Variation in Home Visiting over the First Three Years of Life: Links to Family Characteristics, Aspects of Home Visits, and Child Outcomes

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Research Aims

The question of uptake and continued participation in a home visiting program is examined in the Infant Health and Development Program (IHDP), a randomized multisite study of 985 low birth weight infants and their families. Home visiting and center-based education were provided to the treatment group during the first three years of life. Although variation in home visits did occur, 98% of the families received at least some home visits. At each home visit, a log recorded the duration of the visit and the nature of the caregiver-home visitor relationship. Using data over the first three years of life, the following three questions are examined.

1) What are the different patterns of home visits? Uptake patterns of home visiting frequency are examined over the entire duration of the program.
2) Which child, maternal, and family demographic characteristics and qualities of the home visit are associated with these home visitation patterns? Ten predictors are examined.
3) Since the IHDP is an early childhood educational intervention, whether higher frequency patterns of home visits are associated with greater positive treatment effects for children's cognitive and behavioral outcomes and mothers depression, social support, knowledge of child development and home environment is examined.

Literature Review

Home visiting programs represent a method of service delivery and not a theoretical approach, and programs can differ dramatically. Home visiting programs vary in the age of the child, the risk status of the family, the range of services offered, the intensity of the home visits, and the content of the curriculum used by the program. Programs also vary by who provides the

services (nurses or paraprofessionals), how effectively the program is implemented, and the range of outcomes examined. What home visiting programs share in common is the belief that services delivered in the home will have a generally positive impact on families and that altering parenting practices can have measurable and long-term benefits for children's development.

One important question facing home visiting programs is not whether they work, but under what conditions (Gomby, Colross, & Behrman, 1999; Gomby, 2005; Raikes, Green, Atwater, Kisker, Constantine, & Chazan-Cohen, 2006; Sweet & Appelbaum, 2004). Family participation is vital to successful outcomes. Gomby's (2005) report of home visitation provides an excellent synopsis of family participation. As much as 40% of families invited to enroll in home visiting programs choose not to enroll. Once enrolled, 20 to 80% of families leave programs before the end of the program, with overall attrition rates averaging about 50%. Families who stay receive about half of the scheduled visits, and they often do not do their assigned homework. With such sobering participation rates, and in the absence of knowing the reason for a family's departure, it is imperative to better understand which families participate and which do not. However, research has not been successful in identifying these families (Gomby, 2005; Sweet & Appelbaum, 2004). The general sentiment is that families who drop out earlier are the ones who need the services most (Daro, McCurdy, Falconnier, Winje, Anisfeld, Katzev et al., 2007; Gomby, et al., 1999; Gomby, 2005; Raikes et al., 2006; Wagner, Spiker, & Linn, 2002; Wagner, Spiker, Linn, Gerlach-Downie, & Hernandez, 2003) and who would potentially benefit most from the receipt of services (Gomby, 2005; Olds, Eckenrode, Henderson, Kitzman, Powers, Cole et al., 1997; Zercher & Spiker, 2004).

Few studies have examined predictors of a family's participation in a home visiting program. One recent analysis of Early Head Start examined three aspects of family participation:

quantity (number of home visits, duration in months in the program), quality (engagement of mother during visit), and whether the child was the focus of the home visit (Raikes et al., 2006). Quantity, quality, and whether the visit was child-focused were found to be distinct aspects of home visiting. Ethnicity and teenage parenthood were associated with quantity of home visits. White parents had more home visits, and white parents with a disabled child were in the program for a longer duration. Because the number of home visits was based on parental report, these findings may be somewhat reflective of differences in record keeping. Teenage mothers had shorter visits. Mothers with greater verbal ability and Hispanic mothers were rated as being more engaged during the visit. Finally, Black mothers and single mothers were less likely to have a child-focus visit.

Similarly, Parents as Teachers (PAT) home visiting program found that those who persisted in the home visiting program were older, richer, and more educated (Wagner et al., 2003). However, unlike EHS, PAT found that white mothers showed more engagement during the home visits. Findings from a few other home visiting programs reveal somewhat different findings. In Healthy Families America (HFA), a national child abuse prevention program which uses home visitation, older participants, unemployed participants, and Black families remained in the program longer and had more home visits (Daro, McCurdy, Falconnier, Stojanovic, 2003). A more recent analysis of HFA data, however, revealed that Black families had less home visits, while families with LBW infants had a more positive relationship with the home visitor, and families who lived in more distressed neighborhoods had more visits (Daro et al., 2007). In Hawaii's Healthy Start Program of home visiting, families receiving the most home visits were those who had fathers that were extremely high risk of substance abuse (Duggan, Windham, McFarlane, Fuddy, Rohde, Buchbinder, & Sia, 2000).

Differences in initial status variables (sex, birth weight, health) and family demographic characteristics (e.g., maternal ethnicity, education, family income) were not associated with participation in one study based on IHDP data (Ramey, Bryant, Wasik, Sparling, Fendt, & LaVange, 1992), although another IHDP study found that better infant neonatal health was associated with greater number of home visits (Klebanov & Brooks-Gunn, 2008). A third IHDP study which examined quality of participation found that families who were more active during the home visit were more advantaged: their children were heavier in birth weight, mothers were more likely to be white, older, more highly educated and of higher cognitive ability, and less likely to live below the poverty line (Liaw, Meisels, & Brooks-Gunn, 1995).

In addition, although greater number of home visits are expected to be associated with better outcomes (Olds & Kitzman, 1993; Sweet and Appelbaum, 2004), the extent to which the number and frequency of home visits is associated with such outcomes has only recently been examined. A re-analysis of data from the Comprehensive Child Development Program (CCDP; St. Pierre, Layzer, Goodson, & Bernstein, 1997), a home-based program focusing on parenting and case management, revealed that sites where the average number of home visits per family fell below the median (11 sites) failed to find treatment effects on child outcomes, however, sites where the average number of home visits was above the median (11 other sites) showed positive effects on children's cognitive outcomes from age 3 to 5 (Brooks-Gunn, Burchinal, & Lopez, 2002) .

A recent meta-analysis of home visiting programs for at-risk families by Nievar,VanEgeren, and Pollard (2010) report that two visits per month are associated with a "small, substantive effect" on maternal outcomes; with more intensive programs that have 3 or more visits per month exerting a medium effect, "being more than twice as effective as less

intensive programs (page 499).” The studies chosen for inclusion in their meta-analysis were conducted after 1980 and did not include handicapped or low birth weight or medically at-risk infants. The maternal outcomes examined were primarily those that could be observed such as maternal stimulation, sensitivity and parenting behavior. One shortcoming was that for some studies it was not clear whether the number of home visits per month were based on the scheduled visits or the actual visits. However, these findings represent some of the strongest evidence that home visiting can improve child outcomes if services are sufficiently intensive.

In sum, relatively few studies have systematically examined quantity, quality, and focus of home visits. The studies that have do not always find similar results. The differences in the type of home visitation model involved, the population served, and the goals of the program may account for some of the discrepancy in findings. No studies have examined changes in the frequency of home visiting over the life of a home visiting program. Using data from the IHDP, the present study examines: 1) the differences in the patterns of visits over time, 2) whether child, maternal, and family variables were associated with these differences, and 3) whether greater number of home visits or higher dosage of treatment was associated with positive treatment effects. Because of the dearth of research examining patterns of home visits, our expectations are not firm as to the number or type of patterns we may find. However, the expectation is that 3 or 4 patterns may emerge: low, medium, and high, with one pattern showing some time variation in the direction of decreasing participation over time. While the literature suggests that the families who need services most are often the ones who either drop out of the program or receive fewer visits, we hypothesize that these families should be the ones most likely to participate. Moreover, greater number of home visits is expected to be associated with greater positive treatment effects. These three issues were examined using data from the IHDP

which had a clearly-specified home visitation model serving low birth weight, premature infants and their families. The details of this model are presented below.

Method of Study

These analyses are based on data collected by the Infant Health and Development Program from 1985 to 1988. The educational intervention was the responsibility of the Frank Porter Graham Child Development Center (CDC) at the University of North Carolina at Chapel Hill. The eight medical sites were selected for study based on several criteria: premature birth rate, research and clinical experience, and capability to undertake the educational component. The eight sites were: Arkansas (Little Rock), Einstein (Bronx), Harvard (Boston), Miami, Pennsylvania (Philadelphia), Texas (Dallas), Washington (Seattle), and Yale (New Haven). More detailed information on the eligibility and the randomization procedures can be found in Infant Health & Development (1990) and Gross, Spiker, and Haynes (1997).

