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Projected Outcomes of Nurse-Family Partnership Home Visitation During 1996-2013, United States

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Abstract

Nurse-Family Partnership (NFP) targets intensive prenatal and postnatal home visitation by registered nurses to low-income first-time mothers. Through 2013, 177,517 pregnant women enrolled in NFP programs. This article projects how NFP will affect their lives and the lives of their babies. NFP has been evaluated in six randomized trials and several more limited analyses of operational programs. We systematically reviewed evaluation findings on 21 outcomes and calculated effects on 3 more. We added outcome data from the NFP national data system and personal communications that filled outcome data gaps on some trials. We assumed effectiveness in replication declined by 21.8%, proportionally with the decline in mean visits per family from trials to operational programs. By 2031, NFP program enrollments in 1996-2013 will prevent an estimated 500 infant deaths, 10,000 preterm births, 13,000 dangerous closely spaced second births, 4,700 abortions, 42,000 child maltreatment incidents, 36,000 intimate partner violence incidents, 90,000 violent crimes by youth, 594,000 property and public order crimes (e.g., vandalism, loitering) by youth, 36,000 youth arrests, and 41,000 person-years of youth substance abuse. They will reduce smoking during pregnancy, pregnancy complications, childhood injuries, and use of subsidized child care; improve language development, increase breast-feeding, and raise compliance with immunization schedules. They will eliminate the need for 4.8 million person-months of child Medicaid spending and reduce estimated spending on Medicaid, TANF, and food stamps by \$3.0 billion (present values in 2010 dollars). By comparison, NFP cost roughly \$1.6 billion. Thus, NFP appears to be a sound investment. It saves money while enriching the lives of participating low-income mothers and their offspring and benefiting society more broadly by reducing crime and safety net demand.

Keywords

birth outcomes; birth spacing; crime; Medicaid; systematic review

Nurse-Family Partnership (NFP) is a program of intensive prenatal and postnatal home visitation by registered nurses. It targets low-income mothers and their first children. Visits start prenatally and ideally continue through age 2; 25-30 home visits over 17 months is typical.

NFP's goals are to help parents improve: (1) prenatal health and pregnancy outcomes, (2) child health and development through more sensitive and competent care, and (3) parental life-course by developing and fulfilling a vision for their future, planning future pregnancies, completing educations, and finding work (Olds et al., 2002). Prenatally, NFP focuses on improving diet; reducing alcohol, tobacco, and other drug use during pregnancy; coordinating prenatal care; identifying pregnancy complications and treating them early; and helping expectant mothers plan their future (Kitzman et al., 1997). Postnatal priorities shift to assuring that the baby has a safe and healthy home; improving child physical care, emotional care, play skills, and communication skills that promote developmental gains; encouraging breast-feeding; maintaining maternal health behavior gains; reducing domestic violence (an issue given greater attention after the first randomized trial); and setting and achieving personal life-course goals.

Reviews of social service programs (e.g., Promising Practices Network <http://www.promisingpractices.net/program.asp?programid=16>, Lee et al., 2012; Miller & Levy, 2000) consistently conclude that strong evidence shows NFP works. Recruitment for the program's first randomized controlled trial began in Elmira NY in 1978 (Olds, Henderson, Tatelbaum, & Chamberlin, 1986). Program model developers conducted additional trials in Denver and Memphis (Kitzman et al., 1997; Olds et al., 2002). These trials tracked participants longitudinally. Independent trials in Orange County, California, Louisiana, and the Netherlands added supporting evidence on short-term effects (Mejdoubi et al., 2014; Nguyen, Carson, Parris, & Place, 2003; Sonnier, 2007). Less robust evaluations also are accumulating on NFP effectiveness in broad-based implementation (e.g., Rubin et al., 2011).

Lee et al. (2012) used meta-analytic techniques to assess eight outcomes across the three trials by NFP's developers. This article is broader. It provides a systematic review of findings on 21 outcomes including 10 with evidence from independent trials or operational programs. It adjusts all outcomes downward to account for imperfect fidelity in replication.

NFP began program replication in 1996. Unlike many operational programs, NFP replication is highly regimented and closely monitored (NFP National Service Office, 2011; Olds et al., 2013; Olds et al., 2002). Use of the NFP model and name is limited to implementing agencies that contract with the NSO, participate in centralized training and extensive reporting (including longitudinal data by client), pay fees to the NSO to administer the data system and monitor quality, and comply with 18 quality elements including standards governing maximum case loads of nurses and supervisors, time spent on NFP's six domains, and nurse qualifications. NSO trains all nurse administrators, nurse supervisors, and nurse home visitors. NSO regional staff talk with state program coordinators at least weekly. Model improvements are evaluated in rigorous pilot studies (e.g., Ingoldsby et al., 2013), then rolled out to all sites.

By December 2013, 177,517 pregnant women enrolled in operational NFP programs (NFP National Service Office, 2014). Online Table 1 describes the enrollees. Estimated costs were \$8,742 per family served (Karloly & Bigelow, 2005) and \$1.55 billion total (in 2010 dollars). This article aims to estimate how NFP will affect their lives and the lives of their babies, with future research planned on the associated return on investment.

Between Fiscal Years 2010 and 2014, the federal Maternal, Infant, and Early Childhood Home Visiting (MIECHV) Program provided \$1.5 billion in funding to expand evidence-based home visiting programs. NFP programs received perhaps one quarter of all MIECHV funding. Thus, estimates of NFP's outcomes can inform and bolster periodic reauthorization discussions.

