DEVELOPMENTAL SCREENING SCORES AMONG PRESCHOOL-AGED CHILDREN: THE ROLES OF POVERTY AND CHILD HEALTH

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ABSTRACT

Objectives. To investigate, using a nationally representative sample of preschool-aged children, the relationship among poverty history, child health, and risk of an abnormal developmental screening score.

Methods. Data were derived from the 1988 National Maternal and Infant Health Survey and 1991 Longitudinal Follow-up. Family income in the child's prenatal year and at 2 years old defined a poverty history for each child. Multivariate logistic regression was used to estimate the effects of poverty history on risk of an abnormal screening score or delays in large-motor, personal-social, or language subscales.

Results. Poor and near-poor children were 1.6 to 2.0 times as likely as nonpoor children to be classified as abnormal, even when maternal and household characteristics and the child's health history were taken into account. Preterm birth, chronic illness, dearth of reading materials in the home, and maternal depression were also associated with elevated risks of abnormal scores.

Conclusions. Poverty is the largest single predictor of an abnormal developmental screening score. The implications of inadequate medical care among poor children for the interpretation of individual screening scores and for amelioration of problems are also discussed.

KEY WORDS Children, Socioeconomic factors, Child development, Chronic illness, Preterm birth, Longitudinal studies.

In a recent book, *Consequences of Growing Up Poor*, experts from a wide range of fields documented a pattern of poor cognitive test scores and school performance and an elevated risk of other adverse outcomes among economically deprived children.[1] Children from low-income families have also been shown to be at higher risk of a wide range of health problems in early childhood, including low birth weight, preterm birth,[2] and a variety of chronic illnesses and other health

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conditions[3-5]—factors that can also affect developmental risk directly or through school-loss days. These issues are of concern because they may play an important role in the transmission of poverty from one generation to another, since economic deprivation in childhood increases the risk of poor economic chances later in life.

To reduce the likelihood and severity of adverse outcomes in elementary school and later childhood, early identification of children at risk is critical. Motor, cognitive, and language skills developed in the preschool years are important building blocks toward a successful experience in school. A child who reaches kindergarten without knowing how to name colors, to count to 10, or to manage a pencil and paper is more likely to fall behind better-prepared peers or to suffer from reduced teacher aspirations, hence increasing the risk of school failure. One approach to identifying children who may be at risk for poor developmental outcomes is the use of developmental screening tests such as the Denver II[6] or the Minnesota Child Development Inventory,[7] which can be administered to individual children by a medical care professional or other trained examiner. Although these screening tests are not intended as diagnostic tools, they can be used to identify children who would benefit from additional monitoring for delays in development that may signal a significant problem.[8] Screening tests can also be used to recognize areas of weakness in a child's development that can be addressed by caregiver education or other interventions.

Several studies of data from the National Longitudinal Study of Youth suggest that children from low-income families have lower average developmental screening scores than do children from higher income families, and the effect may be partly mediated by differences in health,[9,10] although health measures in that survey are relatively few and may suffer from retrospective recall bias. This paper uses data from the 1988 National Maternal and Infant Health Survey (NMIHS) and its associated 1991 Longitudinal Follow-up (LF) to analyze the relationship between poverty status, other family social risk factors, and health during the child's early years on the one hand, and developmental screening outcomes among children aged 2 to 3 years on the other. The NMIHS and LF were designed to study determinants of health and development among young children in the United States by collecting information from birth certificates, medical records from health care providers, and questionnaires administered to the mother in the year of the child's birth and again when the child was approximately 3 years old. By combining data from these complementary sources, the NMIHS/LF constitutes one of the few data sets that provide information on a number of important social risk factors in conjunction with individual-level data on developmental status for a nationally representative sample of births. The longitudinal design, which incorporates both socioeconomic and health informa-

tion, is an important feature for the analysis of socioeconomic determinants of health and development and the mechanisms that mediate that relationship.[11]

DATA AND METHODS

Study Sample

Data for this analysis were extracted from the 1988 NMIHS and its companion 1991 LF. The NMIHS was based on a sample of birth certificates for children born in 1988 and included an oversample of black infants and low-birth-weight infants. Mothers of children whose birth certificates were selected were sent a baseline questionnaire to collect information about demographic background, socioeconomic status, and maternal behaviors during pregnancy.[12] In 1991, mothers of infants in the NMIHS were sent another questionnaire about recent income and other sociodemographic characteristics, as well as aspects of the health and development of the child in the sample during the time since the baseline.[13] At the time of follow-up, children in the sample ranged in age from 27 to 48 months, with a mean of 35 months. Of the live births from the NMIHS, 83% were represented in the LF.

