than 12 years of education, and (3) unemployed. There were no differences between the sociodemographic characteristics of those who enrolled and those who declined, except that African Americans were more likely to participate than were whites. At registration, 92% of the 1,139 women registered were African American, 98% were unmarried, 65% were age 18 or younger, 85% came from households with incomes at or below the federal poverty guidelines, and

9% (7% of the African Americans) smoked cigarettes.

Memphis Treatment Conditions

After completion of informed consent and baseline interviews, women were randomly assigned to one of four groups. As described in Table 1, Groups 1 and 2 were control groups that received developmental screenings for their children and (in the case of Group 2) free transportation for prenatal care but no home visits. Group 3 received the transportation and screenings as well as home visits from nurses during pregnancy and twice after childbirth. Group 4 received transportation, screenings, and home visits that began

There were no program effects on birth outcomes such as average birth weight, percentage of newborns with low birth weight, length of gestation, spontaneous preterm delivery, indicated preterm delivery, or Apgar scores.

during pregnancy and continued until the children reached their second birthdays.⁴⁸ Only Groups 2 and 4 were followed for research assessments into the infancy phase of the study, in part because at the time that the Memphis study was planned, there was no indication from the Elmira study that prenatal visitation by itself produced any enduring effect on mothers or children.

The program was conducted through the Memphis/Shelby County Health Department. This trial was conducted during a nursing shortage, which led to fairly high rates of staff turnover (50% in the first two years of the program) because nurses left to take higher-paying jobs in local hospitals. Given that these kinds of factors are likely to buffet the program as it is administered in other community settings, the Memphis findings may provide a good estimate of what the program may be able to achieve if it is replicated on a large scale.

Memphis Outcome Assessments

As in Elmira, outcome assessments were conducted by individuals who did not know the treatment assignments of the participating women and children. Data were derived

from interviews, observations of mother-infant interactions, observations of conditions in the homes, and reviews of mothers' and children's medical and social service records from pregnancy through the children's second birthdays.

Memphis Analyses

In contrast with Elmira, the Memphis sample was almost exclusively unmarried and completely low income, and therefore no analyses were planned or conducted to examine the way those factors moderated the effects of the program in Memphis. Women did differ, however, in their initial levels of psychological resources. To test the pattern of results hypothesized based upon findings from Elmira, analyses were conducted to examine the role of maternal psychological resources in moderating program effects in Memphis.

Memphis Results

At randomization, the nurse-visited and comparison groups in the Memphis trial were essentially equivalent on all background characteristics examined.^{46,49} For those individuals for whom two-year assessments were conducted (90% of those randomized and 96% of those randomized for whom there was no fetal, infant, or maternal death), the groups remained equivalent in terms of background characteristics.

Pregnancy Outcomes

There were no program effects on women's use of standard prenatal care or obstetrical emergency services after registration in the study. However, contrary to expectations, nurse-visited women who were in school at the time of registration had twice as many predelivery hospitalizations as their counterparts in the comparison group (0.18 versus 0.09, $p=.003$). This difference was not explained by any coherent pattern of diagnoses associated with these hospitalizations.⁴⁶

In contrast with women in the comparison group, nurse-visited women had fewer yeast infections after randomization (0.14 versus 0.19, $p=.05$) and fewer instances of pregnancy-induced hypertension (13% versus 20%, $p=.009$). Among women with pregnancy-induced hypertension, those who received nurse home visitors had mean arterial blood pressures during labor that were

4.6 points lower ($p=.006$) than those in the comparison group, an indication of less severe cases.⁴⁶

By the 36th week of pregnancy, nurse-visited women were more likely to use other community services than were women in the control group (29% versus 20%, $p=.01$), and they were more likely to be working (6% versus 3%, $p=.06$).

Despite these differences, there were no program effects on birth outcomes such as average birth weight, percentage of newborns with low birth weight, length of gestation, spontaneous preterm delivery, indicated preterm delivery, or Apgar scores.

Dysfunctional Caregiving

During their first two years, nurse-visited children had fewer health care encounters in which injuries and ingestions were detected than did children in the comparison group (0.43 versus 0.56, $p=.05$), an effect that was accounted for primarily by a reduction in outpatient clinic encounters. Nurse-visited children also were hospitalized with injuries and/or ingestions for fewer days than were children in the comparison group (0.04 versus 0.18, $p<.001$). These benefits were concentrated among children born to mothers with few psychological resources. Examination of case records suggested that nurse-visited children tended to be older when hospitalized and to have less severe conditions. Many of the hospitalized comparison group children appeared to have experienced more seriously deficient care than children visited by nurses, a conclusion that was corroborated by several other differences between the nurse-visited and comparison groups.