Methods

To identify evaluations, we contacted NFP program model developers, replicators, and NSO staff, and searched the literature. We identified 39 evaluation reports on NFP spread over time and place. This included 23 reports on the 3 randomized trials by the program model's developers. We extracted effectiveness estimates for 21 outcomes and added evidence captured by the NFP NSO's mandatory reporting system on six of them. Randomized trials by the program model's developers provided all published evidence on eight of the outcomes. We computed impacts on three additional outcomes – preterm second births, subsidized child care, and Medicaid spending per child recipient from – documented impacts.

Table 1 summarizes the randomized trials and rates their quality. It shows enrollment by arm. Both Elmira and Memphis included arms that only received prenatal visits. Post-natal outcomes were not tracked in Memphis for this arm and the associated control group.

Louisiana trial data are less reliable than data from other trials because of heavy early dropout and loss to follow-up. Documentation is incomplete (simply a list of significant findings) and study staff refused to provide access to unpublished supporting tables. The Orange County trial's birth-outcome evaluation was conducted early, before some pregnancies reached term. Planned Orange County follow-up data were not collected at age 1 and county staff were unable to provide birth outcomes for mothers not included in the published report. We excluded a German trial because it did not use nurses as its home visitors. As in the paraprofessional visitor cohort of the Denver trial (Olds, et al., 2002), NFP delivery by German social workers and midwives had minimal effectiveness (Sandner, 2013a, 2013b).

This article looks across trials to decide which outcomes are assured and which are tentative. Some outcomes, however, only were measured in recent trials or time periods. For example, child psychological assessments first used in Memphis suggested NFP-associated improvements. That finding led to a more probing assessment in Denver which pinpointed the improvements. Such evolution prevents cross-trial comparison. As the last row in Table 1 shows, another source of non-equivalence is the variation in follow-up time between trials, notably in Elmira where follow-ups were spaced by 8-10 years.

The replication studies on operational programs use quasi-experimental designs. They compare outcomes for NFP mothers to outcomes for other mothers. Their quality is reduced by imperfect comparison group matching. Rubin et al. (2009, 2011) and Matone et al. (Matone, O'Reilly, Luan, Localio, & Rubin, 2012a, Matone, O'Reilly, Luan, Localio, & Rubin, 2012b), for example, used propensity scoring to select a comparison group but

lacked the information needed to exclude families who declined NFP services. Decliners probably were at higher risk than those who accepted service. Conversely, lack of data on risk factors used in targeting NFP service offers means the comparison group also may include families at lower risk than NFP families. Thus the direction of bias is unclear.

We estimated program effectiveness using mixed methods. For binary outcomes (e.g., was a birth preterm or was the child injured), we meta-analytically pooled estimates across the randomized trials, favoring estimates that were regression-adjusted to achieve sample balance. We used systematic review methods for continuous outcomes because some NFP effectiveness estimates came from studies that published mean effect differences but nothing precise about their variance. Also, only one or two effectiveness estimates existed for those outcomes so we lacked enough studies to develop cross-study estimates of effect using meta-analytic regressions.

To arrive at effectiveness estimates, we pooled data from randomized trials or computed a mean estimate across them. As described below, we made exceptions for infant mortality as the trials were not powered to detect changes, welfare spending (because eligibility rules changed after the Elmira trial), and immunizations (where replication data favored one trial over another).

Programs typically have lower effectiveness in replication than randomized trial (Lee et al., 2012). Our estimates arbitrarily assume effectiveness declines proportionally with the decline in visits per family from trials to operational programs. That suggests outcomes in replication will be 78.2% of trial outcomes. We used the Crystal Ball® add-in to Excel to run bootstrap simulations that estimated 95% confidence intervals (CIs) around our estimated savings based on our standard error estimates for percentage gains, 10% standard errors for the unit medical costs, and a triangular distribution matching interstate visit rate variation for the replication factor.

Our outcome estimates often include problem incidence absent intervention. Additional baseline levels used to compute NFP savings were: (1) percentage of unmarried pregnant women who report smoking during third trimester (20.6% nationally, from online analysis of 2010 National Survey on Drug Use and Health data), (2) national repeat teen birth rate (Ikramullah, Barry, Manlove, & Moore, 2011), (3) 22% of first-time low-income births involving pregnancy-induced hypertension (PIH) from New York City Medicaid data prior to NFP implementation (Senter, Pai, & Miller, 2010), consistent with the 18% rate in the pooled Memphis and Elmira control groups, (4) national neonatal mortality rate of 0.419% (Martin et al., 2011); a rate for low income infants in Illinois of 1.33 times the average (8.1/6.1) (University of Illinois at Chicago, 2010), (5) national child maltreatment rates for low income families, by year of age, and by type (e.g., physical abuse) (Sedlak et al., 2010), (6) 17.4% of children aged 0-2 annually treated for injury nationally (Corso, Finkelstein, Miller, Fiebelkorn, & Zaloshnja, 2006), (7) national youth arrest rates by year of age in 2009 (Snyder, 2011) with an estimated 5.3% of youth crimes resulting in arrest (Miller & Hendrie, 2015), (8) alcohol, tobacco, and marijuana usage patterns at ages 12-15 from online analysis of 2010 National Survey on Drug Use and Health data.

Results

Table 2 summarizes evidence-based outcomes, our best estimates of effectiveness, and projected cumulative outcomes by 2031 for NFP clients enrolled in 1996-2013. Tables 3 and 4 provide evidence supporting the estimates. Here we describe the rationale for our choices. All effects are statistically significant at the 95% confidence level or greater unless otherwise stated.

