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THE SPECIAL EDUCATION COSTS OF LOW BIRTHWEIGHT

Stephen Chaikind

Hope Corman

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ABSTRACT

This paper investigates the relationship between low birthweight, enrollment in special education and special education costs in the United States. We use the Child Health Supplement to the 1988 National Health Interview Survey, obtaining a sample of approximately 8,000 children aged 6 to 15 who are in school. For these children, we calculate the probability of attending special education, holding constant individual, family and regional variables. We find that children who weighed less than 2500 grams at birth are almost fifty percent more likely to be enrolled in any type of special education than children who were of normal weight at birth. Since previous studies have found the incremental cost of special education (1989-1990) to be $4,350 per student, this results in an incremental cost of special education of $370.8 million (1989-1990) per year due to low birth weight, holding other characteristics constant. These costs, which were conservatively estimated, imply that previous studies, which considered only medical expenditures, substantially underestimate the full cost of low birthweight.

Stephen Chaikind
School of Management
Gallaudet University
800 Florida Avenue N.E.
Washington, D.C. 20002

Hope Corman
Department of Economics
Rider College
Lawrenceville, NJ 08648-3099

I. Introduction

Low birthweight[1] is a serious problem in the United States for several reasons. First, low birthweight is the leading cause of neonatal and infant mortality in the United States. Second, low birthweight survivors are more likely to experience serious health problems in infancy and beyond. Third, low birthweight youngsters are more likely to experience preschool developmental delays, and fourth, low birthweight children are more likely to experience problems in school. The incidence of low birthweight falls disproportionately on poor, poorly educated and black mothers. Although recent medical advances have improved the survival and health of low birthweight babies, the incidence of low birthweight has stopped declining, and has, in fact, risen in the past few years.[2] The rise in low birthweight coincides with an increase in the fraction receiving late or no prenatal care.[3]

Recent studies by the Institute on Medicine (1985), the U.S. Office of Technology Assessment (1987 and 1988a) and Schwartz (1989) detail the infant and child health costs associated with low birthweight. Work by Joyce, Corman and Grossman (1988) indicates that early prenatal care is the most cost-effective means of reducing low birthweight and neonatal

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[1] Low birthweight is medically described as a live birth with a weight of less than 2500 grams.

[2] According to the National Center for Health Statistics (1990), for whites and for blacks, the incidence of low birthweight was at an all-time low in 1984--5.59 percent of white live births and 12.36 percent of black live births. The percent of live births which are low birthweight increased almost two percent for whites and almost three percent for blacks between 1984 and 1987.

[3] According to the U.S. Department of Health's National Center for Health Statistics (1990) the percent of births where prenatal care began in the third trimester, or where there was no prenatal care at all, increased approximately 20 percent between 1980 and 1987.

mortality. These studies all point to policies related to small expenditures for a large number of women in early pregnancy rather than large expenditures for unhealthy children after birth. The studies, thus far, have done an excellent job assessing the health costs, but none to date has provided concrete educational costs associated with low birthweight. The purpose of this study is to fill that gap in the literature by estimating costs associated with low birthweight. These costs can be added to the health costs in order to more fully estimate the total societal costs of low birthweight.

We postulate that there is a direct relationship between those who were low birthweight and those needing and receiving special education services, and that lowering the incidence of low birthweight will yield significant cost savings to the educational infrastructure. We are able to assess the relation between low birthweight and special education in a multivariate context on a nationally representative sample, using the 1988 National Health Interview Survey's Child Health Supplement. Since the passage of the Education for All Handicapped Children Act in 1975 (EHA, PL 94-142), school systems are required to provide special educational services for all handicapped children in need of such services; the cost of such special education services in the United States are substantial. For example, in the 1985-1986 school year, Moore et al. (1988) find the total cost of educating a special pupil to be 2.3 times the cost of educating a regular education pupil--an incremental cost of $3,555 per pupil per year. The U.S. Department of Education (1990) estimated approximately 4.4 million children served by special education in the same period. Thus, in the 1985-86 school year we spent approximately $16 billion in excess of regular educational expenses for special education--we estimate this cost to be close to $20 billion for the 1989-90 school year.

II. Low Birthweight and Special Education

Since the mid-1960's, technological improvements in neonatal intensive care have increased survival rates for low birthweight babies. The current (1988) population of school-aged children were all born during this period of improved neonatal care. Some of these school children have survived despite their prematurity and very low birthweight. Numerous studies have examined morbidity of these survivors during the pre-school period. In extensive literature reviews, Budetti et al. (1981) Stewart et al. (1981) and the U.S. Office of Technology Assessment (1987) all find that although the survival rate of low birthweight babies has increased dramatically, the rate of serious handicaps[4] among survivors has not increased. In fact, the overwhelming majority of survivors do not incur serious handicaps.

In studies with longer follow-up periods for low birthweight survivors, however, researchers such as Francis-Williams and Davies (1974), Hunt et al. (1988), Klein (1988), Klein et al. (1989), and Noble-Jamieson et al. (1982) found more subtle neurological differences between the low birthweight survivors and normal birthweight peers. Such "soft signs" indicate potential learning disabilities and emotional problems. Over half of the students enrolled in special education in the United States are classified as either learning disabled or emotionally disturbed, and fewer than one quarter are "seriously handicapped" as defined above.[5] Thus, the

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[4] Serious handicaps are defined as IQ under 70, significant cerebral palsy, major seizure disorders, blindness or severe hearing impairment.