Nurse-visited mothers, for example, reported that they attempted breast-feeding more frequently than did women in the comparison group (26% versus 16%, $p=.006$), although there were no differences in duration of breast-feeding. By the 24th month of their children's lives, in contrast to their comparison group counterparts, nurse-visited women held fewer beliefs about child rearing that are associated with child abuse and neglect ($p=.003$). Moreover, the homes of nurse-visited

women were rated as more conducive to children's development (32.3 versus 30.9 HOME Inventory points, $p=.003$).⁵⁰ Although there was no program effect on observed maternal teaching behavior, children born to nurse-visited mothers with low levels of psychological resources were observed to be more communicative and responsive toward their mothers than were their comparison group counterparts (17.9 versus 17.2, $p=.03$).⁴⁶

Child Health and Development

After two years in the program, children in the nurse-visited and comparison groups did not differ in their use of well-child care,

Children in the nurse-visited and comparison groups did not differ in their use of well-child care, immunization status, mental development, or reported behavioral problems.

immunization status, mental development, or reported behavioral problems, either for the full sample or for mothers with lower psychological resources.⁴⁶

Maternal Life Course

At the 24th month of their first children's lives, nurse-visited women reported fewer second pregnancies (36% versus 47%, $p=.006$) and fewer subsequent live births (22% versus 31%, $p=.01$) than did women in the comparison group. Nurse-visited women and their firstborn children relied upon welfare for slightly fewer months during the second year of the children's lives than did comparison group women and their children (7.8 months versus 8.4 months, $p=.07$), although there were no differences during the children's first year of life. There were no program effects on mothers' reported educational achievement or length of employment either for the whole sample or for those with few psychological resources.⁴⁶

Summary of Results, Policy Implications, and Program Replication

Many of the beneficial effects of the program found in the Elmira trial that were con-

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centrated in higher-risk groups were reproduced in the Memphis replication, and we are optimistic that the nurses in the Denver trial will produce similar results. Overall, as summarized in Box 1, the Elmira and Memphis trials demonstrated that the nurse home visitation program achieved two of its most important goals—a reduction in the dysfunctional care of children and an improvement in maternal life course. Its impact on the third goal—the improvement of pregnancy outcomes (in particular, the reduction of preterm delivery and low birth weight)—was equivocal.

Pregnancy Outcomes

In the Elmira trial, the program produced the anticipated reduction in cigarette smoking, improvement in diet, and increase in women's use of needed social services and informal social support. There was an increase in the birth weight of infants born to women who were very young (that is, less than 17 years of age at registration) and a

reduction in the rate of preterm delivery from 10% to 2% among women identified as smokers (those who smoked five or more cigarettes per day at registration). (See Appendix C in this journal issue.)

The program's impact on preterm delivery and the birth weight of babies born to young adolescents and women identified as smokers in Elmira was not replicated in Memphis, although the program increased women's use of other human services and decreased the rates of pregnancy-induced hypertension and yeast infections. The absence of a corresponding effect on the rate of preterm delivery among smokers in Memphis was probably a reflection of the very low rate of cigarette smoking among African Americans. While fully 55% of the Caucasian women in the Elmira trial smoked cigarettes during pregnancy and 30% smoked a moderate to heavy amount (10 or more cigarettes per day at registration), only 9% of the Memphis sample smoked, and only 2% smoked a moderate to heavy amount.

Dysfunctional Care of Children

The impact of the program on the rate of dysfunctional caregiving among higher-risk families found in Elmira was substantially replicated in Memphis, where the population served was at much higher risk overall. As has been noted, the beneficial effects of the program in Elmira on dysfunctional care during the children's first two years of life (reflected in rates of state-verified cases of child abuse and neglect and in emergency department encounters) were concentrated among women who were unmarried and from poor households, and were further concentrated among those who, at registration, had little belief in their control over their lives.