The sample used in this analysis included approximately 7,000 children for whom there was information from the mother's questionnaire on developmental items and family income in both the baseline and follow-up years (84% of children in the LF or 70% of live births from the original NMIHS sample). Income observations for both years were needed to calculate a long-term measure of poverty status (see below). Children for whom income was missing in one of the years were more likely than children with income data for both years to be a racial minority or to have a family that was poor during the prenatal period, although there were no differences in mean developmental scores between included and omitted children.

Developmental Screening Scores. To assess the child's development at follow-up, the mother's questionnaire included a set of 16 items from the Motor and Social Development (MSD) Scale for children in the target age range. The MSD is a composite screening scale derived by the National Center for Health Statistics from the Denver, Bayley, and Gesell tests—three standard measures of child development (see Appendix for list and wording of items).[14] Items were closely related to those on the Revised Denver Prescreening Developmental Questionnaires (R-PDQ) for children aged 2-4 and 4-6 years; the R-PDQ were designed to be filled out by a parent and interpreted by a trained medical professional at a pediatric visit, although some items were drawn from the Denver II, which is intended for administration by a clinician. Because the R-PDQ was designed to be based on parental report rather than on observation of the child by a trained examiner, these items are well suited for a health survey such as the LF.

The MSD has been used in other population-based surveys as a way to collect information on child development based on maternal report.[15] In an assessment of validity, Peterson and Moore found that the overall MSD score showed the expected patterns with age, sex, and health at birth in a large population-based sample.[10] Both inter-rater and test-retest reliability of these items are high when the MSD is conducted by trained examiners.[6,16] Evaluation of internal consistency of maternal reports on similar items from the Minnesota Child Development Inventory also revealed high levels of reliability (Cronbach's $\alpha > .70$ for all scales, >.80 for expressive language, language comprehension, and general development scales).[7] In exploratory work, we found that the screening questions were successful at capturing problems related to deficits in hearing, speech, and vision, and problems with eating or swallowing that were reported separately by the mother (data not shown). Developmental delay or mental retardation (indicated by a single item in the survey) was also highly correlated with poor outcomes on the developmental screening.

On the 1991 questionnaire, the mother was asked to report whether her child "has ever done [the specified] activity, even if s/he doesn't always do it." Each item was scored 1 if the child had performed the task and 0 if not. The aggregate score was calculated as the sum of the 16 items. An imputed MSD aggregate score was calculated for children who were missing 1 to 3 MSD items; the aggregate score was set to missing for the 2% of cases with more than 3 items missing.[13] For this study, we assigned each child in the NMIHS/LF sample a percentile score on the MSD based on norms for the aggregate score, which were calculated from the nationally representative sample of the 1981 National Health Interview Survey for children of different ages and sexes.[14,15]

In order to look more closely at patterns of delay for individual items or developmentally related subscales, we classified each of the MSD items for each child as "normal," "caution," or "delay" relative to age norms for that activity, using the criteria (described below) in the screening manual for the Denver II.[5,17] (Because some of the items were drawn from other screening tests, we term this scoring the "Denver-type" approach.) For this analysis, we calculated age percentiles for each item using the NMIHS/LF data, weighted to national levels using the sampling weights provided by the National Center for Health Statistics. A comparison of the internally derived (NMIHS/LF) norms with those from the standardized Denver II sample for items that appear on both versions revealed that the 75th and 90th percentiles used to classify the children's results were generally within 1–2 months of one another, and differences did not have an appreciable effect on scoring outcomes.

A child was classified "normal" on an item if (1) she or he had ever performed

the activity by the age at which 75% of children can do so or (2) had not yet performed the activity, but was younger than the 75th percentile age for that item at the time of the survey. A "caution" was indicated if the child had not yet performed the activity and was between the 75th and 90th percentiles of age for that item, while a "delay" was indicated for an item if the child had not yet performed the activity and was above the 90th percentile of age for that item. Because preterm infants are expected to catch up with their full-term peers by age 2,[5] their scores were based on age in months since birth and were not corrected for differences in postconceptional age.