[5] According to the United States Department of Education (1990), in the 1988-1989 school year, for students who were in elementary and secondary special education, 56.9 percent were classified as either learning disabled or emotionally disturbed, and another 24.2 percent were classified as speech or language impaired. The remaining 18.9 percent were either mentally retarded, severely hearing impaired, orthopedically handicapped, other health impaired, visually handicapped, or multihandicapped. The "seriously" handicapped children would most likely

majority of children in special education would exhibit "soft signs" rather than serious handicaps in early childhood.

Only one study to date has specifically examined the risk of educational handicaps for low birthweight children. Carran et al. (1989) examined two cohorts of inner city-born children from Dade County, Florida. They found an overall higher risk of educational handicap in the low birthweight children compared to a control group of normal birthweight children born in the same hospital. They also found that the risk of educational handicap increases with age. One possible explanation is that "mild" educational problems do not develop (and/or are not recognized) to the extent of interfering with school performance until middle childhood. The authors suggest long-term follow-up studies to assess the true impact of low birthweight on educational achievement.

The current literature, in addition, offers some interesting insights about relationships between low birthweight and special education. First, studies which examine the socio-economic status of the family, as well as low birthweight, indicate that there is an interaction between the two--that low birthweight children from economically disadvantaged households incur more severe handicaps than low birthweight children from economically advantaged households. That is, low birthweight (and subsequent infant health) is only one factor in determining neurological, physical or emotional handicapping conditions that might require special education. Second, according to The Infant Health and Development Program (1990), enrollment from birth to 36 months in early intervention programs, which were not, at the time of the study, mandated by federal law, significantly improves health, intelligence scores and behavior for three year olds. Third, a recent study by Singer et al. (1989) shows that

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be placed in the latter group of classifications.

classification of children into special education and into specific categories of handicapping conditions were found to vary significantly between school districts, indicating that any study which focuses on only one geographic area may not be representative of the entire U.S. in its availability and classification of special education programs.

In the current study, we first examine the relationship between low birthweight and special education in both simple and multivariate contexts. We hold constant many of the social, economic and family factors which are thought to be related to special education. We also use a national sample of children, rather than focusing on one geographic area which could have unusual special education characteristics. Thus, the results are more general than previous studies. The impact of low birthweight on special education is then used to generate cost figures.

III. Data

We use the 1988 Child Health Supplement (CHS) released by the National Center for Health Statistics for our empirical test of the relation between low birthweight and special education. The CHS is a sub-sample of the National Health Interview Survey.[6] We focus on the 6 to 15 year old age group to assure maximum rate of school attendance.[7] Of the 7,738 children in the sample, 6,788 had known values for the variables in

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[6] Refer to U.S. Department of Health and Human Services (1989) for a full description of the National Health Interview Survey. The Child Health Supplement randomly selects one child from each family, and collects detailed health and demographic information on the child and on the family.

[7] We exclude those under 6 years of age because of varying laws and practices regarding special education for those in pre-school and kindergarten. We exclude those 16 years old and over because the decision to drop out of school might be related to problems encountered in school. The effect of poor neonatal health and learning or other school problems on school drop-out rates is a separate issue to be explored in further research.

the analysis. Table 1 presents mean values and standard deviations for the sample of 6,788, and also presents mean values weighted by the population weights presented in the data set. It should be noted that the weighted means are quite similar to the (unweighted) sample means, indicating that the sample is similar to the U.S. population, for the relevant variables.[8] The data are for the 1987-88 school year.

Because our indicator for special education is imprecise, we use two different measures. The CHS asks whether the child is limited, because of health, in school activities. One category within the "school limits" question is "attends special school/classes." This question also has a "not limited" category, which includes those who did not know if their children were in special education classes. In a separate part of the questionnaire, the questions relate to whether the child ever had a delay in development, a learning disability, or emotional/behavior problems. The respondent was asked whether the child attended a special class in the past twelve months for each problem. Our first measure of enrollment in special education equals one if the "school limits" question indicates a child attends special schools or classes or if the child attends special education only due to a developmental delay, learning disability or emotional problem. Otherwise, special education enrollment equals zero. This is our more general measure, which we designate "special education of any kind."

About 7.3 percent of our sample and 7.2 percent of the population (weighted mean) fits the more general measure of enrollment in special education of any kind. However, according to U.S. Department of Education (1990) and U.S. Bureau of the Census (1990) enrollment and population data, approximately 9.9 percent of all children aged 6 to 15 were enrolled in

[8] Note that the National Health Interview Survey explicitly over-sampled blacks, which is reflected in Table 1.

some form of special education. We postulate most of this difference occurs because it is likely that CHS respondents excluded children with speech impairments from those reported to be enrolled in special education classes, since family members probably do not consider speech problems as a significant health impairment limiting school activities, as specifically asked on the questionnaire.[9] If we exclude children classified as speech impaired, approximately 7.3 percent of all children were enrolled in special education, close to our weighted sample mean.[10] Two other factors might also influence differences between the sample and actual measures of enrollment in special education: first, a small fraction of children in special education are in residential facilities and are therefore not living at home and might not show up in the sample data; and second, the children whose "school limits" variable was unknown were coded as not being in special education. Altogether, and assuming a small response to special education for speech impaired children, our figures correspond well to published national figures.