In Memphis (where 98% of the sample was unmarried and all were from poor families), corresponding effects were found for health care encounters in which injuries were detected, for observations of the home environments, and for parents' reports of caregiving and child-rearing beliefs. These beneficial effects in Memphis, while strong enough to emerge as program "main effects," were concentrated among women with lower levels of psychological resources at the time of registration. The effects were

also seen in children's behavior toward their mothers; children of nurse-visited mothers with few psychological resources were observed to be more responsive and communicative toward their mothers than were their counterparts in the comparison group. This was probably a reflection of the mothers' greater sensitivity and responsiveness toward their infants.⁵¹

Thus, in both Elmira and Memphis, many of the most important program effects concerning dysfunctional caregiving were concentrated among those women who had little belief in their control over their lives and few psychological resources. In interpreting this pattern of results, it is important to remember that the nurses visited women with fewer control beliefs and psychological resources substantially more frequently than the other participating women.³⁹ The greater effect of the program for these higher-risk families was thus likely due to (1) the higher rate of dysfunctional caregiving among low-resource parents when caregiving is initiated without help and (2) the greater attention given to these families by the nurses.

Maternal Life Course

The Elmira program produced important effects on a host of maternal life course outcomes from the births of the first children to those children's 15th birthdays. Among women who were unmarried and from low socioeconomic status households at registration, those who were visited by nurses during pregnancy and infancy had fewer subsequent children, fewer months on welfare, fewer behavioral impairments from the use of alcohol and drugs, fewer arrests and convictions, and fewer days jailed during the 15-year period after the births of their first children. It appears that the reduced rate of subsequent pregnancies positioned these mothers to eventually find work, become economically self-sufficient, and avoid substance abuse and criminal behavior.⁴⁰

In Memphis, the program reproduced that same key maternal life course outcome—a reduction in the rate of subsequent pregnancies—albeit at less dramatic levels (a 23% reduction in Memphis versus a 67% reduction for the same period in Elmira). Follow-up work under way in

Memphis will determine whether there were corresponding program effects on parental life course after the program ended at the children's second birthdays.

Child Development

Although the program did not produce important child development benefits for the whole sample, there was some indication in the Elmira trial that the program reduced the rate of neurodevelopmental impairment associated with cigarette smoking during pregnancy, as reflected in differences in the children's IQ scores at ages three and four.^{18,43} Given the simultaneous impact of the program on the rates of child abuse and neglect and compromised maternal life course (major risks for early-onset conduct disorder),⁴ it is not surprising that the 15-year-old children born to women who were unmarried and of low socioeconomic status

One of the clearest messages that has emerged from this program of research is that the functional and economic benefits of the nurse home visitation program are greatest for the families at greatest risk.

exhibited fewer arrests and convictions and lower rates of cigarette smoking, alcohol use, and promiscuous sexual activity. No differences in child development were observed in Memphis through the children's second birthdays, perhaps because part of the impact of the program on intellectual functioning in Elmira was explained by a reduction in prenatal cigarette smoking, and there was too little cigarette smoking in the Memphis sample to observe a corresponding beneficial effect.

Policy Implications

One of the clearest messages that has emerged from this program of research is that the functional and economic benefits of the nurse home visitation program are greatest for the families at greatest risk. In the Elmira study, it was evident that most married women and those from households with higher socioeconomic status managed the care of their children without serious problems and were able to avoid lives of welfare dependence, substance

abuse, and crime without the assistance of the nurse home visitors. Similarly, their children on average avoided encounters with the criminal-justice system, the use of cigarettes and alcohol, and promiscuous sexual activity. Low-income unmarried women and their children in the comparison group, on the other hand, were at much greater risk for these problems, and the program was able to avert many of these untoward outcomes for this at-risk population. Cost analyses suggested that the program's cost savings for government were solely attributable to benefits accruing to this higher-risk group. Among families at lower risk, the financial investment in the program was a loss.

This pattern of results challenges the position that these kinds of programs ought to be made available on a universal basis. Not only is the universal approach likely to

We do not believe this program can be replicated on a large scale in a short time without compromising its effectiveness.

be wasteful from an economic standpoint, but it may lead to a dilution of services for those families that need them the most, because of insufficient resources to serve everyone well.

During the past five years, new studies have been reported that have cast doubt upon the effectiveness of home visitation programs that do not adhere to the elements of the model studied in these trials, including especially the hiring of nurses and the use of carefully constructed program protocols designed to promote adaptive behavior.⁵² These results should give policymakers and practitioners pause as they consider investments in home visitation programs without careful consideration of program structure, content, and methods.