From the scores on the individual developmental items, summary indicators of developmental status were calculated using the Denver II criteria. A child was classified as "abnormal" if she or he had delays on two or more of the items and "questionable" if she or he had one delay and/or two or more cautions.[5] Indicators of the presence of cautions or delays in three of the four subscales of the Denver II were also calculated. The *large-motor* scale included the items on stairs, tricycle, alternating steps, and somersault (see Appendix for the wording of items); the *personal-social* scale included the items on hand washing, dressing, and using the toilet; and the *language* scale included the items on speaking in partial sentences, counting three objects, naming colors, rote counting, notifying of wet or soiled diapers, and knowing their first and last name, their age, and their sex. It was not possible to assess caution or delay in the *fine-motor/adaptive* area because the survey included only one item from that scale (whether the child has "drawn a picture of a man or woman with at least 2 parts of the body besides the head"). That item was not useful for differentiating among children in this sample because the age at which that item is expected to be performed by 75% of children exceeds the highest age in the NMIHS/LF according to both the sample and the national Denver II norms (5 years, 2 months).[5]

A comparison of the child's performance based on the MSD scale versus the aggregate of the individual item scoring using the Denver-type approach revealed a high level of consistency between the two. Children classified as abnormal, questionable, and normal based on the latter scored on average at the 11th, 35th, and 73rd percentile of the MSD, respectively. Only 12% of children scored as abnormal scored above the 25th percentile on the MSD, compared with 63% of questionable and 98% of normal children. Because the Denver II scoring approach allows items to be age normed and examined separately, as well as grouped into related developmental areas, the remainder of this analysis focuses on the Denver-type outcomes. Results using the bottom quartile of the MSD score as the indicator of a poor screening outcome were consistent with those for the Denver-type analyses (not shown).

Poverty Status In each survey, mothers were asked to report on their family income in the preceding year, yielding information on income in the prenatal year (from the baseline survey) and when the child was 2 years old (from the follow-up). Poverty status for each child was based on the average of the income-to-needs ratios in those two years, termed the *long-term income/needs.* For each child, the income-to-needs ratio for each year was calculated by dividing reported family income (excluding the value of food stamps) by the poverty threshold for a family of given size and age composition, adjusted for inflation using the Consumer Price Index.[18] For example, in 1991 a family of two adults and two children with an income of $14,400 would have an income/needs ratio of 1.0 for that year, which would correspond to an income of $12,100 for the same family in 1988.

Based on the long-term income/needs, each child was classified as very poor (below half the poverty line), less poor (between 0.5 and 1.0 times the poverty line), near poor (between 1.0 and 1.85 times the poverty line), low above near poor (between 1.85 and 3.0 times the poverty line), and high (3 or more times the poverty line, which serves as the reference category). It is useful to differentiate the near poor from those immediately above and below them because that group has relatively low income and is eligible for some, but not all, of the programs the poor. For example, families with an income less than 1.85 times the poverty line are eligible for some child care and housing programs, but may not qualify for health insurance.[19]

Other Risk Factors. Other social risk factors include young maternal age, low educational attainment, single-parent household structure, and presence of several other children in the household. Sociodemographic characteristics are categorized as shown in Table I. Measures of parenting involvement and learning resources in the child's home include the number of books the child owns and how often he or she is read to. These items are expected to be most closely related to cognitive and language development. Another factor that may influence a child's development is his or her mother's mental health. The follow-up questionnaire included the items used to calculate the Center for Epidemiologic Studies Depression (CES-D) Scale. An overall CES-D score was calculated for mothers who completed at least 16 of the 20 items; details of question coding and imputation procedures are described elsewhere.[13] Mothers were classified as possibly depressed if they had a CES-D score of 16 to 22 and probably depressed if they had a CES-D score of 23 or higher.[20]

The child's health history was measured by two indicators of health at birth (low birth weight and preterm birth), as well as serious childhood morbidity (presence of asthma or other chronic respiratory illness or other serious chronic

illness). Asthma and other serious, chronic respiratory illnesses were examined as a separate category of chronic illness because of their importance as a cause of childhood morbidity.[3,21] In exploratory analyses, measures of health care utilization, including usual source of care, insurance coverage, and a measure of adequacy of vaccinations at the time of follow-up, were not significant predictors of an abnormal score when socioeconomic factors were also taken into account and are not shown here.

Methods

Figures presented below were weighted to national levels using the final sampling weight from the LF, which incorporates adjustments for the initial sampling design, as well as loss to follow-up.[13] To differentiate between prenatal and postnatal factors that may influence the child's development, multivariate logistic regression was used to estimate relative odds of developmental risk, controlling for health of the child at birth, the child's health history, and mother's characteristics. The SUDAAN software was used to adjust the estimated standard errors for the complex sampling design.[22]

RESULTS

As shown in Table I, the percentage of children who were classified as abnormal according to the screening test decreases markedly with increasing income. Over 9% of children from very poor families were classified abnormal, compared with 7.6% of those who were less poor, 4.8% of those who were near poor, and just over 2% of those who were above near poor. The percentage classified as questionable also decreased with increasing income. In terms of the subscales for specific developmental areas, both large-motor delays and language delays were more prevalent in the lower-income groups, although personal-social delays showed the opposite pattern.