However, to further test the plausibility of our national aggregate estimates, we devised a second, more limited, measure of special education participation. Here, we only include children in special education because of a developmental delay, behavioral problem or learning disability. This measure, designated as "learning disabled, emotional

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[9] Most children receiving school speech services are in regular classrooms for the majority of the school day.

[10] These data were derived as follows: according to the US Department of Education (1989), there were, in the 1987-1988 school year, approximately 3.4 million children aged 6 to 15 who were receiving special education services in total. According to The U.S. Bureau of the Census (1990), there were 34.3 million children aged 6 to 15 in the United States in 1988. Thus, approximately 9.9 percent (3.4 million / 34.3 million) of children in the United States were enrolled for special education. If .9 million speech and language impaired children receiving services are omitted, 7.3 percent (2.5 million / 34.3 million) are enrolled.

problems or developmental delay," is more specific to actual classification categories in special education. The sample unweighted mean is 6.5 percent and the population (weighted) mean is 6.4 percent. These correspond very closely to national figures for the 1987-88 school year.[11]

Table 2 presents the relationship between low birthweight and special education, without holding constant the important explanatory variables. Our survey data show that normal birthweight babies have a 6.9 percent chance of being in special education of any kind, whereas low birthweight babies have an 11.3 percent chance of being in special education. This means that low birthweight babies are 64 percent more likely to attend special education of any kind than normal birthweight babies. For the more specific definition of special education, low birthweight babies are 48 percent more likely to attend special education than normal birthweight babies.

IV. Multivariate Estimation

The raw data in the previous section provide a first and simple indicator of the increased likelihood of being enrolled in special education programs for low birthweight children. However, because many of the same factors related to the probability of having a low birthweight baby are also related to the probability of being in special education, given birthweight, it is important to estimate the probability of attending special education in a multivariate context. For example, Corman and

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[11] Using the same data and sources as in footnotes 10, there were, in the 1987-1988 school year, approximately 2.2 million children aged 6 to 15 who were receiving special education services under three classifications: mentally retarded, emotionally disturbed or learning disabled. These correspond to the three health classifications of developmentally delayed, emotional/behavioral problems or learning disability. Taking these as a ratio of the 34.3 million 6 to 15 year olds, approximately 6.4 percent of children in the United States were enrolled for special education for the three specific classifications.

Grossman (1985) found poverty to be a significant predictor of neonatal mortality.[12] And Carran et al. (1989) found that low family income increases the probability of being in special education for children who were of low birthweight. Since low income (poverty), low birthweight and special education are all directly related, a simple estimate of the relation between low birthweight which excluded poverty would tend to overstate the relation between low birthweight and special education.

For the multivariate estimation, then, we use a logit function with a dichotomous dependent variable. The dependent variable is equal to one if the child is in special education, zero if not. We use several measures of the family's home environment, the child's characteristics and regional differences as right hand variables, as well as birthweight. First, to hold constant the effect of the current home environment of the child we include three variables: whether the household is a two-parent household; whether the family is below the poverty level, as defined by the National Health Interview Survey; and the education level of the head of the household.[13] We would expect children who are not poor,[14] and whose household head is well-educated to be less likely to be in special education.[15] A two-parent household would also be expected to reduce the

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[12] Low birthweight is strongly related to neonatal mortality rates.

[13] In early estimates, we also included a variable for household income. Once we hold constant the education of the household head and poverty, this variable was never statistically significant. Therefore, we excluded it in subsequent estimates.

[14] Note, however, that because special eduction is more costly for the school district than regular education, children living in poor school districts may have to be more educationally needy to receive special education services.

[15] In preliminary estimates, we included variables relating to the number of siblings and birth order. We hypothesized that the greater the number of children, the fewer resources the parents could devote to each child, and the greater likelihood of requiring special education. These variables were never found to be statistically significant.

likelihood of requiring special education.

Four variables in the specification relate to the child's characteristics: age, sex, a dichotomous variable for Hispanic ethnicity and a dichotomous variable for Black ethnicity. As stated above, other researchers have found the likelihood of requiring special education to increase with the child's age, as handicapping conditions are discovered. Also, younger children have had access to more sophisticated medical and educational services in infancy and the pre-school period. Therefore, younger children may be less handicapped when reaching school age because of the greater level of medical and educational services which were previously received. Generally, boys are found to be more in need of special educational services than girls. The ethnicity variables may reflect differences in access to health and educational services.

We also include a dichotomous variable for whether the child lives in an SMSA, and for three of the four regions of the United States reported in the CHS. These variables are included to account for geographic differences in health and education programs and in classification schemes.[16] Finally, we include a dichotomous variable for whether the child was a low birthweight neonate. Holding the family, geographic, and demographic variables constant, we expect a positive relationship between low birthweight and enrollment in special education.