The trial begun in 1994 in Denver, Colorado, is directly relevant to this issue, because it compares program effects when the home visitors are nurses with effects when home visitors are paraprofessionals. Preliminary results suggest that nurses were able to complete about five more visits over

the course of the study than paraprofessionals, that turnover among paraprofessionals was higher than among nurses (17 paraprofessionals were hired over the course of the study, whereas there was no turnover among the 10 nurses), but that paraprofessionals spent about seven minutes longer on completed home visits than did nurses.⁵³ Additional analyses will examine program outcomes for parents and children and the effects of these variations in service patterns on those outcomes. Even if the results of the Denver trial show benefits for the paraprofessionals, those benefits must be understood in the context of the thoroughly developed visit-by-visit program protocols and excellent clinical supervision they were provided (two full-time licensed clinical social workers each supervised five paraprofessionals).

With the increased focus on brain development in the first three years of life,⁵⁴ there is increased pressure to fund programs for very young children. It would be a mistake to do so, however, without solid scientific evidence that the particular model promoted is able to achieve its intended effects.

Replication and Scale-Up of the Nurse Home Visitation Program

Even when communities choose to develop programs based on models with good scientific evidence, programs run the risk of being watered down in the process of being scaled up. Under a grant from the U.S. Department of Justice and the Administration for Children and Families (within the Department of Health and Human Services) an investigation is under way to examine the process of replicating this program in high-crime neighborhoods across the country. Programs are being established in Los Angeles, Fresno, and Oakland, California; Oklahoma City, Oklahoma; St. Louis, Missouri; and Clearwater, Florida, and research is exploring what is required to develop the program in new communities with fidelity to its essential elements.

In this program-replication phase (which has expanded to include the entire state of Oklahoma and will soon expand to include 15 to 20 additional sites beyond the Department of Justice initiative), state and local governments are securing financial support for the program (about \$7,000 per family for two and one-half years of services,

in 1998 dollars) out of existing sources of funds, such as Temporary Assistance to Needy Families, Medicaid, the Maternal and Child Health Services Block Grant, child abuse funds, and crime-prevention dollars. Sharing the costs among several government agencies reduces the strain on any one agency's budget.

We do not believe this program can be replicated on a large scale in a short time without compromising its effectiveness. We plan to move ahead with a larger number of communities after we have learned from this first group of sites how to develop the program successfully in a variety of new contexts.

The work reported here was made possible by support from many sources. These sources include (grant numbers) the Administration for Children and Families (90PD0215/01 and 90PJ0003), Biomedical Research Support (PHS S7RR05403-25), the Bureau of Community Health Services, Maternal and Child Health Research Grants Division (MCR-360403-07-0), Carnegie Corporation (B-5492), The Colorado Trust (93059), The Commonwealth Fund (10443), The David and Lucile Packard Foundation (95-1842), The Ford Foundation (840-0545, 845-0031, and 875-0559), Maternal and Child Health, Department of

Health and Human Services (MCJ-363378-01-0), the National Center for Nursing Research (NR01-01691-05), the National Institute of Mental Health (1-K05-MH01382-01 and 1-R01-MH49381-01A1), Pew Charitable Trusts (88-0211-000), the Robert Wood Johnson Foundation (179-34, 5263, 6729, and 9677), the U.S. Department of Justice (95-DD-BX-0181), and the W.T. Grant Foundation (80072380, 84072380, 86108086, and 88124688).

The authors thank John Shannon for his support of the program and data gathering through Comprehensive Interdisciplinary Developmental Services, Elmira, New York; Robert Chamberlin for his contributions to the early phases of this research; Jackie Roberts, Liz Chilson, Lyn Scazafabo, Georgie McGrady, and Diane Farr for their home visitation work with the Elmira families; Geraldine Smith for her supervision of the nurses in Memphis; Jann Belton and Carol Ballard for integrating the program into the Memphis/Shelby County Health Department; Kim Sidora and Jane Powers for their work on the Elmira and Memphis trials; Jon Korfmacher, Ruth O'Brien, JoAnn Robinson, Lisa Pettitt, Dennis Luckey, Peggy Hill, Pilar Baca, and Susan Hiatt for their work on the Denver trial; the many home visiting nurses in Elmira, Memphis, and Denver; and the participating families who have made this program of research possible.

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