Enrollment criteria. Of the total of 4551 infants who would reach 40 weeks post-conceptual age between January 1985 and October 1985, with birth weights less than or equal to 2500 g, 3249 were excluded prior to randomization based on the following criteria: gestational age > 37 weeks, hospital discharge outside of the designated recruitment period, the presence of an illness or neurological deficit that would preclude participation in the intervention program, residence outside of the catchment area. Before being discharged from the hospital, consent was obtained for random assignment to either the Intervention or Follow-up group. Of the 1302 eligible infants, 274 (21%) would not provide consent to be randomized and 43 later withdrew prior to participation. This resulted in 985 infants (377 intervention and 608 follow-up) upon whom the primary analyses have been conducted (IHDP, 1990).

Randomization. Shortly after hospital discharge in 1985, eligible infants at the eight medical institutions were stratified by study site and birth weight ($\leq$2000 g or 2001 to 2500 g). An adaptive randomization method was used that monitored for a 2:1 balance between the two birth weight groups. Because the lighter born group at infants were considered to be at higher developmental and health risks relative to the heavier birth weight group, one-third of the sample came from the heavier born group; two-thirds came from the lighter birth weight group. To minimize the overall cost of the study, one-third of the infants within each weight group were randomly assigned to the intervention (INT) group; two-thirds to the Follow-up group (FUO). Balance was also monitored for: gender, maternal education, maternal race (Black, Hispanic, and White), primary language in the home, and infant participation in another study.

Program. The program began once the infant was discharged from the hospital and continued until corrected age three years. All infants received a pediatric follow-up of medical, developmental, and social assessments and were referred for other services as needed. Pediatric care services were provided through clinic visits at 40 weeks from conception, and at 4, 8, 12, 18, 24, 30, and 36 months. In addition, the INT infants received home visits, childcare at a center-based child development center (CDC), and families could attend parent-group meetings.

Weekly home visits began during the first year with bi-weekly visits during the second and third years. The purpose of the visits was to provide the family with health and child developmental information and family support. Two types of curricula were implemented. The first, *Partners for Learning* (Sparling & Lewis, 1984; Sparling, Lewis, & Neuwirth, 1988) taught the parent age appropriate games and activities they could use with their child. This curriculum focused on the levels of the child's cognitive, linguistic, and social development. The second curriculum, *Problem Solving for Parents* (Wasik, 1984) provided a systematic approach to helping parents deal with life problems.

The CDC's provided the INT children with an enriched, extra-familial, educational experience beginning at 1 year (corrected age) and continuing until the last child at the site reached 3 years of age (corrected age). The children were scheduled to attend the center at least 4 hours daily, 5 days per week. The mean number of hours attended per day was 5; the mean number of days attended in each year was 130 to 135. For most children, transportation was provided by the program.

Study sample. Data on the number of home visits at each assessment period and on initial status characteristics were obtained for all 377 INT families. The initial status characteristics of the INT were comparable to those in the FUO (IHDP, 1990). Babies in the INT group weighed 1,819 grams at birth (SD=439), had a neonatal health index of 100.7 (SD=16; 100 being average), were 49.9% male, 53% Black, 10% Hispanic, and 37% White, and 43% of their mothers had less than a high school education, 28% were high school graduates, and 29% had post-high school education. On average, 67 home visits were made to each child during the three years of the intervention (Ramey et al., 1992). This is roughly two thirds of the scheduled visits. Efforts were made for families to receive nearly uniform home-visiting services because the sites maintained the same home-visiting schedule.

Measures

Home visit report. After the end of each home visit, the home visitor completed information as to the length and the general tone of each visit (rapport between the caregiver and home visitor). Home visiting records are available at 4, 8, 12, 18, 24, 30, and 36 months. Because the time periods were based on 4 month intervals for the first year and 6 month intervals thereafter, we computed and based our analyses upon the number of visits per month. In addition, indications of the quality of the home visit were measured at 4, 8, and 12 months. The proportion of trusting visits was measured by the number of home visits that were rated as

trusting divided by the total number of visits. In addition, the average time (in minutes) of each home visit and the average number of times the family was contacted to schedule each visit were measured.

Clinical site. The eight clinical sites were controlled for as site clusters in all analyses.

Child characteristics. These variables were obtained prior to randomization into the intervention: birth weight (in grams for descriptive purposes; mean standardized and expressed in kilograms for data analytic purposes), sex, neonatal health index (calculated based on length of stay in the newborn nursery, adjusted for birth weight, the scores were standardized to a mean of 100 and a standard deviation of 16, with higher values indicating better health [Scott, Bauer, Kramer, & Tyson, 1997]). Children having an illness visit, ER visit, or hospitalization at randomization were considered to have had a medical visit.

Family characteristics. Mothers who were 19 years or younger at the time of the child's birth were considered teenage mothers. Residential moves were any move over the first three years.

Maternal Characteristics. Mothers reported their ethnicity as Black, Hispanic, or White.

Maternal knowledge of child development was measured at three years by the Concepts of Development Questionnaire (CODQ, Sameroff & Feil, 1985). The CODQ measures the level of complexity which the parent interprets the developmental behavior of the child. A total score, based on 20 items, was used. Higher scores indicate greater levels of thought complexity.

Maternal depressive symptoms at three years were assessed using the General Health Questionnaire (GHQ). The GHQ consisted of 12 items that tapped depression and anxiety dimensions (Goldberg, 1972). Respondents provided reports as to how they have been feeling over the past few weeks (e.g., in terms of concentration, happiness, making decisions,

experiencing strain, facing up to problems). Responses ranged from better than usual (0) to much less than usual (3), with scores ranging from 0 to 36.

Mothers' social support network was measured at three years by six vignettes asking mothers to report Yes or No on sources of monetary, emotional, and child-care support inside and outside of the household (Cohen & Lazarus, 1977). An overall score was obtained by considering whether support was present both inside and outside of the household and summing across the vignettes (range = 0 to 12). Higher scores indicate greater social support.

Coping was measured at three years by the *Health and Daily Living Form* Revised Version (Moos, Cronkite, Billings, & Finney, 1986), administered at three years, is a 32-item self-report scale, developed for use with clinical populations and adolescents. Coping responses are classified into active cognitive coping, active behavioral coping, and avoidance coping. Respondents rate a recent stressful event as to frequency with which they use each coping response, from 0 (No) to 3 (Yes, Fairly often).

Home environment. The preschool version (ages 3-6) of the *Home Observation for Measurement of the Environment* (HOME; Caldwell & Bradley, 1984) was administered when the child was three years of age (corrected for prematurity). The total scores and two subscales are used here: provision of learning stimulation, a 32 item composite of the learning, academic, and language stimulation and variety in experience subscales (e.g., child has toys which teach color, size, shape, child is encouraged to learn the alphabet and numbers) and warmth (7 items, e.g., parent caresses, kisses child during visit).

Child outcomes. Cognitive functioning is measured using the *Stanford-Binet Intelligence Scale Form L-M*, 3rd edition (Terman & Merrill 1973) at three years (corrected for prematurity).

Children's receptive vocabulary (hearing, as opposed to speaking) was measured at three years using *The Peabody Picture Vocabulary Test-Revised* (PPVT-R; Dunn & Dunn, 1981).

Behavioral functioning is measured by the *Child Behavior Checklist for Ages 2-3* (CBCL/2-3; Achenbach, Edelbrock, & Howell 1987). The CBCL/2-3 is a 99-item questionnaire that measures behavioral competence. Mothers rate the degree to which statements about their child are not true (0) to very true or often true (2) within the past two months. The overall behavior problem score and the internalizing and externalizing subscales are used, with higher scores indicating more behavior problems.

Data Analysis

Ward's method of cluster analysis was used to identify patterns of home visits over the first three years. Multinomial logistic regression was then used to determine which family characteristics were associated with membership in the different clusters. Finally, since the pattern of home visits were not randomly assigned, rather than doing traditional impact analyses, propensity score matching was used to examine treatment and control differences. Based on the home visiting patterns observed in the treatment group, a propensity score matching technique was used to identify families in the control group who, based on a list of child and family demographic characteristics used in the match, would have fallen into one of the four patterns if they had been in the treatment group. Propensity score matching was used for home visiting data over the first three years. These techniques control for the selection bias inherent in making comparisons between families with high-participation rates and the entire control group. This process creates an appropriate matched control group for any given high-participation treatment group in that, on average, the groups being compared should look quite similar in terms of a large number of selected pre-treatment variables.