We test our model using the two alternative measures of special education as our dependent variables. A non-weighted logit procedure is

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[16] The four national regions are the most detailed geographic information reported on the NHIS's public release tape. The decision regarding classification into special education and placement of the child, given classification, is made at the school district level. By including only the broad regional variables, we do not fully account for the district-to-district variations in special education.

used.[17] Results are presented in Table 3. Equation A is the more general definition of enrollment in special education and equation B is for enrollment due only to learning disability, emotional problem or developmental delay. The logit coefficients appear in columns (1) and (3) for each specification, respectively. These coefficients are converted to OLS-type equivalents, presented in brackets below the logit coefficients.[18] The standard errors of the logit coefficients appear in columns (2) and (4), respectively. The overall equations are highly significant.[19]

Except for some regional variables, all coefficients are statistically significant, and have the expected sign. For example, children in poor households are more likely to be enrolled in special education[20] and children in two-parent households are less likely to be enrolled in special education. The more educated the household head, the less likely the enrollment of the child in special education. Girls are less likely to be enrolled in special education, and the likelihood of special education increases with age, as Carran et al. (1989) found. The coefficient on low birthweight is positive and highly significant in both

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[17] Maddala (1983, p.171) states that when using a stratified sample, there is no reason to use a weighted least squares procedure when the stratification is based on the right-hand variables, rather than on the dependent variable.

[18] The logit equation is of the functional form: $\ln P/(1-P) = a_0 + b_i X_i$. The OLS-type coefficient, evaluated at the mean, is found by taking the partial derivative of P with respect to X_i. This is: $b_i\ (P)\ (1-P)$. We use the (weighted) mean for P to derive the value of the OLS-type coefficient.

[19] A likelihood ratio test was performed on equations A and B to test the null hypothesis that all coefficients equal zero. The null hypothesis was rejected at the 99% confidence level.

[20] In a separate equation, not presented above, we ran a model which interacted poverty and low birthweight. We found that children who are both poor and low birthweight are more likely to be in special education than the additive effects of the two variables, presented in Table 3.

equations.

We did not predict signs for the geographic variables. The results indicate that those living in SMSA's are more likely to be enrolled in special education, and that those living in the mid-west (the excluded category) are more likely to be in special education. We interpret these to be access-related variables. Further, Black and Hispanic children are less likely to be in special education, holding all else constant. Again, we interpret this as an access variable, since we are holding constant infant health, household characteristics, and regional differences.[21]

These results also provide some indication of the magnitude of the relationship between low birthweight and special education enrollment. The OLS-type coefficient in equation A, evaluated at the mean, indicates that a child who was a low birthweight baby is 3.5 percentage points, or close to 49 percent[22] more likely to be enrolled in any type of special education than a child who was of normal birthweight. Equation B indicates that a child who was low birthweight is 2.4 percentage points, or 38 percent more likely to be enrolled in special education for a developmental delay, a learning disability or an emotional problem. These results confirm previous research, discussed above, which predicted that the "soft" neurological signs found in preschoolers might predict educational problems during school years.[23]

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[21] This is an interesting result, in light of the Singer, et. al. (1989) study, and deserves further research into ethnic differences in access to special education.

[22] 3.5 divided by 7.2 (the weighted mean of overall special education enrollment) is 48.6 percent.

[23] Our results are consistent with Carran et al. (1989), the only other study which specifically examines special education enrollments. Our studies differ, however, since the Carran et al. study divides the children into low (1500-2499 grams) and very low (less than 1500 grams) birthweight categories. Because of the large number of variables and the small numbers of children who were very low birthweight, we consolidated the two

V. The Special Education Costs of Low Birthweight

The previous sections have demonstrated that children born with low birthweight are disproportionately more likely to be receiving some type of special education instruction, both in aggregate and only for those classified as learning disabled, having emotional/behavioral problems and developmental delays. Overall, our sample indicates that low birthweight children are 64 percent more likely to be enrolled in special education classes than normal birthweight children if only medical factors equally likely for both groups are controlled for. This probability is reduced to 49 percent if other family, social and economic factors are controlled for, as indicated by our logit results. For the more limited sample of learning disabled, emotionally disturbed and developmentally delayed children, the corresponding percentages are 48 percent and 37 percent. Hence, the incidence of low birthweight births can have a significant cost impact for special education programs. In this section, we estimate the potential magnitude of such costs.

In order to estimate costs that are current and useful for policymakers, we needed to resolve several key issues. First, because special education services and costs are now intrinsically tied to the provisions in the Education of the Handicapped Act (EHA) and Chapter 1 of the Elementary and Secondary Education Act (ECIA), as amended, we limit our estimate to recent data reflecting the full implementation of these laws. The EHA was enacted in 1975, with national implementation beginning in

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birthweight categories to allow a more precise estimation. In other estimates, not presented above, where fewer right-hand variables were used, our results indicated that both categories were positively and significantly related to enrollment in special education, and that very low birthweight children were far more likely to be in special education classes than the low birthweight children. This distinction deserves further research.