Differences in developmental screening scores according to mother's educational attainment were also large, with particularly high rates of abnormal scores, most notably in the language area, among children born to women with less than a high school education. Minority racial groups and children who lived in households with three or more additional children were also at elevated risk of an abnormal screening score. Most of the other sociodemographic characteristics showed smaller associations with the developmental outcomes. Adverse health of the child at birth and presence of serious chronic illness were associated with higher rates of abnormal scores overall and in each of the subscales. For example, children who were born preterm were three times as likely to be classified abnormal as their full-term counterparts, with the largest differences observed in the large motor and language areas. A three-fold excess risk was also observed for children who had a serious chronic illness.

TABLE I Denver Developmental Screening Status and Subscale Delay by Socioeconomic Characteristics and Child Health History: Preschool Children NMIHS/LF (Weighted)*

	Overall Screening Status				% with 1+ Delays in Subscales†		
	# Cases	% Normal	% Questionable	% Abnormal	Large motor	Personal-social	Language
Overall sample	6,996	62.7	33.3	4.0	4.2	7.1	9.6
Socioeconomic characteristics							
Poverty status‡							
Very poor	1,282	55.0	35.9	9.1	7.2	8.0	18.4
Less poor	2,369	55.5	37.0	7.6	7.0	6.9	14.3
Near poor	1,303	59.3	35.9	4.8	3.7	7.8	11.8
Low above near poor	1,363	66.7	30.9	2.4	3.1	5.4	7.6
High	1,961	66.4	31.6	2.0	3.3	7.8	5.8
Mother's education							
Less than high school	1,436	50.4	39.1	10.4	7.2	9.8	20.5
High school, no higher	2,856	64.7	31.9	3.4	4.2	5.8	8.9
College	2,388	65.8	32.3	1.8	2.9	7.2	5.8
Post-graduate	316	65.3	31.8	2.9	3.9	7.6	7.2
Mother's age at birth							
Teen	1,044	62.6	32.6	4.7	4.5	7.3	12.2
20–24	1,936	64.1	32.2	3.8	4.3	5.7	10.0
25–29	2,002	64.7	30.9	4.4	4.0	7.2	9.4
30–34	1,329	61.8	35.7	3.2	4.2	8.0	8.0
35 or older	522	54.6	41.6	3.9	3.7	9.4	8.4
Mother's marital history§							
Never married	1,900	63.0	32.0	5.0	4.6	6.7	12.8
Married throughout	3,566	63.5	33.2	3.3	3.7	7.3	8.3
Marital disruption	556	60.5	34.2	5.8	4.5	8.7	12.1
Got married	356	62.3	31.7	6.0	5.8	6.0	10.8
Other	595	56.5	38.5	5.0	6.1	5.9	12.3
Number of children in household							
Sample child only	1,851	66.6	30.0	3.4	5.1	7.4	6.7
1–2 other children	4,166	62.2	34.0	3.8	3.6	7.4	9.2
3+ other children	979	55.3	37.6	7.1	4.2	6.5	12.6

Because sociodemographic characteristics such as mother's educational attainment and household composition are correlated with both income and developmental screening scores, multivariate models were used to estimate the relative odds of being classified as abnormal for children in the different income groups, controlling for possible confounding factors (Table II, model I). Subsequent models introduce controls for the child's health history (model II) or measures of parenting practices and maternal health (model III) to assess the extent to which those factors mediate the relation between poverty and developmental lags. Model IV includes controls for the health and parenting variables.

Children in poor and near-poor households are considerably more likely than their peers from higher income households to have an abnormal screening score. For example, children from families with income below half the poverty line are

TABLE I Denver Developmental Screening Status and Subscale Delay by Socioeconomic Characteristics and Child Health History: Preschool Children NMIHS/LF (Weighted)*

		Overall Screening Status			% with 1+ Delays in Subscales†		
	# Cases	% Normal	% Questionable	% Abnormal	Large motor	Personal-social	Language
Race/Hispanic origin							
Non-Hispanic white	3,044	66.4	31.4	2.2	3.1	6.9	6.8
Non-Hispanic black	3,190	60.4	34.2	5.4	5.8	6.2	11.7
Hispanic	568	49.7	40.9	9.4	7.6	8.0	19.2
Other	194	46.0	40.7	13.3	6.5	12.8	21.2
Child's health							
Birthweight							
<1500 g	788	40.6	47.3	12.1	10.1	17.1	18.9
1500–2499 g	1,087	58.0	34.2	7.9	6.8	8.6	13.8
2500+ g	5,121	63.3	33.1	3.6	3.9	6.9	9.2
Length of gestation							
Preterm	1,528	58.0	32.8	9.2	7.0	9.6	15.0
Full term	5,418	65.9	30.9	3.2	3.9	6.9	9.1
Serious chronic illness‖	555	48.5	42.0	9.5	8.4	12.5	15.8
Asthma, other serious respiratory	1,095	58.4	35.2	6.5	6.1	8.7	12.1

*All percentages were weighted with sample weights from the Longitudinal Follow-up. Standard errors were corrected for the complex sample design using SUDAAN software, version 7.0. Sample sizes are unweighted.