Propensity score matching has been used as an approach to causal inferences in studies of child care and early childhood intervention (Shonkoff & Phillips, 2000). Extensions of this analytic technique have been used successfully with Infant Health and Development Program (IHDP) data on children's attendance at child development centers to estimate dosage effects (Hill, Waldfogel, & Brooks-Gunn, 2002). Given the impressive findings based on children's attendance at child development centers, this study examined whether such treatment and control differences would be found based on family participation in home visits.

Results

Patterns of home visits over the first three years. Ward's method of cluster analysis groups families into clusters so that the minimum variances within clusters are optimized (Ward, 1963). Based on this procedure and criterion, four patterns of home visits were identified over the first three years (using records from birth to 4 months, 4 to 8 months, 8 to 12 months, 12 to 18 months, 18 to 24 months, 24 to 30 months, and 30 to 36 months; expressed in number of visits per month): low (n=34 or 9%; 2.1 visits, 0.6 visits, 0.08 visits, 0 visits, 0.03 visits, 0.1 visits, 0.03 visits), medium decreasing (n=23 or 6%; 3.2, 2.5, 2.8, 1.0, 0.2, 0, 0.2 visits), medium stable (n=199 or 53%; 3.0, 2.7, 2.6, 1.7, 1.5, 1.5, 1.5 visits), and high (n=121 or 32%;4.1 visits, 3.1 visits, 3.4, 1.9, 1.7, 1.7, 1.7 visits).[i] Figure 1 presents the four clusters.

Table 1 presents descriptive demographic information for the four clusters based on home visitation over all three years. Study site, residential moves, average proportion of trusting home visits, average time spent on home visit, and average number of contacts made to schedule visits were all significantly associated with patterns of home visits. Families in the low visitation group were less likely to have trusting visits, less time spent per visit, and fewer attempts were made to

contact them, compared to all other groups. Neonatal health was marginally associated with patterns of home visits ($p < .06$).

Predictors of home visitation patterns. Multinomial logistic regression examined associations between home visiting patterns and four sets of predictor variables entered simultaneously:[ii] 1) maternal demographic variables (Black or Hispanic ethnicity, teenage parenthood), 2) child demographic variables (mean standardized birth weight and neonatal health, gender, whether the child had any illness visit, ER visit, or hospitalization at randomization or 1 year[iii], 3) whether there was a residential move by the family over the first three years, and 4) qualities of the home visit averaged over 4, 8, and 12 months (mean standardized proportion of visits where the relationship with the home visitor was trusting, average time of the visit [in minutes], and average number of contacts made to schedule home visits). All analyses controlled for site clusters.[iv] Also, the low group did not contain any cases of twins or cases of mothers reporting any chronic health problems (e.g., gestational diabetes, diabetes, asthma, obesity, hypertensive disease or heart disease). Thus, twin status and maternal health problems, despite being highly important determinants of home visitation, could not be included in our multinomial logistic regression models. Since there were four patterns of home visits, the multinomial logistic regression was run for three patterns of home visits with the fourth pattern omitted as the reference group.

Comparisons with the high home visiting group. Table 2 presents the odds ratios for each of the predictors in the multinomial logistic regression model that included the low, medium decreasing, and medium stable groups, with the high group omitted as the reference group. For example, in column 1, an odds ratio presents the ratio of the odds of being in the low group relative to the odds of being in the high group, controlling for all the other variables in the model. An odds

ratio of 1 means that there is equal likelihood of being in the low or high group. An odds ratio of less than 1 means that the odds of being in the low group is less than the odds of being in the high group. An odds ratio greater than 1 means that the odds of being in the low group is greater than the odds of being in the high group. As shown in Table 2, column 1, the odds ratios were significant for child medical visits and average time for home visit. Thus, children who had a medical visit were 13 times less likely to be in the low group than the high group; families who had longer home visits were 20 times less likely to be in the low home visit group than the high home visit group.

As shown in column 2 of Table 2, the odds of being in the medium decreasing group relative to the odds of being in the high visit group were significant for neonatal health and average proportion of trusting visits. Infants with better neonatal health were somewhat less likely to be in the medium decreasing group than the high group; families with more trusting visits were 1.6 times less likely to be in the medium decreasing group than the high group.

As shown in column 3 of Table 2, boys and families with a greater number of contacts to schedule a home visit were almost two times more likely to be in the medium stable group than the high group. However, children with better neonatal health, higher birth weight, and greater than the average time spent per visit were less likely to be in the medium stable group than the high group.

Comparisons with the medium stable home visiting group. As shown in column 1 of Table 3, infants with better neonatal health were somewhat more likely to be in the low group compared to the medium stable group, however, children who had a medical visit were 10 times less likely to be in the low group compared to the medium stable group. In addition, families with a greater proportion of trusting home visits were 1.5 times more likely to be in the low group compared to the medium stable group, while families with more time spent per home visit were 9 times less likely to be in the low group compared to the medium stable group.

Comparisons with the medium decreasing home visiting group. As shown in column 2 of Table 3, Hispanic families were almost six times more likely to be in the medium decreasing group than the medium stable group and families with more time spent per home visit were over two times more likely to be in the medium decreasing group than the medium stable group. However, boys were about a third less likely to be in the medium decreasing group compared to the medium stable group.

In column 3, Hispanic families and children with medical visits were 37 and 7 times, respectively, more likely to be in the medium decreasing group than the low group. However, children with better neonatal health and boys were less likely to be in the medium decreasing group compared to the low group. In addition, families with more time per home visit were 22 times more likely to be in the medium decreasing group than the low group, while families with a greater proportion of trusting visits were half as likely to be in the medium decreasing group than the low group.

Summary of findings. Time spent on home visits emerged as an important predictor variable, significant for 5 of the 6 comparisons between home visiting groups. In addition, neonatal health was significant for 4 of the 6 comparisons; child medical visits, child sex, and the proportion of trusting home visits all were significant for 3 of the 6 comparisons. Child medical visits, having more time on home visits, better neonatal health, and greater proportion of trusting visits were generally associated with a greater likelihood of being in a high frequency home visitation group. Boys were less likely to be in the medium decreasing group than the medium stable or low group. Hispanic ethnicity was significant for 2 of the 6 comparisons, while birth weight was significant for only one of the comparisons. Hispanics were more likely to be in the medium decreasing group than the medium stable or low groups. Black ethnicity, teenage motherhood, and residential moves

all were not associated with frequency of three year home visits (nonsignificant results for all six comparisons).

Ancillary analyses. To further highlight the differences between the four home visiting groups, the predicted probability that different values of a predictor would belong to each of the four home visitation groups was computed, controlling for all other predictors in the model. Table 4 presents the predicted probabilities of ethnicity, child sex, and child medical visit by the four home visiting groups. The predicted probabilities for continuous variables such as birth weight, neonatal health, proportion of trusting visits, time spent per home visit, and number of contacts to schedule visits by the four home visiting groups are presented in Figures 2 to 6.

As shown in Table 4, relative to Blacks and Whites, Hispanics were less likely to be in the low and medium stable groups, but were more likely to be in the medium decreasing and high groups. The predicted probabilities for Blacks and Whites were very similar across the four home visiting groups. Boys were much more likely to be in the medium stable group but less likely to be in the medium decreasing group. Children in the low group were about three times less likely to have some medical visits rather than none; children in the high group were more likely to have some medical visits than none. Children in the medium decreasing and medium stable groups had comparable probabilities as to whether they had a medical visit.

The results for birth weight (Figure 2) confirm that as birth weight increases, the probability of being in the medium stable group decreases while the probability of being in the high group increases. The probabilities of being in the low and medium decreasing groups remain about the same regardless of birth weight. As shown in Figure 3, a similar pattern of results was found for neonatal health. As neonatal health improves the probability of being in the medium decreasing group decreases, but the probability of being in the high group increases.

Figure 4 shows that as the proportion of trusting visits increases, the probability of being in the medium stable group and the medium decreasing groups decrease, while the probability of being in the high group increases.