1977.[24] Data representing the full impact of these laws on costs were therefore not available prior to the early 1980's, when they were first provided by all states. Second, since our data show a nationally representative relationship between low birthweight and special education participation, we also base our estimate on a single nationally representative average cost for such services. A single authoritative national cost for special education, however, is difficult to determine for several reasons, notably because funding for special education programs is decentralized--with money flowing from federal, state and local sources. In addition, costs are often reported for and vary greatly across each individual handicapping condition and program type.[25] Third, any assessment of the costs of special education need be marginal to the costs of regular education; that is, the total or per pupil cost should be in addition to funds that would be expended if there were no special education services provided.

Fortunately, the recently released expenditure survey by Moore et al. (1988) addresses several of these problems. This study is a relatively recent nationally representative large scale special education cost analysis. Using an adapted resource cost methodology and data developed

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[24] Another reason to limit our analysis to the post-1975 period is that improvements in low birthweight survivability resulting from neonatal intensive care advances stabilized around 1975 (see Hoy, Bill and Sykes (1988)). These advances have implications for special education services and costs.

[25] Children with handicaps can receive special education services in several different types of programs. The three most common are resource, self-contained and preschool programs. In resource programs, which are sometimes referred to as "pull-out" programs, children generally spend most of their classroom time in regular classrooms, receiving special services for usually under 15 hours each week in either the regular classroom or in a resource room. Self-contained programs serve students for longer periods of time each week (and may include programs in special schools), while preschool programs serve those under the age of 6. Other types of services are provided in residential and home/hospital programs.

from a survey of school district expenditures, they show that average per pupil special education expenditures were $3,649 in 1985-86.[26] Each of the 60 districts surveyed (located in 18 states) reported information on the resources used, resource costs, and pupils enrolled in both special and regular education programs. In addition to national average costs, the study also provided separate costs for resource, self-contained, preschool and residential programs. And, importantly, they provide a true marginal cost approach to special education expenditures by defining the excess costs of special education as "...the total costs required to educate a special education student minus the costs to educate a regular education student...." (p. 101). In the 1985-86 school year, they estimate this excess cost to be $3,555 per pupil for all programs. The marginal costs for special education are less than the average per pupil costs because most special education recipients receive at least some regular education services.

These estimates have been corroborated with actual data on expenditures and enrollment reported by the U. S. Department of Education (1990). In the 1985-86 school year, the last year for which aggregate cost data are available, total federal, state and local expenditures from both the EHA-B and Chapter 1 of ECIA (SOP) programs totaled $16 billion for all age groups, the same as the $16 billion total cost estimate presented in the Moore et al. study. Further, dividing these total expenditures by the nearly 4.4 million children ages 0 - 21 served by these funds in that year, we have a per child estimate of $3,669--similar to the $3,649 estimate reported by Moore et al.

Kakalik et al. (1981), the previous large scale national study on

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[26] For reviews of the various methods used to estimate special education expenditures, see Moore et al. (1988); Slobojan (1987); and Raphael, Singer and Walker (1985). The resource cost method was devised by Hartman (1979) and Chambers and Parrish (1983).

special education expenditures used a similar methodology as Moore et al. Kakalid et al. estimate the added costs of special education as $1927 (in 1977-78 dollars) more than the cost of regular education; the total cost for educating a handicapped child in that year was 2.17 times the cost of regular education (pp. 31-32 and 41).[27] Moore et al. use this estimate to calculate a total real growth in per pupil special education costs of approximately 10 percent between this 1977-78 estimate and their 1985-86 estimate (p.66). Other studies provide less useful comparisons because they pre-date the full implementation of the EHA,[28] focus more narrowly on specific school districts, localities or program types,[29] or concentrate on costs for specific handicapping conditions.[30]

Hence, we use the $3,555 per pupil marginal cost presented in Moore et al. as the basis for our estimate.[31] In terms of constant 1989-90 dollars, we estimate per pupil cost will be $4,350, derived by inflating the $3,555 1985-86 cost by the Consumer Price Index between the two

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[27] Moore et al. estimate this ratio to be 2.3 for all program types on average.

[28] Rossmiller et al. (1970), for example, provided cost estimates based on a representative sample of 27 school districts (with 24 reporting usable data) for the 1968-69 school year. This study also reviews earlier cost estimate approaches.

[29] Raphael, Singer and Walker (1985) and Singer and Raphael (1988), for example, derive per pupil expenditure estimates for three metropolitan school districts using information on student and teacher time-use and school district budgets; these estimates, however, are not meant to be national in scope.

[30] Kirchner (1983) and Czerwinski (1982), for example, examine the costs of services specifically for blind and visually impaired children.