†Problems = one or more cautions or delays in subscale items. The large-motor scale included four items: stairs, tricycle, alternating steps, and somersault; the personal-social scale included three items: hand washing, dressing, and using the toilet; the language scale included eight items: speaking in partial sentences, counting three objects, naming colors, rote counting, diapers, and knowledge of their first and last name, their age, and their sex. The 16th item, drawing a person with at least 3 body parts, was the only fine-motor question and was not analyzed separately.

‡Very poor = below half the poverty line; less poor = between 0.5 and 1.0 times the poverty line; near poor = between 1.0 and 1.85 times the poverty line; low above near poor = between 1.85 and 3.0 times the poverty line; and high = 3 or more times the poverty line. Calculations based on the average of family income-to-needs ratios at baseline and follow-up.

§Marital history was defined by comparing the mother's marital status at baseline and at follow-up.

‖Serious chronic illnesses include chronic heart or bone problems, conditions of the brain (including hydrocephalus and hemorrhage), cerebral palsy, seizures, neuromuscular conditions, sickle cell disease, genetic disorders, and a category of unspecified other serious chronic diseases.

more than 3 times as likely as those from families with incomes above 1.85 times the poverty line to have delays on two or more of the developmental items, even when the mother's educational attainment, age and marital history and the number of siblings in the household are taken into account (Table II, model I). Relative odds for the less poor and near poor are 2.1 and 1.8, respectively.

Children of mothers with less than a complete high school eduction are also at elevated risk. When the effects of the other characteristics are controlled, there is a positive relationship between abnormal scores and mother's age. In the multivariate models, children whose mothers were unmarried or divorced at some point since the child's birth were also at lower risk.

TABLE II Odds Ratios From Logit Models* of Abnormal Score on Developmental Screening Test† by Long-term Poverty

	I		II		III		IV	
	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR	*P* Value
Socioeconomic traits								
Poverty status								
Very poor	3.08	.0004	3.01	.0005	2.27	.01	2.18	.02
Less poor	2.10	.01	2.03	.02	1.80	.04	1.74	.07
Near poor	1.81	.03	1.84	.03	1.55	.13	1.56	.14
Mother's age								
Under 20 years	0.80	.43	0.76	.37	0.89	.67	0.83	.54
25–29 years	1.72	.02	1.76	.02	1.84	.01	1.90	.007
30–34 years	1.60	.09	1.58	.11	1.59	.10	1.58	.11
35 years or older	1.91	.06	2.01	.04	1.82	.10	1.88	.09
Mother's education								
Less than high school	2.10	.0002	2.09	.0003	1.87	.003	1.84	.004
College	0.69	.13	0.71	.17	0.74	.24	0.76	.29
More than college	0.98	.97	1.04	.94	1.08	.90	1.15	.81
Marital history								
Never married	0.54	.04	0.53	.03	0.57	.06	0.56	.06
Marital disruption	0.77	.45	0.68	.29	0.86	.66	0.78	.47
Got married	0.93	.81	0.94	.85	1.02	.95	1.04	.90
Other marital history	0.69	.28	0.64	.22	0.70	.33	0.66	.25
Three or more siblings	0.84	.36	0.82	.29	0.76	.16	0.74	.12
Race/Hispanic origin								
Non-Hispanic black	1.50	.06	1.34	.19	1.30	.26	1.12	.61
Hispanic	1.88	.009	1.91	.009	1.76	.02	1.74	.03
Other race (except non-Hispanic white)	4.06	.0001	4.54	.0001	3.50	.0001	3.72	.0001
Child's health								
Preterm			2.85	.0001			2.94	.0001
Serious chronic illness			2.32	.001			1.93	.01
Asthma, other respiratory			1.65	.03			1.84	.008
Parenting behaviors and health								
Mother depressed					1.36	.23	1.33	.26
Child read to 3+ times/week					0.83	.40	0.82	.38
Child has 10 or more books					0.58	.009	0.56	.006
Adjusted Wald F statistic	86.3		69.1		69.9		57.0	

*Weighted with sample weights from the Longitudinal Follow-up. Standard errors were corrected for the complex sample design using SUDAAN software, version 7.0. OR = odds ratio.

†See footnotes to Table I for definitions of variables.