Figure 5 shows that as the time spent per visit increases, the probability of being in the low group decreases greatly, while the probability of being in the high group increases. The probability of being in the medium stable group first increases, peaking around 37 minutes, then decreases.

Figure 6 shows that the probabilities for the low and medium decreasing groups remain stable regardless of the number of times they were contacted; however the probability of being in the medium stable group increases as the number of contacts increase, while the probability of being in the high group decreases as the number of contacts increase.

Treatment dosage effects. Following guidelines used by other researchers, the variables used in the propensity score match were those associated with our child and maternal outcomes of interest, but not associated with exposure/assignment to treatment (Brookhart, Schneeweiss, Rothman, Glynn, Avorn, & Sturmer, 2006). These variables are: minority status, whether the mother was a teenager when the infant was born, maternal education, marital status, and maternal health problems at birth, mode of delivery, twin status, neonatal health, birth weight, gender, number of other children in the household at birth, child medical visits, and residential moves. Because of sample size limitations for our home visitation groups, matches were made across, rather than within site. [v]

Based on these baseline variables used in the match, we evaluated the quality of the matches by using diagnostic statistics that indicate the balance across the treatment groups. Balance across groups is summarized by *t* statistics of the difference in means across each of the 4 treatment groups for these variables. The larger the t statistic, the more noncomparable the groups and the more

biased the treatment effect estimate. *t* statistics that exceed an absolute value of 1.0 are often noted. Table 5 displays the number of *t* statistics that exceed 1.0 for the three year home visitation groups, based on the 21 baseline variables examined (13 background characteristics plus 8 site variables). The ITT comparison in the first column shows the balance found with randomization. There were 9 *t* statistics whose absolute values exceeded 1.0 (of which 4 were greater than 1.5). For example, for the no-match comparison of the low dosage group, 10 *t* statistics exceeded 1.0. (of which 6 *ts* exceeded 1.5 and of which 4 exceeded 1.95). In comparison, values based on the match yielded 0 values greater than 1.95. Generally, across all home visiting treatment groups, the balance across groups was improved by matching.

There were no significant treatment effects at three years for the two lowest visitation groups (results available from the authors upon request). However, treatment effects were found for both the medium stable and high groups. Table 6 presents the regression adjusted treatment effect estimates and standard errors for the medium stable group. ITT treatment effect estimates and standard errors are included as benchmarks for all analyses. For the medium stable group, significant treatment effects were found for the overall home environment, learning environment, and IQ and PPVT scores. Matched estimates resulted in larger treatment effects than unmatched estimates for all outcomes (except externalizing behavior problems). The results for the high group (Table 7) reveal significant treatment effects for only three year IQ and PPVT scores. Matched estimates for IQ and PPVT were generally better than ITT effects, but not better than unmatched effects.

To summarize, significant positive treatment effects were found primarily for children's outcomes at three years. A greater number of significant treatment effects were found for the

medium stable group than for the high group. This finding may be attributed, in part, to the greater cell size for the medium stable home visiting group (n=199) compared to the high group (n=121).

Because the medium stable and high groups converged on the number of home visits as time progressed, ancillary analyses were conducted that combined the two groups to re-examine whether a higher home visitation group would be associated with more significant treatment effects. Table 8 shows that combining the medium stable and high groups resulted in significant treatment effects for IQ and PPVT scores, as well as for home learning environment and externalizing behavior problems at three years. Although the treatment estimates for the combined medium stable and high group are somewhat smaller than the estimates for the medium stable group alone, the treatment effect for externalizing behavior was now significant.

Summary and Conclusion

For the first three years of home visiting, cluster analysis produced four different patterns of home visitation: low, medium decreasing, medium stable, and high. Contrary to the statistics about family participation presented in Gomby (2005), families in the IHDP generally maintained a high level of participation. The majority of families were in the medium stable or high visitation group (53% and 32%, respectively), with only a small minority of the sample in the low visitation and medium decreasing groups (9% and 6%, respectively),

Although the underlying sentiment in the research literature is that more advantaged families are the ones more served or involved in home visitation (See Raikes et al., 2006, for review of literature), some studies have found that more disadvantaged or at-risk families had more home visits (Daro et al., 2003, 2007; Duggan et al., 2000). Our results indicate that the low visitation group is a unique group of families who are not in urgent need of services. Mothers in this group did not have any chronic health conditions, nor were there any twins in this group.

Children in the low group were less likely to have medical visits themselves compared to children in all other groups and to be in better neonatal health than the medium decreasing and medium stable groups. Aspects of the home visit were also important. Although the low group was more likely to have trusting home visits than the medium decreasing and medium stable groups, they generally had less time spent per home visit than all other groups.

The medium decreasing group was more likely to be Hispanic and to have families with daughters (than the medium stable or low groups). This group was also characterized as having a moderate need for home visiting services. Children in the medium decreasing group were more likely have poorer neonatal health (compared to low and high groups) and were more likely to have had a medical visit (than the low group). Moreover, aspects of the home visit were also important. The medium decreasing group was less likely to have trusting home visits (compared to the low and high groups), although there was more time spent per home visit (than the low or medium stable groups).

The medium stable group, similar to the medium decreasing group, also had a moderate need for home visiting services and mixed results for the quality of home visits. Children in the medium stable group were more likely to have poorer neonatal health (compared to low and high groups), lower birth weight (than high group) and were more likely to have a medical visit (than low group). The medium stable group was less likely to have trusting home visits (compared to the low group), but more time spent per home visit (compared to the low group) and more contacts made to schedule visits (compared to the high group).

The high group had better neonatal health (than the medium decreasing and medium stable groups), and higher birth weight (compared to the medium stable group). However, the high group was more likely to have child medical visits than the low group. Aspects of the home

visit were again important. Families in the high group had more time spent per visit (compared to children in the low and medium stable groups), more trusting home visits (than the medium decreasing group), and fewer contacts to schedule visits (compared to the medium stable group).

Three demographic predictors, Black ethnicity, teenage parenthood, and residential moves, were not associated with differences in the patterns of home visits. The results for Blacks and teenage parenthood are not surprising since these factors "seem to be either unrelated or inconsistently related to family retention in home visiting programs" (Raikes et al., 2006, p. 5). However, the result for residential moves is somewhat unexpected since moves were significantly associated with patterns of home visitation in descriptive analyses that presented unadjusted percentages (Table 1). Families in the low home visit group were much more likely to move over the three year period than families in the high home visit group.

Propensity score analyses reveal that matches improved the balance across the treatment groups and resulted in larger treatment effects for most outcomes. In addition, our analyses revealed an interesting dosage effect for home visits. No treatment effects were found for any of the maternal or child outcomes for the low and medium decreasing groups, whereas significant treatment effects were found for many outcomes for the medium stable and high dosage groups. In fact, the treatment effects were stronger and were significant for more outcomes for the medium stable group than for the high group. Combining the medium stable and high groups resulted in somewhat attenuated treatment effects compared to those based on the medium group alone, but with stronger treatment effects than for the high group alone.

Limitations and Directions for Future Research

The IHDP is a sample of premature, LBW infants and their families. The needs of LBW infants are greater, especially in the first few years of life, than for normal birth weight infants.

These differences may affect the magnitude of the results, with stronger results more likely for those based on an LBW sample. Thus, the generalization of our findings to the overall population may be limited and replication with a normal birth weight sample is recommended. In addition, the IHDP program was conducted over 20 years ago. The extent to which this poses a threat to external validity is not known, but should be noted.

The IHDP sample contained few families in the low home visitation group (34 families or 9% of the sample) and medium decreasing home visitation groups (23 or 6%). Having so few families restricted the number of predictors that could be included in our data analytic models.

Although the groups created are based on an objective measure of the number of home visits, a broader measure that encompasses the amount of time and the quality of visits is desirable. Moreover, the extent to which selection bias is reduced by propensity score matching depends on the richness and quality of variables available for the match. Finally, the present analyses examined the effect of home visitation dosage upon outcomes at three year of age. Future research should explore the long-term effects of such dosage effects.

Implications and Recommendations

The goal of home visitation was accomplished in the IHDP. The low home visitation group, who was not in need of services, represented a small minority of the sample. What distinguished the majority of families in the higher frequency groups from the low group was family need and quality of home visits. Compared to all other groups, families in the low group were less likely to have had child medical visits and were more likely to have a child with better neonatal health. Families in the low group also were more likely to have trusting home visits, but a lower than average time spent on each home visit.