Reduced Smoking during Pregnancy

NFP mothers smoke 24.2% less tobacco during their pregnancy.

Rationale for Percentage Chosen—Cotinine is the gold-standard measure of tobacco use. Therefore, we chose the Denver trial's value (times 78.2% expected in replication) over the self-reported estimates. The PA study and NFP data system captured number of smokers rather than quantity smoked. Their information came from birth certificates or other self reports which are an unreliable source of data on smoking during pregnancy (Northam & Knapp, 2006).

Reduced Pregnancy-Induced Hypertension (PIH)

PIH declined by 31.3%.

Rationale—We multiplied a pooled 40% PIH reduction in Elmira and Memphis times the 78.2% replication factor.

Fewer Preterm First Births

NFP reduces preterm births (less than 37 weeks) by 14.7%.

Rationale—Because we want to estimate the impact of NFP in the US, we used the 18.8% pooled decrease across 5 US randomized trials times the 78.2% replication factor. We suspect this estimate is a conservative lower bound, both because prenatal visits per family have not declined from trials to replication and because the 30% reductions observed in three analyses of operational programs suggest that 14.7% may be low.

Fewer Infant Deaths

NFP participation reduces infant deaths by 45.4%.

Rationale—We chose the 58% (95% CI 44%-70%) mortality reduction from Cox's OK study over the Cincinnati rate because results were not commingled with another program. We conservatively defined it as mortality reduction before age 1 and chose it over the sustained 60.7% reduction in Memphis through age 9. Although the evidence came from operational programs, comparison group biases (see the online supplement) led us to reduce effectiveness with the 78.2% replication factor.

Improved Birth Spacing

NFP mothers have 31.2% fewer closely spaced second births within 24 months, thus reducing risks of costly complications. In years 3-12 post-partum, NFP neither raises nor lowers the birth rate.

Rationale—The pooled 39.9% estimate of reduction in close spacing from the 3 randomized trials is of highest quality. Applying the 78.2% replication factor yields a 31.3% reduction in closely spaced births in replication, close to the 27% decline for young mothers in PA and the 31% decline in New York City. Multiplying the percentage reduction times the U.S. 2008 repeat teen birth rate of 23.46% (Ikramullah et al., 2011) (a more conservative choice than the 28.0% rate among controls in the pooled trials) suggests NFP mothers choose to bear an average of .0735 fewer subsequent children than controls (or .094 before the replication adjustment, a number used in the online supplement).

Fewer Abortions within 48 Months of the First Birth

30.7% reduction in abortions through child age 3.

Rationale—We multiplied the 39.2 % reduction in pooled Elmira low income, Memphis and Denver data times the 78.2% replication factor.

Fewer Subsequent Preterm Births

NFP mothers have 0.035 fewer subsequent preterm births.

Computations—The online supplement describes the calculations. They account for the preterm birth rate for any subsequent birth and the rate elevation for closely spaced births.

Increased Breastfeeding Attempts

11.2% (7.6 percentage point) increase in mothers who tried breastfeeding.

Rationale—In pooled Elmira and Memphis data, breastfeeding rose 9.7 percentage points. Multiplying times 78.2% yields an estimated 7.6 percentage point increase (an 11.3% increase over the 2011 WIC-eligible breastfeeding level). This estimate should be conservative as it is lower than the observed 10.0-11.6 percentage point increase in operational programs.

Reduced Intimate Partner Violence (IPV)

16.1% reduction in IPV through child age 4.

Rationale—Violent victimization is subject to recall bias (Bushery, 1981). Therefore, we favored 6-month over 3 year recall in Denver. As the online supplement details, we adjusted recall beyond 6 months for recall bias and computed 6-month victimization rates from longer-term reports. Pooling US data from like time periods (including using the presumably understated 2% estimate from Memphis at ages 0-5 multiple times), average reductions were 31.7% prenatally, 19.5% at ages 0-2, and 26.9% at age 4. Reductions of 12.5% - 15.1% at ages 6 and 9 were not significant at even the 80% confidence level, so we assumed

reductions ended at age 4. From ages 0-4, IPV was reduced by 20.6%, which we multiplied times the 78.2% replication factor. We defined IPV rates per 6-month period absent NFP as the 13.7% post-natal probability and 18.1% prenatal probability in the pooled control groups from US trials.

Fewer Childhood Injuries

Through age 2, NFP babies have 32.6% fewer injuries treated in emergency departments (EDs) or admitted to hospital.

Rationale—Multiplying the pooled 41.6% reduction (95% CI 32.4%, 49.6%) across the Elmira, Louisiana, and Memphis trials times 78.2% suggests a 32.6% reduction in replication.

Fewer Child Maltreatments

NFP reduces child maltreatment by 31.0% at ages 4 through 15.

Rationale—We multiplied the 39.7% US reduction from Elmira (which is slightly lower than the Dutch reduction) times the 78.2% replication factor. Child maltreatment follows a severity distribution so we assume unconfirmed case counts will change as CPS-confirmed (substantiated or otherwise indicated) counts do. That assumption is conservative because NFP increases detection and captures evidence required for substantiation (Olds, Henderson Jr., Kitzman, & Cole, 1995), which should cause a larger decrease in unconfirmed than confirmed cases. Temporally, reductions are concentrated at ages 4-15 (Zielinski et al., 2009). Our analysis conservatively assumes any effect before that age is subsumed in the broader reduction in nonfatal injury through age 2.