[31] We use an average per pupil cost in this paper because we are estimating the effect of low birthweight on enrollment in special education programs in aggregate. That is, we assume that low birthweight affects all handicapping conditions, on average, equally.

periods--an increase of approximately 16.5 percent in total,[32] and by adding a real growth rate of 1.25 percent annually.[33] It is likely that this real growth assumption understates the actual real growth rate for future years, since the special education annual reports show a total per child increase of 13.0 percent between 1984-85 and 1985-86 alone, a period when the inflation rate was between 3 and 4 percent. We note that while the costs for special education services actually range from well under $2,000 to over $20,000 per pupil (in 1985-86) depending on handicapping condition and type of service provider (Moore, pp. 86 and 107), we use the average cost across all handicapping conditions and providers in this paper. Our constant 1989-90 dollar estimate of $4,350, then, indicates a total expenditure for special education in 1989-90 of between $19 and $20 billion dollars, depending on caseload growth.

Based on the above reported increased probability of being in a special education program if born with a low birthweight, the average costs per pupil, and number of low birthweight children who are aged 6 to 15, we can estimate the potential costs to the public educational system of low birthweight, and on the magnitude of potential savings from reducing the incidence of low birthweight children. These results are presented in Table 4. At the simplest level, we estimate the total enrollment and costs to special education programs resulting from low birthweight (among children ages 6 to 15) if we assume equivalent risks shared by both normal

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[32] The price index for the last two months in the 1989-90 school year (July and August) was not available at the time of this writing; we assumed a rate of increase for these two months equal to that of the previous two months to estimate the inflation rate between the 1985-86 school year and the 1989-90 school year. A school year was assumed to run from September through August. The price index used was the CPI-W.

[33] A total real growth in per pupil special education costs of 10 percent between 1977-78 and 1985-86 was calculated by Moore et al. (p. 66) as noted above. We assume that this approximate 1.25 percent real growth rate continues subsequent to the 1985-86 school year.

and low birthweight children (i.e. no control for other background variables). The resulting 4.4 percent differential between the two groups translates into an additional 107,000 low birthweight pupils enrolled as the result of their birthweight conditions, costing an estimated $466 million in 1989-90.[34]

However, as shown above, controlling for concurrent family and economic background factors which can influence the need for special education services reduces the probability that low birthweight children will be in such programs to 49 percent, or 3.5 percentage points. We can conclude, then, that approximately 85,000 children in special education programs are enrolled due to handicapping conditions that result primarily from the fact that the were born at less than 2500 grams. Services for these children require approximately $370 million in expenditures in the 1989-90 school year.

Our estimates of the special education costs of low birthweight are conservative (underestimates) in several respects. First, we only examine children aged 6 to 15. Additional costs accumulate for children over the age of 15 and under the age of 6.[35] Second, we use a conservative estimate to inflate the average per pupil costs from the 1985-86 base to 1989-90 dollars. In addition, as noted above, our sample data

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[34] Our estimate of the number of 6 to 15 year olds born with low birthweights is 2.435 million, based on a 7.1 percent incidence of low birthweight, and 34.3 million 6 to 15 year olds. 4.4 percent of these 2.435 million low birthweight 6 to 15 year old children equals slightly more than 107,000.

[35] By restricting our study to 6 to 15 year olds, we account for only 3.4 million of the approximately 4.6 million students in special education in the 1988-1989 school year. [Source: U.S. Department of Education (1990)]. We arrive at the 3.4 million estimate by including the 3.95 million school aged children 6-17 served by EHA-B and Chapter 1 of ECIA (SOP), subtracting the approximately .5 million children ages 16 and 17 receiving EHA-B services, the rounding down further to account for an unknown number of ECIA 16 and 17 year olds (even though it is likely there are not a large number of such participants).

underestimates the percentage of those receiving special education services when compared to population estimates; the two probable explanations for this undercount might also have cost impacts. First, children receiving services from residential programs are not included in the data. If the impact of low birthweight is greater on this more costly program type, then the differential between the shares of normal and low birthweight children in special education might be higher than the estimate shown--as would be the costs. However, if the undercount occurs because parents are less likely to report children with lesser disabilities (such as speech impairments) as receiving special education services, then the differential could be higher or lower, depending on the relationship between birthweight and those handicapping conditions. There is no a priori way to tell the direction of this difference, and such omissions might affect costs in either direction as well.

Because information on those classified as learning disabled, mentally retarded and emotionally disturbed appear to be more fully reported, we provide parallel estimates of the costs of low birthweight for only those three handicapping conditions, excluding those with speech impairments and other disabilities from the estimates. As can be seen from Tables 2 and 4, the differential between the chance of normal and low birthweight children in these three groups being in a special education program is 3.0 and 2.4 percentage points in the simple and multivariate estimate, respectively. These percentages translate into 73,000 and 58,000 children, and costs of $318 and $254 million annually.[36]

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[36] We continue to evaluate these pupils at the average per pupil cost of $4350. Even though we are excluding a large group of speech impaired services from this alternative estimate (most of which take place in less costly resource programs), we are also excluding the much more expensive services received by other children predominantly in self-contained and residential programs. We assume that these cost differences will balance, resulting in approximately the same average cost.