Home visiting programs should target the families who are most in need of services. Families who are not in need of services are less likely to participate and to benefit; families with greater need are more likely to participate and to reap the most benefit. Continued family participation is also fundamental. For the low visitation group, the decline in the average number of home visits per month was evident within the first year and for the medium decreasing group visits continued to level off over the next two years (Figure 1). Residential moves by the family did not contribute to a family's non-participation. Moreover, repeated contacts by the home visitor to schedule home visits were not necessary for the high group or effective for the low and medium decreasing groups in getting families to participate.

However, for the majority of families (85% of the sample in the medium stable and high groups), the level of participation was maintained throughout the three years. Establishing and maintaining trust between the caregiver and the home visitor was crucial to a family's participation. Continued family participation is vital to successful outcomes. Maintaining a schedule of two home visits a month is conducive to achieving positive effects upon the home environment and children's cognitive and verbal test scores.

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Table 1. Home Visiting Clusters Over the First Three Years by Predictor Variables

Predictor Variable	Number in Each Home Visiting Cluster (N=377)				
	Low	MediumDecreasing	Medium Stable	High	Significance
	n=34	n=23	n=199	n=121	
Arkansas Site	13.6	11.6	14.7	8.7	*
Einstein Site	13.1	13.2	2.9	13.0	
Harvard Site	10.1	14.9	8.8	17.4	
Miami Site	7.5	19.8	8.8	8.7	
Penn Site	15.1	6.6	11.8	26.1	
Texas Site	17.1	6.6	17.6	4.3	
Washington Site	10.6	15.7	26.5	8.7	
Yale Site	13.1	11.6	8.8	13.0	
Blacks	47.1	52.2	57.8	47.9	
Hispanics	5.9	21.7	8.5	10.7	
Whites	47.0	26.1	33.7	41.4	
Teenage Mother	23.5	26.1	22.6	24.0	
Neonatal Health	102.5	95.0	99.5	103.2	
Birth Weight (g)	1938.8	1824.6	1770.8	1864.7	
Boys	52.9	30.4	54.3	45.5	
Residential Moves	89.5	78.9	67.7	56.2	**
Any Child Medical Visit	9.1	40.0	34.9	29.1	
Proportion Trusting Visits	0.3	0.8	0.8	0.9	***1<2,3,4
Time per Visit (mins)	20.3	48.5	46.8	49.0	***1< 2,3,4
Contacts to Schedule Visit	1.9	5.4	5.8	4.3	***1< 2,3,4

Table 2. Odds Ratios of Membership in Different Patterns of Home Visitation Over the First Three Years

Predictor Variables	Low	Medium Decreasing	Medium Stable
Hispanic	0.08	3.11	0.55
Black	0.69	1.41	0.88
Teenage Motherhood	1.30	0.70	0.75
Neonatal Health	1.04	0.96*	0.98**
Birth Weight (kg)	2.37	0.78	0.61*
Child is Male	1.52	0.50	1.73*
Child Medical Visits	0.08**	0.54	0.81
Residential Moves	3.23	1.45	1.46
Proportion Trusting Visits	1.30	0.61*	0.84
Time per Visit (mins)	0.05***	1.16	0.49***
Contacts to Schedule Visit	0.96	1.32	1.75**

Note: Comparison group is High Home Visitation Group.

*p < .05 **p< .01 ***p< .001

Table 3. Odds Ratios of Membership in Different Patterns of Home Visitation Over the First Three Years

Predictor Variables	Low	Medium Decreasing	Med Decreasing
Hispanic	0.15	5.63*	37.38**
Black	0.79	1.61	2.04
Teenage Motherhood	1.73	0.93	0.54
Neonatal Health	1.06*	0.99	0.93*
Birth Weight (kg)	3.90	1.28	0.33
Child is Male	0.88	0.29**	0.33*
Child Medical Visits	0.10*	0.67	6.96*
Residential Moves	2.21	0.99	0.45
Proportion Trusting Visits	1.54*	0.72	0.47*
Time per Visit (mins)	0.11***	2.36*	21.95***
Contacts to Schedule Visit	0.55	0.76	1.38

Note: Comparison group in first 2 columns is Medium Stable; Comparison group in column 3 is Low.

*p < .05 **p< .01 ***p< .001

Table 4. Predicted Probabilities (in Percent) of Home Visiting Patterns over the First Three Years

	Predicted Probabilities of Home Visiting Pattern			
	Low	Medium Decreasing	Medium Stable	High
Mother's Ethnicity				
White	7.7	4.2	57.0	31.1
Hispanic	3.4	15.3	42.9	38.3
Black	6.9	6.2	54.0	32.9
Child's Sex				
Female	6.7	9.1	47.5	36.8
Male	6.9	3.6	60.6	28.9
Child's Medical Visits				
None	10.1	7.7	53.2	29.0
Some	3.4	5.2	55.6	35.8

Note: Predicted Probabilities are calculated under the multinomial logistic regression model, holding the values of all the other covariates constant.

Table 5. Balance *t* Statistics for All Comparisons on 21 Baseline Variables

	ITT	First Three Years Home Visitation Groups							
		Low		Medium Decreasing		Medium Stable		High	
		no match	match	no match	match	no match	match	no match	match
Number of *ts*> 1.0	9	10	0	6	3	8	0	9	1
Number of *ts*> 1.5	4	6	0	2	2	5	0	6	0
Number of*ts*> 1.95	1	4	0	1	0	3	0	5	0

Table 6. Results for Outcomes for Three Year Medium Stable Group Compared with ITT Estimates

Year and Outcome	No Match		Medium Stable		ITT	
	Treatment Effect	SE	Treatment Effect	SE	Treatment Effect	SE
Three Year						
Home Total	1.69*	(0.801)	3.38**	(1.091)	1.52**	(0.664)
Home Warmth	0.09	(0.148)	0.13	(0.207)	0.00	(0.124)
Home Learning	1.55**	(0.526)	2.65***	(0.734)	1.35***	(0.436)
Knowledge of Child Development	0.01	(0.025)	0.06	(0.033)	0.01	(0.021)
Depression	-0.58	(0.429)	-0.32	(0.590)	-0.78*	(0.361)
Social Support	0.13	(0.233)	0.09	(0.332)	0.08	(0.193)
Cognitive Coping	0.51	(0.468)	0.36	(0.669)	0.34	(0.391)
Behavioral Coping	-0.12	(0.538)	0.21	(0.745)	-0.05	(0.461)
Avoidance	0.17	(0.347)	-0.06	(0.474)	0.24	(0.293)
IQ	6.35***	(1.687)	10.63***	(2.133)	8.65***	(1.418)
PPVT	5.35**	(1.670)	9.00***	(2.072)	6.35***	(1.395)
Behavior Problems	-3.38	(1.887)	-2.20	(2.584)	-3.10*	(1.559)
Internalizing	-0.97	(0.550)	-0.61	(0.757)	-0.75	(0.460)
Externalizing	-2.20*	(1.090)	-1.59	(1.461)	-2.07*	(0.893)

*p < .05 **p< .01 ***p< .001

Table 7. Results for Outcomes for Three Year High Group Compared with ITT Estimates

Year and Outcome	No Match		High		ITT	
	Treatment Effect	SE	Treatment Effect	SE	Treatment Effect	SE
Three Year						
Home Total	1.31	(0.961)	1.12	(1.388)	1.52**	(0.664)
Home Warmth	-0.08	(0.146)	-0.09	(0.254)	0.00	(0.124)
Home Learning	1.14	(0.635)	1.09	(0.933)	1.35**	(0.436)
Knowledge of Child Development	0.01	(0.029)	-0.01	(0.045)	0.01	(0.021)
Depression	-1.32**	(0.513)	-0.99	(0.763)	-0.78*	(0.361)
Social Support	-0.03	(0.265)	0.10	(0.379)	0.08	(0.193)
Cognitive Coping	0.02	(0.552)	0.78	(0.840)	0.34	(0.391)
Behavioral Coping	-0.18	(0.674)	-0.30	(1.078)	-0.05	(0.461)
Avoidance	0.30	(0.414)	-0.02	(0.591)	0.24	(0.293)
IQ	12.92***	(2.000)	11.81***	(2.870)	8.65***	(1.418)
PPVT	8.42***	(2.038)	8.05**	(2.795)	6.35***	(1.395)
Behavior Problems	-3.27	(2.203)	-2.41	(2.997)	-3.10*	(1.559)
Internalizing	-0.70	(0.667)	-0.19	(0.921)	-0.75	(0.460)
Externalizing	-2.07	(1.255)	-2.00	(1.738)	-2.07*	(0.893)