Better Language Development

NFP reduces language delay by 39.1%, thus reducing the need for pre-school or school-based remedial services.

Rationale—Although the Elmira and Memphis trials demonstrated language development gains, Denver measured them more clearly. We multiplied the 50% reduction in Denver times the 78.2% replication factor.

Fewer Youth Criminal Offenses

NFP reduces youth arrests by 44.6% at ages 11 through 19, with reduced arrests of girls predominating and arrest probabilities equalizing by age 19.

Rationale—To date, this outcome only was reported in Elmira. We multiplied Elmira's 57% reduction times the 78.2% replication factor. We assumed reduction in crimes committed mirrored reduction in arrests.

Reduced Youth Substance Abuse

NFP reduces alcohol, tobacco, and marijuana use by 53.2% at age 12 until at least age 15.

Rationale—We multiplied the 68% average reduction in Elmira and Memphis times the 78.2% replication factor.

Increased Immunizations

NFP participation is associated with a 13.0% (9.1 percentage point) increase in probability that children covered by Medicaid will have complete immunizations at age 2.

Rationale—We multiplied the 11.6 percentage point reduction versus Elmira controls without transport assistance times the 78.2% replication factor. The Memphis trial estimate on this measure is contaminated because the trial reminded controls about and transported them to immunizations. Although 2 operational program comparisons found statistically significant 19 and 22 percentage point differences ($p > .95$), neither was based on a carefully matched sample.

Reduced TANF Payments

NFP reduces Temporary Assistance for Needy Families (TANF) payments by 5.6% for 12 years post-partum. These savings result from reduced subsequent births and altered earning patterns that reduce TANF eligibility and payments per eligible family.

Rationale—We multiplied the 7.2% average reduction for the TANF-specific Memphis and Denver evaluations times the 78.2% replication factor. Applying this percentage to current TANF participation data accounts for the downward shift in participation since 1996.

Reduced Food Stamp Payments

NFP reduces food stamp payments by 9.6% for at least 12 years post-partum. These savings result from reduced subsequent births and altered earning patterns that reduce food stamp eligibility and payments per eligible family.

Rationale—We multiplied the 12.3% average reduction across the 3 trials times the 78.2% replication factor.

Reduced Need for Medicaid Coverage

NFP reduces person-months on Medicaid by 7.6% for at least 15 years post-partum, with these savings expected to continue. The participation reductions have two causes. First, the reduced second birth rate resulting from NFP services and possibly differences in earning patterns increase Medicaid graduation of mothers and to a lesser extent, of first-born children (although fewer children would graduate today because the Child Health Insurance Program and Affordable Care Act raised many state income eligibility thresholds). Second, NFP mothers bear fewer children. The births avoided are closely spaced ones at high risk of costly complications. Associated Medicaid cost savings include both birth-related costs and costs of continuing Medicaid participation of these second babies.

Rationale—We multiplied the 9.8% average reduction across the 3 trials times the 78.2% replication factor.

Lower Costs if on Medicaid

NFP reduces the present value of Medicaid spending per child recipient by 8.5% from birth through age 18 (bootstrap-estimated 95% CI 4.5%, 12.5%). As documented above, NFP reduces smoking during pregnancy and related prematurity, pregnancy-associated preeclampsia, child injury in the first two years of life, medical and mental health spending on victims of child maltreatment, adherence to immunization schedules, and second births with complications. Those health status improvements should reduce Medicaid claims costs of mothers and first-born children.

Rationale—Data availability prevented direct evaluation of savings in the randomized trials. The online supplement models the savings. We divided the savings by the present value of annual Medicaid spending per child recipient from birth through age 18 exclusive of live birth costs, \$35,287 (Henry J Kaiser Family Foundation, n.d.).

Reduced Subsidized Child Care, Second Births

An estimated 4.85% of the second babies who would have been born within two years of the first birth would have used subsidized child care funded by the Child Care Development Block Grant.

Computation—4.85% of Medicaid and SCHIP children use subsidized child care nationwide (Office of Child Care, 2010). We multiplied that rate times the 7.35% reduction in subsequent births (derived above).

Other Outcomes

As the on-line supplement details, low birth weight, subsequent miscarriages, intimate partner violence after age 4, maternal criminal offenses, maternal depression, and grade retention declined in some trials but not in others or changed consistently but not enough to differ statistically from controls at the 90% confidence level.

Outcomes Achieved

The last column in Table 2 shows estimated problems that program enrollments in 1996-2013 prevented or are projected to prevent and 95% confidence intervals for those estimates. NFP enrollments through 2013 will prevent a projected 500 infant deaths, 10,000 preterm births, 4,700 abortions, 13,000 dangerous closely spaced second births, 42,000 child maltreatment incidents, 16,000 other child injuries, 36,000 intimate partner violence incidents, 90,000 violent crimes by youth, 594,000 property and public order crimes (e.g., vandalism, loitering) by youth, 36,000 youth arrests, and 41,000 person-years of youth substance abuse. It will cause 16,000 children to comply with immunization schedules.

Since NFP families earn more and space children better, they place fewer burdens on government safety net programs. NFP is expected to eliminate the need for 4.8 million person-months of child Medicaid coverage. In 2010 dollars, (converted to present value using a 3% discount rate), it will reduce estimated spending on TANF by \$250 million, on food stamps by \$540 million, and on Medicaid by \$2.2 billion. Safety net savings will total \$3.0 billion.