Introduction of controls for pre-term birth and diagnosis of a chronic illness by the time of assessment do not alter the poverty coefficients appreciably, although each of the health conditions is strongly related to developmental risk (model II). When the number of books owned by the child, frequency with which she or he is read to, and an indicator for whether the mother is depressed are controlled, however, the relative odds for the very poor group decline from 3.1 to 2.3, a decrease of roughly 30% (model I versus model III). The corresponding reductions for the less poor and near poor were 13% and 17% respectively,

suggesting that part of the association between poverty and developmental scores is explained by differences in the mother's mental health and the availability of learning resources in the household. Other analyses (not shown) suggest that the mother's depression and learning resources each explain about half of the reduction in risk for poor children, relative to the model without those controls (model I).

To investigate whether these factors have different effects on the different components of the over-all developmental score, separate models were estimated for any large-motor delays, any personal or social delays, and any language delays. As shown in Table III, when the effects of other socioeconomic characteristics, child health, and parenting are taken into account, the large-motor area exhibits the largest differentials according to poverty status. Children who are poor are 60% to 70% more likely than non-poor children to have a large-motor delay, compared with (statistically insignificant) excess risks of 20% to 30% for language or personal/social items. Income differences in risk of a delay in any of the developmental subscales are smaller than those observed for the over-all "abnormal" classification. This pattern may be due to the fact that a child must have at least two delays to be classified abnormal, which may magnify the discrepancies between the income groups relative to that for any one of the subscales.

Analysis of the subscales reveals that most of the excess risk among Hispanic children and those of classified as other race is due to large excess risks in the language area; differences in the other two areas were smaller and not statistically significant. As in the over-all scale, children of mothers with less than a high school education have a higher risk of a delay in each of the subscales than do children of better-educated mother, with particularly marked differences in the personal/social and language areas. As would be expected, the number of books owned by the child and the frequency with which she or he is read to are strongly and inversely related to risk of language delays, but show no association with large-motor or personal/social development. Maternal depression is predictive of both personal/social and language delays, but not with large motor development.

DISCUSSION AND CONCLUSIONS

This paper has shown a strong inverse relationship between family income in early childhood and risk of a poor developmental screening score based on items from the Motor and Social Development Scale. Living in a poor family was the strongest single predictor of developmental risk of any characteristic included in the model. Other sociodemographic factors, such as maternal age and educational attainment, explained part but not all of the association between income and development risk. Even when the effect of those characteristics is taken into

TABLE III Odds Ratios from Logit Models* of Delays on Large Motor, Personal-social, or Language Items by Long-term Poverty†

	Large Motor		Personal-Social		Language	
	OR	*P* Value	OR	*P* Value	OR	*P* Value
Socioeconomic traits						
Poverty status						
Very poor	1.73	.05	1.23	.47	1.35	.17
Less poor	1.62	.07	0.96	.87	1.07	.74
Near poor	0.93	.79	1.28	.21	1.27	.17
Mother's age						
Under 20 years	0.79	.40	1.15	.60	0.99	.96
25–29 years	1.23	.35	1.42	.06	1.27	.13
30–34 years	1.54	.09	1.70	.007	1.18	.38
35 years or older	1.24	.55	2.09	.003	1.29	.31
Mother's education						
Less than high school	1.23	.25	1.64	.02	1.56	.005
College	0.86	.49	1.30	.10	0.86	.33
More than college	1.15	.76	1.12	.71	1.04	.91
Marital history						
Never married	0.59	.04	0.85	.52	0.83	.36
Marital disruption	0.61	.17	0.94	.81	0.80	.38
Got married	0.82	.53	0.82	.46	0.86	.52
Other marital history	0.94	.86	0.66	.14	0.83	.45
Three or more siblings	0.64	.02	0.75	.06	1.11	.42
Race/Hispanic origin						
Non-Hispanic black	1.33	.15	0.77	.13	0.86	.33
Hispanic	1.55	.09	0.92	.70	1.50	.03
Other race (except non-Hispanic white)	1.36	.43	1.42	.24	2.63	.0002
Child's health						
Preterm	1.63	.01	1.45	.02	1.57	.002
Serious chronic illness	1.71	.04	1.54	.05	1.48	.06
Asthma, other respiratory	1.46	.10	1.26	.21	1.23	.19
Parenting behaviors and health						
Mother depressed	1.06	.82	1.61	.02	1.48	.04
Child read to 3+ times/week	1.13	.63	0.81	.32	0.75	.10
Child has 10 or more books	0.83	.35	1.17	.35	0.55	.0001
Adjusted Wald F statistic	74.4		80.7		65.9	

*Weighted with sample weights from the Longitudinal Follow-up. Standard errors were corrected for the complex sample design using SUDAAN software, version 7.0. OR = odds ratio.