VI. Policy Implications

Given our conservative estimate of a $370 million dollar cost to federal, state and local special education budgets incurred by services to children whose handicapping conditions may be uniquely attributed to low birthweight, it can be seen that even small improvements in prenatal screening--especially to poor or teenage mothers--can lead to substantial future savings to the special education system. Policies, for example, which act to reduce the incidence of low birthweight children--or those which improve the weight of those in each weight category--by 10 percent annually (8,500 cases) potentially can save the educational system $37 million per year in constant 1989-90 dollars once all these children are enrolled in school, and close to $4 million in savings when the first cohort reaches the first grade in 6 years (assuming all handicapping conditions are diagnosed by age 6, and that the 10 percent improvement does not affect the distribution of those children who do and do not require special educational services).[37] It is likely that with the current emphasis on early educational intervention, however, budgetary savings would be more immediate; that is, as problems associated with low birthweight are recognized sooner and educational responses occur at an earlier age, the reduction in the incidence of low birthweights will lead to more immediate cost savings by reducing the costs of early intervention as well.[38]

It is important to point out that these savings to the educational

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[37] A small additional cost, however, might accrue if additional infants survive who would not have previously done so under less intensive prenatal care policy, and subsequently require special education services.

[38] We note that the immediate cost impacts of early intervention programs may mitigate the longer-term costs somewhat if the earlier intervention acts to reduce the need for future special education services. See The Infant Health and Development Program (1990).

system of improved prenatal screening to reduce the incidence of low birthweights births are in addition to the much more frequently discussed savings (and costs) accruing to the health care infrastructure; the educational benefits are rarely cited.[39] However, given the magnitude of the expected savings noted above, it is important to include educational benefits in any estimate of savings from improved prenatal care. For example, if, as a recent study by the U. S. Office of Technology Assessment (OTA) (1988b, p. 8) points out, "...encouraging poor women to obtain early prenatal care through expanded Medicaid benefits is a good investment for the Nation....", then the marginal additional savings in special education costs will make such care an even better investment. OTA projected that health costs and benefits of improved prenatal screening which would result from the expansion of prenatal care under Medicaid needs to prevent between 133 and 286 low birthweight births out of 194,000 eligibles to have benefits that outweigh their estimated $4 million costs. The study asserts that the effects of such prenatal care are expected to reduce such births by much more than the stated requirement. Our data indicate that for each 250 children who do not require special education, there will be ultimate and additional savings of at least $1 million annually. In another study, Schwartz (1989, p. 173), using data for hospitals representing only 54 percent of national low birthweight care, estimated that between $9 and $28 million (1985 dollars) in immediate health care net savings would result from improvement in the birth weights of 20 percent of all low birthweight infants up to the next 250 gram category. This projects to approximately $20 to $60 million in full year, nationally representative net savings in 1989-90. Compare this to our estimate that a 10 percent reduction in low

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[39] As noted previously, one recent study that did relate health conditions at birth with educational outcomes--albeit from one inner city hospital and through only one school system--is Carran et al. (1989).

birthweight births will save $37 million is special education costs each year when fully effective.

It may also be instructive to briefly illustrate the magnitude of the educational benefits in yet one more way, on the basis of an individual's cost. In 1984, OTA estimated that the average hospital cost of low birthweight infants is between $12,000 and $39,000 (roughly between $15,000 and $50,000 in 1990 dollars), with additional health care costs over the individual's lifetime. (U. S. Office of Technology Assessment, 1987) The cost of keeping one child in special education programs for 10 years in 1989-90 dollars, and assuming no discount rate, would be $43,500. Hence, the special education costs for children who need such services over a 10 year period are about as costly as the upper bound of initial hospital costs for an average low birthweight infant. If it is cost effective to prevent low birthweight births from a health care prospective, then there will be significant additional savings from the educational perspective as well.

Conversely, the recent and alarming surge in the births of infants exposed to illegal drugs, and especially those linked to the current crack cocaine epidemic, is potentially more explosive for policymakers. Many of these infants are born underweight, and exhibit the same special education needs as non-drug related low birthweight children. According to a special report by Chira (1990), approximately 100,000 infants are born each year exposed to crack cocaine. They cite the March of Dimes as saying that there could be between 500,000 and 4 million crack-exposed children by the year 2000 (p. B5). While data on this population group are still not clear (i.e. it is not known exactly what percentage of this group are low birthweight nor if a greater percentage of them will require special education services than other drug-free low birthweight infants), the costs for this group are potentially enormous. For every one percent of these children who require special education-that is, for every 5,000 to 40,000 children--annual special education costs ultimately will be increased by between $22 million and $175 million 1989-90 dollars.

VII. Conclusions

This note provides a preliminary basis for relating prenatal care and neonatal health conditions to the demand for special educational services. We provided preliminary evidence of such relationships, and indicated that cost-savings to the educational sector can be large. Indeed, we show that pre-natal screenings which lead to even a 10 percent reduction in low weight births will result ultimately in more than $37 million in additional annual savings in 1989-90 dollars.

Our investigation suggests that further research can focus on several issues. First, we provided information based on a specific data set; other data may unveil additional aspects of the issue. Second, we provided average data, aggregated across all health and handicapping conditions for those who demand special education services, and for three specific groups of special education enrolles combined. A clearer picture may arise if we are able to provide more detailed information by handicapping condition, providers of services, types of programs or other aspects of the need for special education services. Third, we focused on the economic benefits in terms of special education programs for school aged children; other benefits accrue to pre-school programs, post-secondary students, and workforce outcomes.