Discussion

NFP has broad-reaching effects on lives of mothers and children. Longitudinal NFP trials, therefore, can assess hundreds of outcomes. Statistically, a 95% confidence level means 95 of 100 significant differences are real and 5 are artifacts, random events that do not represent true differentials. Given that, this systematic review fills a critical need by identifying findings that are consistent across trials or are significant at the 99% confidence interval, meaning they should remain significant after statistical adjustment to account for the large number of outcomes tested.

Ethnic diversity of the trial populations is both a strength and a weakness. Reassuringly, trial findings replicate across cultures. Differential effectiveness, however, could represent cultural differences rather than lack of replicability. Olds et al. (1986) reported Elmira results for white mothers only while Orange County was restricted to teenaged Hispanic mothers. By design, these trials essentially become subgroup analyses. If outcomes vary by race/ethnicity, our practice of computing pooled cross-trial impacts giving each family equal weight may not yield a valid picture for the US as a whole. At the same time, stratifying by race would virtually exclude Asians and Native Americans and force reliance on subgroup analyses for blacks. Smaller samples in subgroup analyses tend to lack statistical power and have wide uncertainty.

Our analysis has additional limitations. Some outcomes only were evaluated in one trial. Even pooling across six trials, impacts on birth outcomes are clouded by modest statistical power. (Ongoing trials should elucidate these effects.) Recent changes in safety net program rules, smoking rate, and teen birth rate reduce our confidence that related trial outcomes are replicable. Impact estimates also are less certain for outcomes like child maltreatment and medically treated injuries where nurse presence can increase reporting or change treatment decisions. Estimated Medicaid savings largely are computed, not observed. Although effectiveness is likely to decline from trials to operational programs, the degree of decline is unclear so our adjustment unavoidably is somewhat arbitrary. Finally, our national estimates implicitly assume operational program and trial populations are similar. Indeed, the birth-proximal outcomes generally replicate or are exceeded in the trials not conducted by the developers, the national data system, and many of the methodologically weaker evaluations of program efficacy in operational programs.

NFP clearly achieved most of its goals. It enriched the lives of participating low-income mothers and their offspring. It will benefit society more broadly by reducing crime and safety net demand. The \$3.0 billion in expected TANF, food stamp, and Medicaid spending reductions (95% CI: \$2.0-\$4.1 billion) far exceed the program's \$1.6 billion cost.

Federal policy has embraced home visiting programs. Our findings affirm that home visiting using the NFP program model makes major differences in the lives of low income families. It reduces intimate partner violence, child maltreatment, and youth crime and substance abuse, increases independence, and saves both money and lives. Expanding MIECHV and other public funding for NFP thus seems a wise investment. Nevertheless, the high cost per family requires a substantial front-end investment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics and Quality of Randomized Nurse-Family Partnership Trials

Site	Denver 1994-1995	Elmira 1978-1980	Louisiana 1999-2000	Memphis 1990-1991	Netherlands ^b 2006-2009	Orange County ^c 2000
Enrollment	235	216 (70) ^a	241; 152 with >= 1 visit	458	237	104
Nurse-Visited, Prenatal	235	116 ^a	106; 69 with >= 1 visit	228	237	N/A
Nurse-Visited, Post-natal	255	184 (105) ^a	116; 88 with >= 1 visit	681	223	121
Comparison Group, Prenatal	255	184 ^a	116; 88 with >= 1 visit	515	223	N/A
Comparison Group, Post-natal	87%	62%	93%	97%	82%	100%
Unmarried	95%	61%	100%	85%	71% not working	100%
Low Income	15%	11%	53%	92%	7%	0%
Black	49%	0%	44%	0%	8%	100%
Hispanic or Creole	0%	0%	0%	0%	15%	0%
Asian	36%	89%	3% ^d	8%	54% ^e	0%
White Non-Hispanic	9	19 (23 underway)	1	12 (17 underway)	Birth	Birth
Archival Data Through Age	0, 1, 2, 4, 6, 9 years	0, 1, 2, 4, 15, 19, 23 years	0, 6-8 mos, 14- 16 mos	0, 1, 2, 6, 9, 12, 17 years	Intake, week 32 of pregnancy; 2, 6, 12, 24 months	0
Survey @ Ages	A	B at ages 0-4 due to exclusion of non-whites & inclusion of middle class in most estimates; A- thereafter due to small sample size excluding middle class	C- due to spotty documentation, heavy attrition and loss to follow-up	A	B+ since its eligibility criteria yielded a focus on a needier group than the US programs and birth data from midwives were incomplete	B- due to sparse outcomes, some pregnancies not at term when data were collected

^aIncludes 10 women who declined nurse-visitation and 11 who declined control group participation. Numbers in parentheses are counts of unmarried low-income mothers.

^bAll enrollees were under age 26.

^cAll enrollees were under age 20.

^dIncludes Asian and Native American, as well as white.

^eInsufficient information was available to classify 16%. White includes 5% Turks and Moroccans.