†See footnotes to Table I for definitions of variables.

account, however, children from families below half the poverty line were more than three items as likely as non-poor children to be classified abnormal based on a developmental screening test administered through maternal report when the child was about 3 years old. Children from "less poor" families face over twice the risk, and those in near-poor families 1.8 items the risk of the non-poor. The association between income and risk of a large-motor delay is particularly large. Although an abnormal or questionable score on a developmental screening test such as the one used on the NMIHS/LF does not by itself confirm the presence of a developmental delay, the fact that a higher proportion of poor

than non-poor children screen as abnormal or questionable suggests that the proportion of children with true delays is also higher among the poor.

One possible source of confounding in the association between poverty and screening scores stems from the fact that the wording of the MSD items on the questionnaire did not distinguish between a child who never had the opportunity to perform a skill and a child who had not performed the skill for other reasons. For example, some children might not have had the chance to pedal a tricycle, either because they did not have access to one or because their caregiver did not believe there was a safe place for a young child to ride—both factors that are likely to be more prevalent among poor than non-poor children. Other skills might not have been introduced because of beliefs concerning activities appropriate for children in this age range. While the ability to turn a somersault may be useful as a screening item for large-motor development, it is not an activity a child is likely to undertake spontaneously, nor one that will necessarily be taught by caregivers or others in the child's environment. To the extent that items on the MSD are valuable for their own sake or as intermediate steps toward skills that will be needed for self-care or in school, these are topics that could be covered with reviewing the normal progression of development with the child's caregivers.

In order to differentiate among families that are long-term poor, poor only temporarily, and never poor, this study used a measure of family income based on two observations of annual income, spaced three years apart, that straddle the child's lifetime to the time of assessment. This measure provides a more stable or "permanent" way to classify family income or poverty status during the child's lifetime than a single, cross-sectional income measure at the time of the survey. When assessing the relationship between poverty and child well-being in the United States, these distinctions are important because children's poverty experiences vary considerably in terms of how poor they have been and for how long.[1,23] In the NMIHS sample, approximately 28% of children who were poor at the time of assessment were nonpoor according to the two-observation measure, while roughly 15% of those who were poor according to the two-observation measure were not poor at assessment, indicating the importance of observing income over a period of several years when assessing poverty status. Previous studies have suggested that estimated health deficits of poor relative to nonpoor children that are based on single-year measures of income understate the deficits associated with long-term poverty by 30% to 50%.[24,25]

Another important finding of this study is that although a child's health history is an important predictor of a poor developmental score at 3 years of age, it does not account for much of the excess risk of low scores among poor children. Children born prematurely were nearly three times as likely to be classified abnormal as their full-term peers, although the screening guidelines

suggest that adjustment for premature birth is no longer necessary after 24 months of age. Preterm birth was associated with elevated risk of one or more delays in each of the three subscales, with slightly greater risks in the large-motor and language areas than in the personal-social area. Chronic illness, which encompassed a wide range of serious health conditions, was also associated with an elevated risk of an abnormal developmental screening score. Asthma was most strongly related to risk of large-motor delays, with a more modest effect in the other two areas.

Previous studies have demonstrated that quality of the child's early home environment—including provision of both cognitive stimulation and emotional support—is an important predictor of cognitive performance and behavior problems in early childhood.[26,27] Although few aspects of the home environment are measured in the NMIHS/LF, those items demonstrate strong associations with related dimensions of child development. Children who owned at least 10 books were less than 60% as likely as their peers with fewer books to be classified abnormal on the screening test. As expected, most of this difference is a consequence of fewer deficits in the language items, the area that is most closely related to cognitive skills. In this sample, only about half of poor children had 10 or more books, compared with virtually all (95%) children in the highest income group. Studies based on other data have also found substantial differences in the availability of books and educational toys according to household income.[28] These differences account for as much as half of the difference in cognitive test scores between the lowest and highest income groups.[29–31] Our findings, too, suggest that, although the availability of learning resources is an important correlate of developmental outcomes, these resources explain only a portion of the worse outcomes among poor children. More detailed information about other experiences and materials that promote development would help shed light on other mechanisms through which income affects child outcomes.