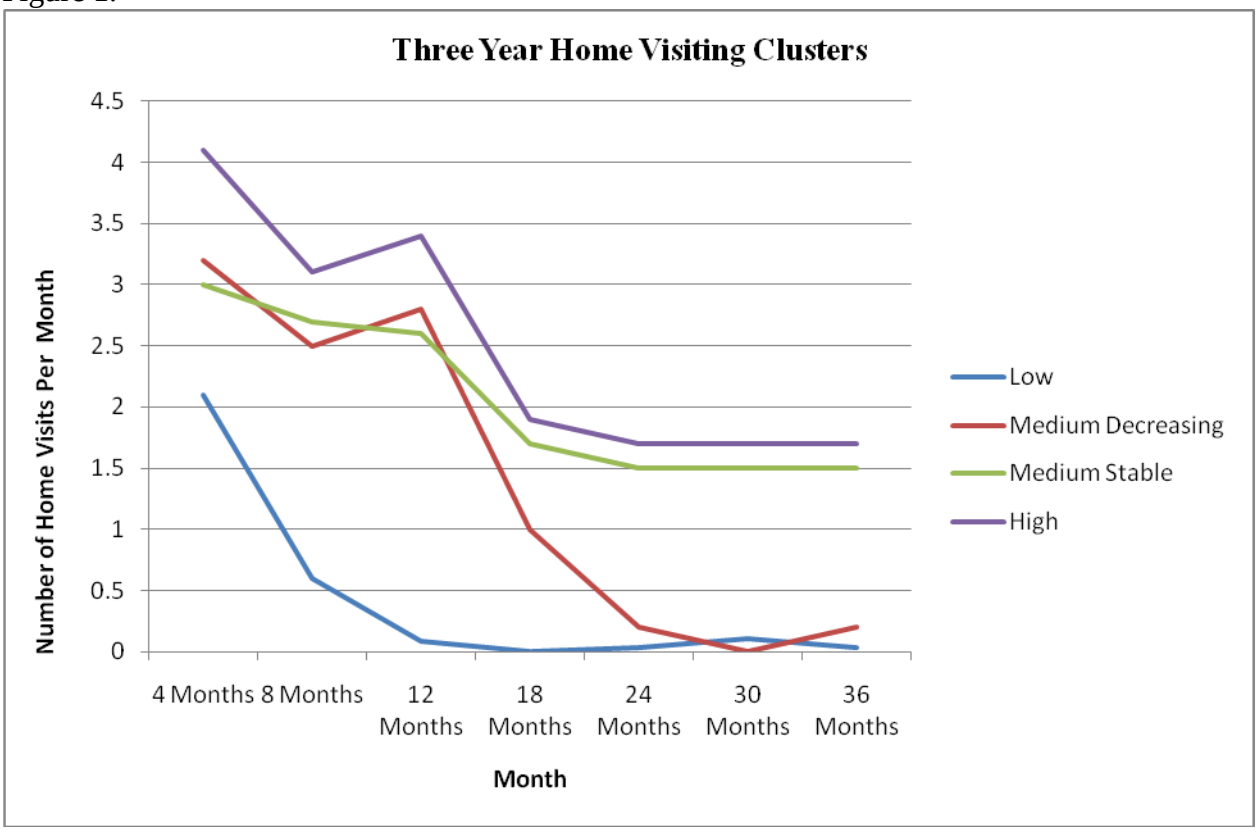
*p < .05 **p< .01 ***p< .001

Table 8. Results for Outcomes for Three Years of Home Visiting—Medium Stable and High Groups Combined

Three Year Outcome	No Match		Combined Medium Stable and High Groups	
	Treatment Effect	SE	Treatment Effect	SE
Home Total	1.54*	(0.675)	1.80*	(0.903)
Home Warmth	0.02	(0.126)	0.07	(0.173)
Home Learning	1.39**	(0.444)	1.67**	(0.601)
Knowledge of Child Development	0.01	(0.021)	0.03	(0.030)
Depression	-0.87*	(0.363)	-0.85	(0.484)
Social Support	0.07	(0.196)	0.08	(0.266)
Cognitive Coping	0.32	(0.398)	0.67	(0.562)
Behavioral Coping	-0.14	(0.469)	0.56	(0.668)
Avoidance	0.22	(0.297)	0.34	(0.414)
IQ	8.94***	(1.433)	11.21***	(1.978)
PPVT	6.56***	(1.416)	7.24***	(1.921)
Behavior Problems	-3.34*	(1.567)	-4.21	(2.164)
Internalizing	-0.87	(0.464)	-0.80	(0.639)
Externalizing	-2.15*	(0.899)	-2.68*	(1.239)

*p < .05 **p< .01 ***p< .001

Figure 1.


Three Year Home Visiting Clusters
Number of Home Visits Per Month
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4 Months
8 Months
12 Months
18 Months
24 Months
30 Months
36 Months
Month
Low
Medium Decreasing
Medium Stable
High

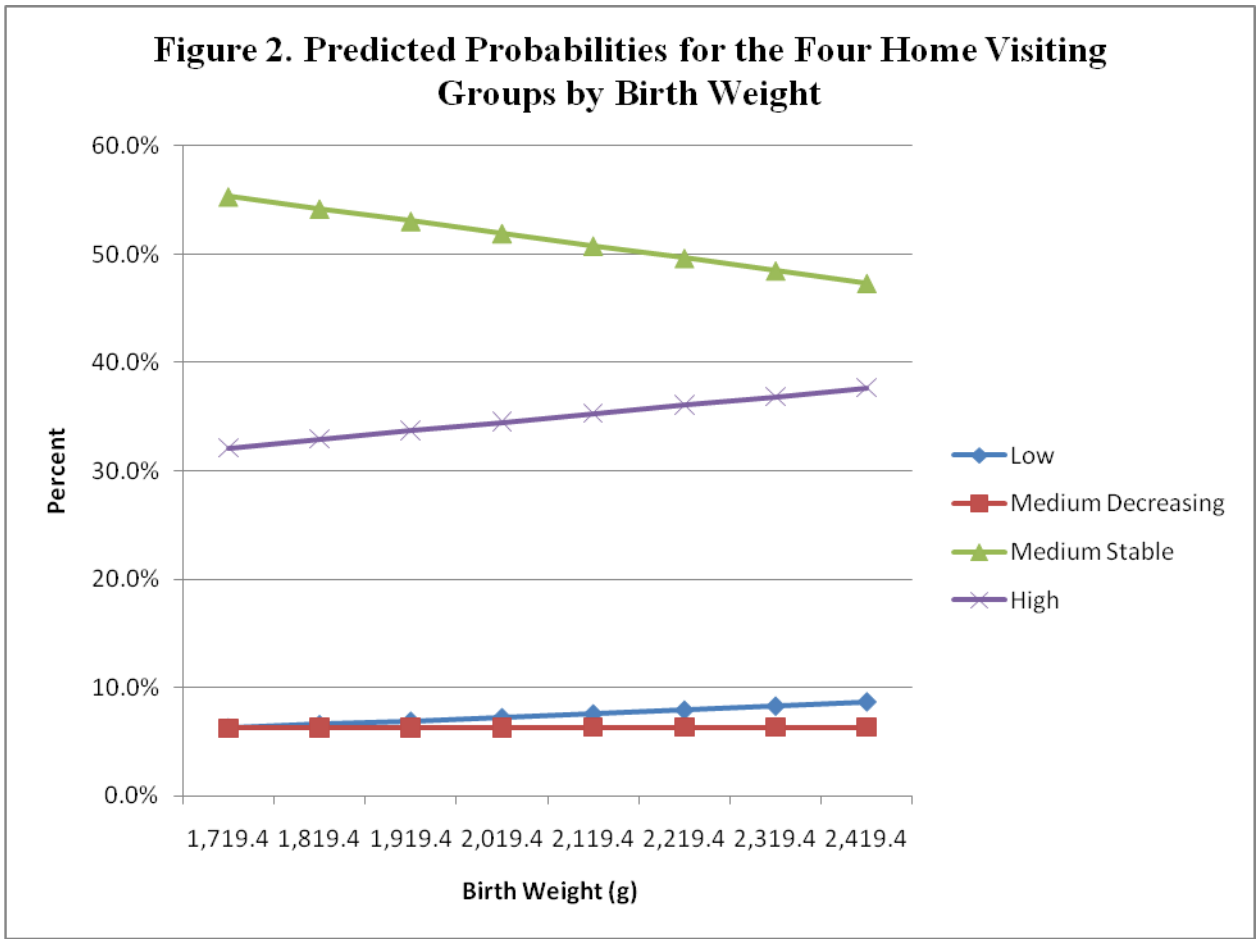


Figure 2. Predicted Probabilities for the Four Home Visiting Groups by Birth Weight
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent
1,719.4 1,819.4 1,919.4 2,019.4 2,119.4 2,219.4 2,319.4 2,419.4
Birth Weight (g)
Low
Medium Decreasing
Medium Stable
High