Table 2

Expected life status and financial outcomes when first-time low-income mothers receive Nurse-Family Partnership home visitation services and projected total outcome change due to 177,517 NFP enrollments in 1996-2013

Outcome	Change [95% CI]	Total [95% CI]
Smoking During Pregnancy	24% [5% CI: 2%, 47%] reduction in tobacco smoked	8,865 [558, 17,172]
Pregnancy Complications	31% [16%, 47%] reduction in pregnancy-induced hypertension	12,216 [6,211, 18,221]
Preterm First Births	15% [-2%, 32%] reduction in births below 37 weeks gestation (25 fewer preterm births per 1,000 families served)	3,732 [-545, 8,009]
Infant Deaths	45% [31%, 63%] reduction in risk of infant death (2.8 fewer deaths per 1,000 families served)	505 [323, 688]
Closely Spaced Second Births	31% [17%, 45%] reduction in births within 2 years postpartum (73 [40, 107] fewer children per 1,000 families served within 2 years & lifetime)	12,989 [7,069, 18,909]
Subsequent Abortions	31% [3%, 38%] reduction in therapeutic abortions through 4 years post-partum	4,724 [964, 8,484]
Subsequent Preterm Births	35 [19, 51] fewer subsequent preterm births per 1,000 families served	6,284 [3,437, 9,131]
Breastfeeding	11% [4%, 19%] increase in mothers who breastfeed	13,465 [4,250, 22,680]
Intimate Partner Violence	16% [8%, 24%] reduction through age 4	36,418 [18,694, 54,141]
Childhood Injuries	33% [22%, 43%] reduction in injuries treated in emergency departments, ages 0-2	15,732 [10,452, 21,012]
Child Maltreatment	31% [17%, 45%] reduction in child maltreatment, ages 4-15	42,450 [22,696, 62,204]
Language Development	39% [9%, 69%] reduction in language delay; 0.14 [.03, .25] fewer remedial services by age 6	28,180 [15,067, 41,294]
Youth Violent Crimes	45% [30%, 60%] reduction in crimes, ages 11-19	89,612 [59,354, 119,870]
Youth Property & Public Order Crimes	45% [30%, 60%] reduction in crimes, ages 11-19	593,611 [393,177, 794,045]
Youth Arrests	45% [30%, 60%] reduction in arrests, ages 11-19	36,103 [23,913, 48,293]
Youth Substance Abuse	53% [26%, 81%] reduction in alcohol, tobacco, & marijuana use, ages 12-15	41,296 [19,957, 62,635]
Immunizations	13% [-3%, 29%] increase in full immunization at age 2	16,154 [7,807, 24,501]
TANF Payments	6% [-2%, 13%] reduction through year 12 post-partum; no effect thereafter	\$247 M [-92 M, 586 M]
Food Stamp Payments	10% [3%, 16%] reduction through at least year 12 post-partum	\$540 M [165 M, 916 M]
Person-months of Medicaid Coverage Needed	8% [2%, 13%] reduction through year 18 post-partum due to reduced births and increased program graduation	4.8 M [3.5 M, 6.1 M]
Costs if on Medicaid	8.5% [4.5%, 12.5%] reduction through age 18	\$1,433 M [880 M, 1,986 M]
Total Medicaid Spending	Sum of monetized person-months of coverage needed plus costs if on Medicaid	\$2,226 M [1,445 M, 3,007 M]
Subsidized Child Care	Caseload reduced by 3.6 children [1.9, 5.2] per 1,000 families served	630 [343, 917]

M = millions. Costs are in 2010 dollars.

Table 3
Estimates by randomized trial and pooled estimates for 10 dichotomous NFP program outcomes

DOMAIN	Community, Details of Measure, First Author (Year)	Control Cases	Yes (% or mean)	Treatment Cases	Yes (% or mean)	Relative Risk Decline	95% CI
Pre-eclampsia							
	Elmira, whites only, Olds et al. (1986)	142	7.0%	166	4.0%	42.9%	[-48.7%, 78.0%]
	Memphis, Kitzman et al. (1997)	671	20.0%	455	13.0%	35.0%	[13.8%, 51.0%]
	<i>Pooled (p<.001)</i>	813	17.7%	621	10.6%	40.0%	[21.2%, 54.3%]
Preterm First Birth							
	Denver, Olds et al. (2002)	237	10.1%	222	10.4%	-2.3%	[-75.9%, 40.5%]
	Elmira, includes nonwhites, M. Knudtson, personal communication (2013)	160	7.5%	192	7.3%	2.8%	[-104.2%, 53.7%]
	Louisiana, Sonnier et al. (2007)	88	12.5%	151	6.0%	52.3%	[-10.5%, 79.4%]
	Memphis, Kitzman et al. (1997)	633	12.0%	426	10.3%	14.0%	[-22.1%, 39.4%]
	Orange County, Nguyen et al. (2003)	85	8.2%	69	4.3%	47.2%	[21.0%, 94.0%]
	<i>Best Estimate: 5 pooled US trials (p = .053)</i>	1203	10.8%	1,060	8.8%	18.8%	[-4.6%, 37.0%]
	Netherlands, Mejdoubi et al. (2013)	143	7.0%	186	8.6%	-23.0%	[-162.9%, 42.4%]
	All NFP 2005-07 vs US age-matched, NFP NSO (2014); National Center for Health Statistics (n.d.)		13.3%		9.3%	30.1%	
	Oklahoma single birth very preterm <30 weeks, NFP vs other first time, Carabin et al. (2005) ^a	8,598	0.7%	55,737	0.9%	27.1%	[4.7%, 44.3%]
	Central Ohio, Allen et al. (2010) vs undescribed local comparison group	-	-	>220	-	37-45%	-
Mortality							
	Memphis thru age 9, Olds et al. (2007) (p=.08)	489	2.04%	217	0.46%	77.5%	[-74.9%, 97.1%]
	Memphis thru age 20, preventable-cause deaths, Olds et al. (2014b) (p=.04)	489	1.84%	217	0%	100.0%	Cannot compute
	Denver infant, Olds et al. (2004b)	237	0.84%	222	0.45%	46.6%	[-484.6%, 95.1%]
	Oklahoma, before age 1, NFP vs other first time, Carabin et al. (2005) ^a	55,737	0.55%	8,598	0.29%	47.6%	[21.2%, 65.1%]
	Oklahoma, unmarried, before age 1, NFP vs other first time, Carabin et al. (2005) ^b	22,556	-	5,239	-	64%	[37%, 83%]
	Oklahoma, mix of endpoints, ages between 1 and 5, NFP vs other first time, Cox (2006) ^a	-	0.82%	12,474	0.34%	58.7%	[44%, 70%]
	Cincinnati, infant, NFP or a 2nd program vs other local, Donovan et al. (2007)	2,145	2.10%	715	0.70%	66.7%	[16.5%, 86.7%]
Breastfeeding Attempted							
	Elmira, attempt, whites only, Olds et al. (1983)	121	31.0%	68	36.0%	16.2%	[-23.1%, 75.8%]