Another interesting finding concerns the importance of the mother's mental health in the association between poverty and a poor developmental score. Maternal depression appears to account for as much as one-sixth of the association between severe poverty and risk of an abnormal screening score. In our sample, the prevalence of depression among mothers declined sharply with increasing family income, from 19% among the very poor and 13% among the less poor, to 3% among the nonpoor. This pattern is consistent with previous studies that showed higher rates of depression among persons who were unemployed, had lower educational attainment, or were unmarried[20]—conditions that are more common among the poor. Children of mothers who were classified as probably depressed based on the CES-D Scale were 45% to 60% more likely than children of nondepressed mothers to exhibit delays in personal-social or language items,

although large-motor development was unaffected. This difference in patterns for the three subscales is important because it suggests that the observed effect is not merely an artifact of depression influencing a mother's reports of her child's development; the areas affected were those most likely to be dependent on interaction between the mother and child.

Another concern about the large differentials in screening scores according to income is related to the need for continuity in care for appropriate interpretation of screening results. Recommendations for the use of developmental screening tests state that results should ideally be part of a monitoring process that includes repeated developmental assessments to examine progress across time because similar concerns noted at several different points in time are more indicative of a lasting problem with development.[16] Developmental screening results should also be interpreted in conjunction with information about the child's health and family context, and a single subnormal score should not be taken as indicative of a serious problem because results at any particular time can be confounded by factors such as fatigue or lack of cooperation on the part of the child. These considerations underscore the importance for each child of a consistent health care provider, who can observe his or her development over the course of months or even years and can correctly interpret the findings in conjunction with health and other relevant circumstances.

Figures on the adequacy of medical care for poor children are sobering: nearly 40% of poor children in the NMIHS/LF reported fewer than 10 medical visits in their first three years of life—far fewer than the minimum needed for appropriate screening and other preventive care—compared with approximately 20% of children from families well above the poverty line. Poor children were far more likely to receive their health care in a clinic rather than a doctor's office and were nearly three times as likely to have no usual source of care; both are factors that reduce the likelihood that they will be observed over time by one health care professional who can take the time to know them well. Figures from other national surveys confirm these patterns of inadequate and erratic care.[2]

As is well known, the deprivation of poor children is not limited to the health care arena. Inadequacies in the access to and quality of food, clothing, housing, and child care also jeopardize the health and development of children from low-income families.[5] The recent debate on welfare and health policy in the United States has focused attention on programs and policies that are designed to reduce the prevalence of child poverty[32] and to mitigate the effects of poverty on children.[33] Some programs, such as Head Start, would directly address issues of child development. Others, such as the food stamp or school lunch programs, could have beneficial indirect effects by improving the health and nutritional status of these young children.

For children who have delays identified in one or more areas, additional instruction for parents on issues related to child development is also important. This objective underscores the need for creative approaches to teaching parents about appropriate expectations for their children's development and about indications of possible problems. One possible approach would involve the use of medical assistants or health educators to give instruction in areas identified by the screening process. Pamphlets and other educational media could also be used to distribute information, although care should be taken to ensure that these are written at a level that is accessible to less-educated persons. Instructional materials or personnel should also be available in languages other than English in light of the greater risk of language delay among Hispanics in this sample. These informational materials should also emphasize developmentally appropriate goals and tasks for preschool-aged children, such as learning to count, to name colors, to say their full name, and to use a pencil, to ensure that by the time they reach school all children are capable of these basic school readiness skills.

APPENDIX: DEVELOPMENTAL ITEMS FROM THE LONGITUDINAL FOLLOW-UP QUESTIONNAIRE*

Circle "1" if (child) has ever done an activity, even if s/he doesn't always do it. Otherwise, circle "2."

Yes	No		
1	2	a.	Spoken in a partial sentence of three words or more?[L]
1	2	b.	Walked up stairs by (himself/herself) without holding on to a rail?[M]
1	2	c.	Washed and dried (his/her) hands without any help except for turning the water on and off?[P]
1	2	d.	Counted three objects correctly?[L]
1	2	e.	Let someone know, without crying, that wearing a wet or soiled diaper bothered (him/her)?[L]
1	2	f.	Gone to the toilet alone?[P]
1	2	g.	Walked up stairs by (himself/herself) with no help, stepping on each step with only one foot?[M]
1	2	h.	Said the names of at least 4 colors?[L]
1	2	i.	Pedaled a tricycle or big wheel at least 10 feet?[M]
1	2	j.	Done a somersault without help from anybody?[M]
1	2	k.	Dressed (himself/herself) without any help except for tying shoes (and buttoning the backs of dresses)?[P]
1	2	l.	Said (his/her) first and last name together without someone's help (nickname may be used for first name)?[L]
1	2	m.	Counted out loud up to 10?[L]
1	2	n.	Drawn a picture of a man or woman with at least two parts of the body besides the head?[F]

Does (child) know (his/her) own age?[L]
Yes No

Does (child) know (his/her) own sex?[L]
Yes No

*L: language scale; M: large motor scale; F: fine motor/adaptive scale; P: personal-social scale.

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