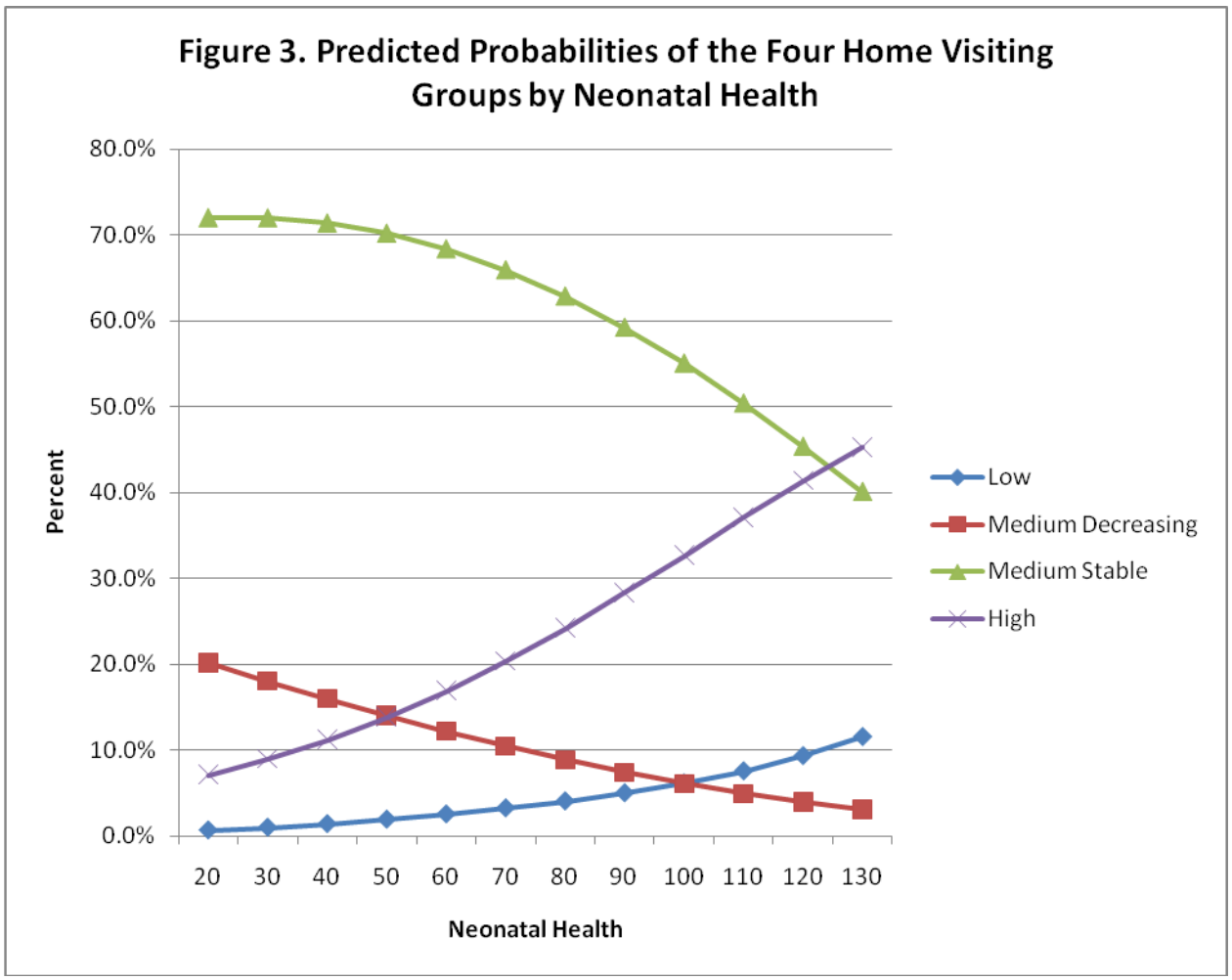


Figure 3. Predicted Probabilities of the Four Home Visiting Groups by Neonatal Health
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent
20
30
40
50
60
70
80
90
100
110
120
130
Neonatal Health
Low
Medium Decreasing
Medium Stable
High

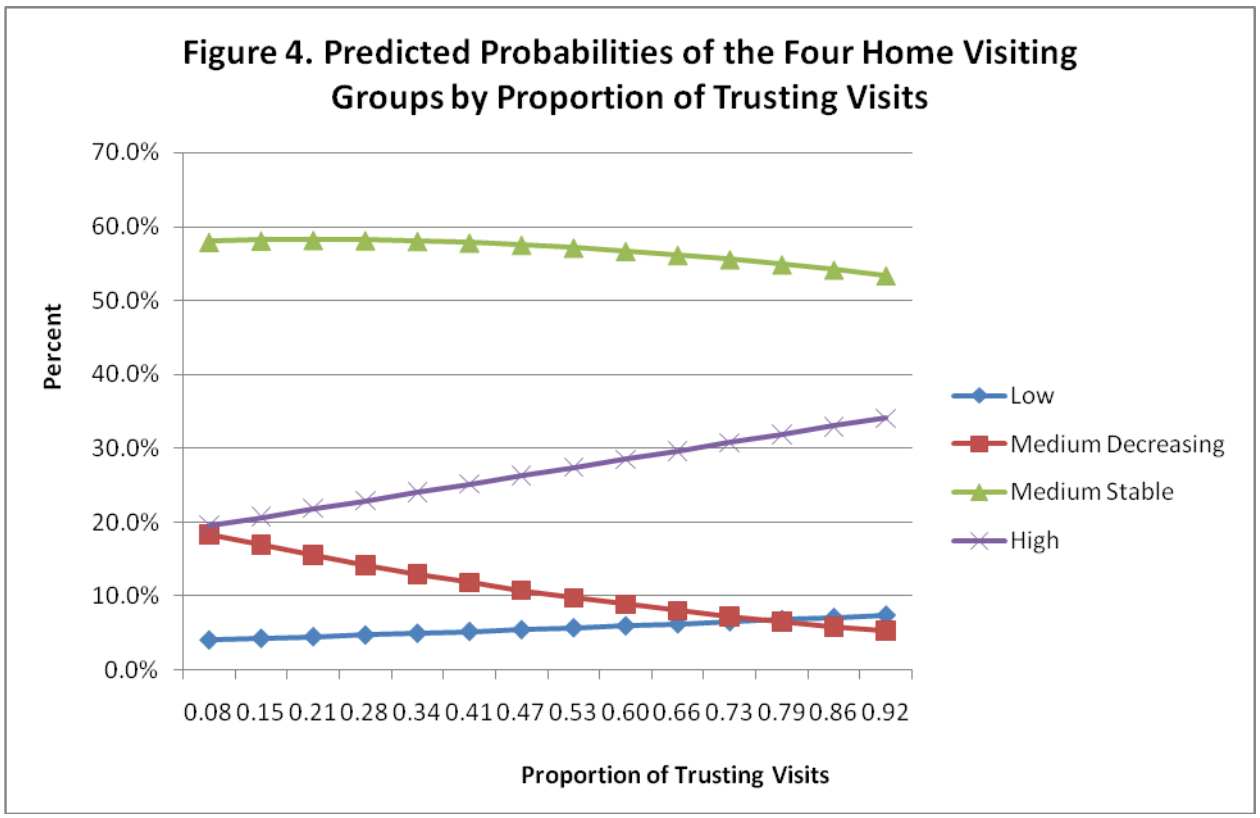


Figure 4. Predicted Probabilities of the Four Home Visiting Groups by Proportion of Trusting Visits
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent
0.08 0.15 0.21 0.28 0.34 0.41 0.47 0.53 0.60 0.66 0.73 0.79 0.86 0.92
Proportion of Trusting Visits
Low
Medium Decreasing
Medium Stable
High