DOMAIN	Community, Details of Measure, First Author (Year)	Control Cases	Yes (% or mean)	Treatment Cases	Yes (% or mean)	Relative Risk Decline	95% CI
	Memphis, at 6 months, Kitzman et al. (1997)	471	15.7%	211	26.1%	65.9%	[21.8%, 125.9%]
	<i>Pooled (p = .001)</i>	592	18.8%	279	28.5%	51.3%	[17.8%, 94.3%]
	Netherlands attempt, Mejdoubi et al. (2014)	109	78.0%	158	82.3%	5.5%	[-6.7%, 19.4%]
	Netherlands at 6 months, Mejdoubi et al. (2014)	108	5.6%	156	13.5%	142.3%	[1.1%, 480.4%]
	NYC, attempt vs first-time Medicaid, NYC Dept of Health & Mental Hygiene (2013)	-	86%	V	91%	5.8%	-
	NYC, exclusive at 2 months, NYC Dept of Health & Mental Hygiene (2013)	-	30%	-	40%	33.3%	-
	All NFP in 2009, attempt, NFP NSO (2014) vs all WIC-eligible, Johnson et al. (2012)	1,400,000	67.1%	13,490	79.1%	17.9%	-
	Child Injury at Ages 0-2						
	Elmira, 0-24 months, whites only, Olds et al. (1986)	121	40.0%	75	27.0%	32.5%	[-3.9%, 56.2%]
	Memphis, 0-24 months, unpublished 2006 reanalysis with improved statistical methods, D Olds, personal communication (2011)	467	56.0%	208	42.0%	39.1%	[27.8%, 48.7%]
	Louisiana, 0-15 months, Sonnier (2007)	116	69.0%	66	34.5%	50.0%	[28.8%, 64.9%]
	<i>Pooled (p < .001)</i>	704	64.0%	349	37.4%	41.6%	[32.4%, 49.6%]
	Pennsylvania, 0-24 months, ED-treated, Matone et al. (2012b)	16,704	36.4%	5,016	41.5%	-14.0%	[-9.7%, -18.5%]
	Child Maltreatment						
	Elmira, ages 4-15 years, Eckenrode et al., 2000	184	73%	116	44%	39.7%	[22.8%, 53.0%]
	Netherlands, 0-36 months, Mejdoubi et al. (2015)	164	18.9%	168	10.7%	43.3%	[2.8%, 67.0%]
	Second Birth Within 24 Months						
	Elmira low-income whites, Olds et al. (1988)	52	39.0%	25	10.8%	72.2%	[10.0%, 91.4%]
	Memphis, Kitzman et al. (1997)	467	31.0%	208	22.0%	29.0%	[5.2%, 46.9%]
	Denver, Olds et al. (2002)	223	19.0%	194	12.0%	36.8%	[-0.01%, 60.4%]
	<i>Pooled (p < .001)</i>	742	28.0%	427	16.8%	39.9%	[23.5%, 52.7%]
	Pennsylvania, 2000-2003, Rubin et al. (2010)	-	18.9%	-	19.3%	-9%	[-26%, 5%]
	Pennsylvania, 2004-2005, Rubin et al. (2010)	-	19.0%	-	16.8%	13%	[4%, 20%]
	Abortion Within 48 Months						
	Elmira low-income whites, Olds et al. (1988)	54	12.0%	28	10.0%	16.7%	[-213.6%, 77.9%]
	Memphis, Kitzman et al. (2000)	443	10.0%	203	5.0%	50.0%	[3.1%, 74.2%]
	Denver, Olds et al. (2004b)	220	5.2%	204	4.9%	5.7%	[-115.5%, 58.8%]
	<i>Pooled (p = .034)</i>	717	8.7%	435	5.3%	39.2%	[3.3%, 61.8%]
	Intimate Partner Violence Through Age 4						

DOMAIN	Community, Details of Measure, First Author (Year)	Control Cases	Yes (% or mean)	Treatment Cases	Yes (% or mean)	Relative Risk Decline	95% CI
a.	Denver, ages 0-6 mos, M. Knudtson, personal communication (2014)	220	12.7%	184	10.3%	18.9%	[-40.4%, 53.1%]
b.	Denver, ages 6-12 months, same source as a	219	9.6%	187	10.2%	-6.0%	[-91.0%, 41.2%]
c.	Denver, ages 15-21 monthss, same source as a	225	9.3%	202	8.9%	4.5%	[-74.0%, 47.6%]
d.	Denver, age 4, Olds et al. (2004b)	220	10.0%	204	4.9%	51.0%	[-0.1%, 76.2%]
e.	Denver pooled ages 0-4	884	10.4%	777	8.5%	18.4%	[-10.3%, 39.6%]
f.	Memphis, ages 0-5, Olds et al. (2004a), recall-adjusted 6 month	444	18.2%	197	17.8%	1.8%	[-21.1%, 20.4%]
g.	Louisiana, ages 0-1, Nagle (2002)	63	28.6%	56	19.6%	31.3%	[-32.8%, 64.4%]
	Best US estimate per 6 months, ages 0-4; pool e, f, g (p=.036)	1,391	13.7%	1,030	10.9%	20.6%	[1.1%, 36.1%]
	Netherlands, ages 1-2, Mejdoubi et al. (2013), recall-adjusted 6 month	223	37.7%	237	22.4%	40.5%	[22.8%, 54.1%]
	All NFP, intake vs 36 weeks, NFP NSO (2014)	83,313	2.9%	83,313	1.8%	37.9%	[33.9%, 41.8%]
Youth Arrests, Lifetime							
	Elmira, ages 11-19, Eckenrode et al. (2010)	140	0.86	91	0.37	57.0%	[20%, 77%]

Note: NS=Not significant - = Not reported

^aThe control group had higher income and marriage rates. The article lacked data needed to combine its regression adjusted estimates. Looking across 4 subgroups, it seemed unlikely that preterm births declined.

^bComparison group estimate regression-adjusted for equivalency.

Table 4

Evidence about six outcomes of NFP by study

Domain Community	Study	Comparison	NFP	% change	Notes
<i>Measure Smoking During Pregnancy</i>					
Elmira self-report, cigarettes/smoker	Olds et al. (1986)	11.3%	-16.0%	-27.4%	p<.01
Memphis, self-report, cigarettes/smoker	D. Luckey, personal communication (2012)	-	-	decline	NS
Denver, smoker cotinine level	Olds et al., 2002	-12.32	-259.00	-31.3%	p<.05
Netherlands, self-report, # cigarettes	Mehjdoubi et al. (2014)	61.7%	73.4%	-19.0%	p=.03 ?
Pennsylvania, operational start-up, birth certificate, # smokers	Matone et al. (2012a)	25.8%	28.4%	-10.1%	p=.11
Pennsylvania, mature operational program, birth certificate, # smokers	Matone et al. (2012a)	27.5%	35.4%	-28.7%	p<.01
All NFP, intake vs 36 weeks, # self-reported smokers	NFP National Services Office (NSO) (2014)	12.6%	10.6%	-15.9%	weak evidence
<i>Language Development</i>					
Elmira, language development, measured at age 3 & age 4, white low income teens	Olds, Henderson & Kitzman (1994)			11%, 20%	p<.01
Memphis, storytelling skills & receptive vocabulary, age 6	Olds et al. (2004a)			3%, 5%	p<.05
Denver, language delay at age 2 & age 4; confirmed by Memphis measures at age 6	Olds et al. (2002, 2004b, 2014b)			-50%	p<.05
<i>Youth Substance Abuse</i>					
Elmira, 6-month use alcohol, tobacco, & other drugs, ages 12-15	Olds et al. (1998), reanalyzed	-	-	-67%	p<.05
Elmira, 6-month use alcohol, age 19	Eckenrode et al. (2010)	31.8%	28.4%	-10.7%	p=.60
Elmira, 6-month use illicit drugs, age 19	Eckenrode et al. (2010)	51.9%	48.7%	-6.2%	p=.57
Memphis, 30-day use ATOD, age 12	Kitzman et al. (2010)	5.1%	1.7%	-69%	p=.04
<i>Full Immunization</i>					
Elmira, complete at age 2, whites only	Olds et al. (1983)	66.8%	78.4%	17.4%	p=.14
Memphis, age 2, control received reminder & transport	Kitzman et al. (1997)	68%	70%	2.9%	p=.60
NYC, age 2, NFP vs all births	NYC Dept of Health & Mental Hygiene (2013)	77%	94%	22.1%	-
Nationally, age 2, NFP nurse-assessed vs Medicaid HMO client HMO-assessed	NFP NSO (2014), National Committee for Quality Assurance (2011)	70%	92%	31.4%	-
<i>TANF Payments Per Year</i>					
Elmira, ages 0-15	Glazner et al. (2004)	4,358	2,866	-34.2%	p=.05
Memphis, ages 0-12	Olds et al. (2010)	2,782	2,467	-11.3%	p=.14 ^a
Denver, ages 0-4	Glazner et al. (2004)	3,304	3,204	-3.0%	p=.64
FOOD STAMPS					
Elmira, ages 0-15	Glazner et al. (2004)	2,119	1,476	-30.3%	p=.03

<i>Domain</i>	<i>Community</i>	<i>Study</i>	<i>Comparison</i>	<i>NFP</i>	<i>% change</i>	<i>Notes</i>
Memphis, ages 0-12		Olds et al. (2010)	3,222	2,870	-10.9%	p<.01
Denver, ages 0-4		Glazner et al. (2004)	2,684	2,383	-11.2%	p=.22
<i>Months per Year Income-Eligible for Medicaid</i>						
Elmira, ages 0-15		Olds et al. (1997)	4.67	4.10	-13.0%	p=.16
Memphis, ages 0-12		Olds et al. (2010)	8.39	8.08	-3.7%	p=.22 ^b
Denver, ages 0-6		D. Luckey, personal communication (2012)	4.15	3.91	-5.8%	p=.48

Note: NS=Not significant - = Not reported

^aMonths on TANF differ at p=.05

^bMedicaid HMO payments differ at p<.01