Figure 5. Predicted Probabilities of the Four Home Visiting Groups by Time Spent per Visit

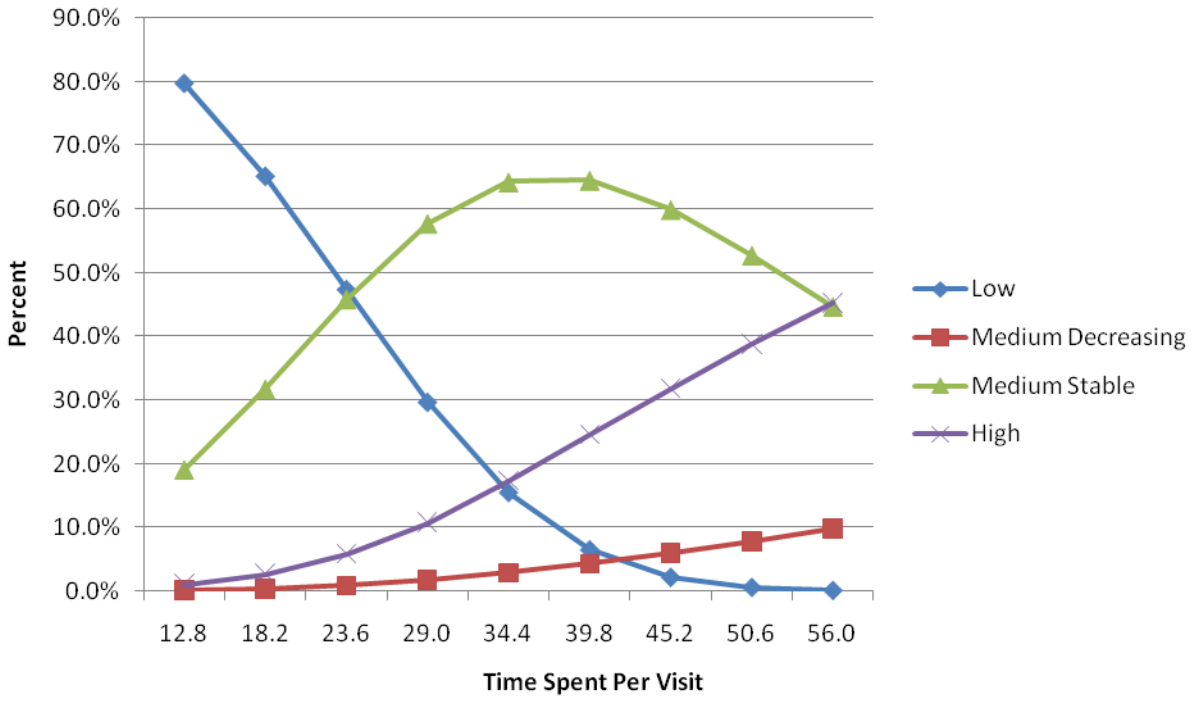
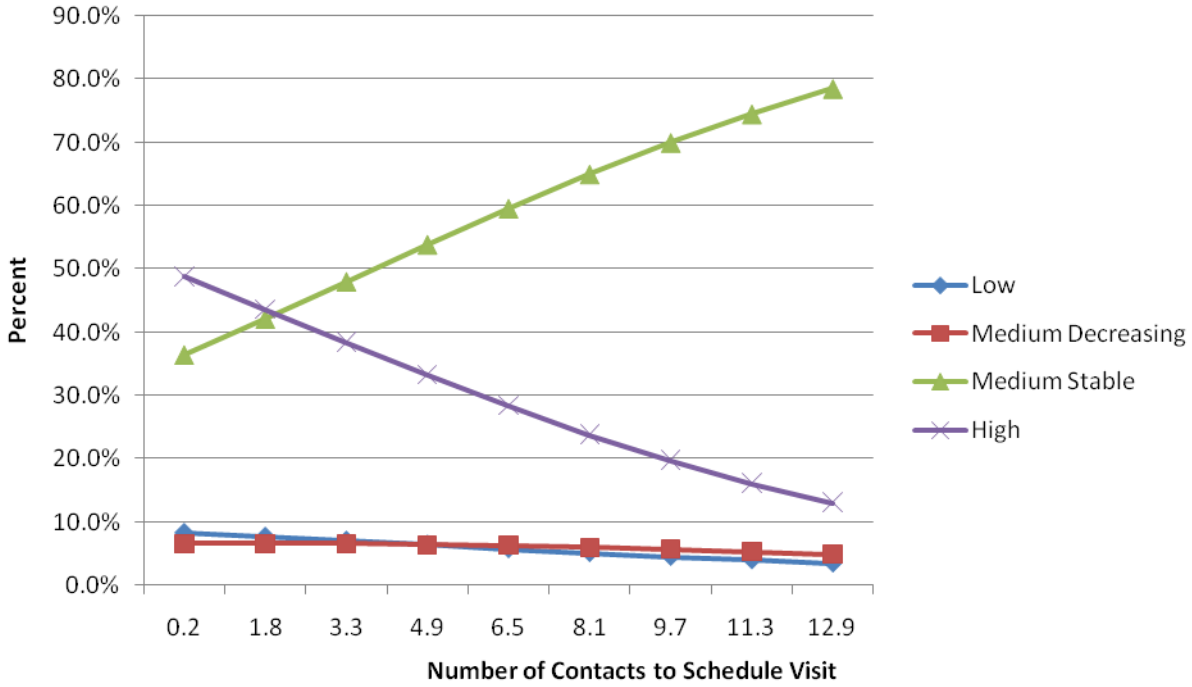


Figure 6. Predicted Probabilities of the Four Home Visiting Groups by Number of Contacts to Schedule Visit



[i] A cluster analysis based on one year of home visiting was also conducted and similarly revealed four patterns of home visiting: low (n=31; 1.6 visits, 0.1 visits, 0.1 visits), medium decreasing (n=98; 3.2 visits, 2.4 visits, 2.0 visits), medium stable (n=107; 2.7 visits, 2.8 visits, 3.3 visits), and high (n=141; 4.1 visits, 3.1 visits, 3.2 visits). Crosstabulating the four patterns of home visits based on the first year with the four patterns based on the entire three years revealed a high degree of concordance (Chi Sq=371.5 df=9, $p < .00001$): 87% of those classified as low on first year home visits were classified as low on three year home visits, 79% of those classified as medium decreasing on first year visits were classified as medium decreasing on three year visits, 71% classified as medium stable on first year visits were classified as medium stable on three year visits, and 65% classified as high on first year visits were classified as high on three year visits. The results of the multinomial logistic regression based on the first year clusters and the propensity score analyses based on the first year clusters are available from the authors upon request. In addition, a second data analytic technique, Nagin's (1999) semiparametric technique, was also used to examine patterns of home visitation for the first year and for the entire three years. This technique also produced four patterns of home visits at both times. The results of this analysis are available from the authors upon request.

[ii] For descriptive purposes and ease of interpretation, some of the control variables are coded differently in the Methods section from how they are coded in the data analytic section.

[iii] Illness, ER visits or hospitalizations were combined into a single measure of any medical visit because there were so few children in each individual category.

[iv] Since we are interested in controlling for site variation, not in the nature of site differences per se, and want a parsimonious number of parameters, analyses controlled for site clusters rather than site dummy variables.

[v] Additional propensity score analyses based on the highest home visitation group (since this group had the largest sample size) were conducted where the match was made within each site. Nineteen of the 20 outcomes examined at age 1 and 19 of the 20 outcomes examined at age 3 were similar for both types of analyses (i.e. from those based on matches made within site and those based on matches made across site). For the high frequency first year home visitation group, the treatment effect for home total environment at 3 years was nonsignificant for matches made within site, but significant for matches made across site. For the high frequency three year home visitation group, the treatment effect for depressive symptoms at 1 year was nonsignificant for matches made within site, but significant for matches made across site.