BIBLIOGRAPHY

Budetti, P., P. McManus, N. Barrand, et al. The Costs and Effectiveness of Neonatal Intensive Care (Health Technology Case Study #10) prepared for the Office of Technology Assessment, U. S. Congress, PB 82-101 411 (Springfield, VA: National Technical Information Service, August 1981).

Carran, Deborah T., et al. "The Relative Risk of Educational Handicaps in Two Birth Cohorts of Normal and Low Birthweight Disadvantaged Children," Topics in Early Childhood Special Education, Vol. 9, No. 1, 1989, pp. 14-31.

Chambers, Jay G. and Thomas B. Parrish. The Development of a Resource Cost Model Funding Base for Education in Illinois, Illinois State Board of Education, 1983.

Chira, Susan. "Children of Crack: Are The Schools Ready?" The New York Times, May 25, 1990, p. A1.

Corman, Hope and Michael Grossman, "Determinants of Neonatal Mortality Rates in the U. S.: A Reduced Form Model," Journal of Health Economics, Vol. 4, 1985, pp. 213-236.

Czerwinski, Michael H. A Study of Yearly per Case Costs For Regular Itinerant Services to Blind and Visually Impaired Children in New Jersey. New Jersey Commission For the Blind and Visually Impaired, March, 1982.

Francis-Williams, Jessie, and Pamela Davies, "Very Low Birthweight and Later Intelligence," Developmental Medicine and Child Neurology, Vol. 16, 1974, pp. 709-728.

Hartman, William T. Policy Issues in Funding Special Education Programs. National Institute of Education, School Finance Study. Washington, D. C, 1979.

Hoy, Elizabeth, John M. Bill, and Donald H. Sykes, "Very Low Birthweight: A Long-Term Developmental Impairment?" International Journal of Behavioral Development, Vol. 11, No. 1, March 1988, pp. 37-67.

Hunt, Jane, et al., "Very Low Birthweight Infants at 8 and 11 years of Age: Role of Neonatal Illness and Family Status," Pediatrics, Vol. 82, No. 4, October 1988, pp. 596-603.

Institute on Medicine, Preventing Low Birthweight, National Academy Press, Washington, D. C., 1985.

Jones, Philip R. Cost of Special Education: Is Mainstreaming Really Cheaper? Paper prepared for the American Education Finance Association, March 1990.

Joyce, Theodore, Hope Corman and Michael Grossman, "A Cost-Effectiveness Analysis to Reduce Infant Mortality," Medical Call, Vol. 26, No. 4 (April 1988) pp. 348-360.

Kakalik, J. S., W. S. Furry, M. A. Thomas, and M. F. Carney. The Cost of Special Education. The Rand Corporation, November, (1981).

Kirchner, Corinne. "Special Education for Visually Handicapped Children: A Critique of Data on Numbers Served and Costs." Journal of Visual Impairment and Blindness, May, 1983, pp. 219-223.

Klein, Nancy K., "Children Who Were Very Low Birthweight: Cognitive Abilities and Classroom Behavior at Five Years of Age." The Journal of Special Education, Vol. 22, No. 1, Spring 1988, pp. 41-54.

Klein, Nancy K., Maureen Hack, and Naomi Breslau, "Children Who Were Very Low Birthweight: Development and Academic Achievement at Nine Years of Age," Developmental and Behavioral Pediatrics, Vol. 10, No. 1, Feb. 1989, pp. 32-37.

Maddala, G. S., Limited-Dependent and Qualitative Variables in Econometrics, Cambridge: Cambridge University Press, 1983.

Moore, Mary T., E. William Strang, Myron Schwartz, and Mark Braddock. Patterns in Special Education Delivery and Cost, Decision Resources Corporation, Washington, D. C., December, 1988.

Noble-Jamieson, C. M., Diane Lukeman, M. Silverman, and Pamela A. Davies, "Low Birth Weight Children at School Age: Neurological, Psychological, and Pulmonary Function," Seminars in Perinatology, Vol. 6, No. 4, Oct. 1982, pp. 266-273.

Raphael, Ellen S., Judith D. Singer, and Deborah Klein Walker. "Per Pupil Expenditures on Special Education in Three Metropolitan School Districts." Journal of Education Finance, Summer, 1985, pp. 69-88.

Rossmiller, Richard A., James A. Hale, and Frohreich. Educational Programs For Exceptional Children: Resource Configuration and Costs. National Educational Finance Project. Department of Educational Administration. The University of Wisconsin, August, (1970).

Schwartz, Rachael M., "What Price Prematurity?" Family Planning Perspectives, Vol. 21, No. 4, July/August 1989, pp. 170-174.

Singer, Judith and Ellen Raphael, Per Pupil Expenditures for Special Education: To Whom Are Limited Resources Provided. Final Report, Collaborative Study of Children with Special Needs, Graduate School of Education, Harvard University, Cambridge, MA., August, 1988.

Singer, Judith D., et al., "Variation in Special Education Classification Across School Districts: How Does Where You Live Affect What You Are Labeled?" American Educational Research Journal, Vol. 26, No. 2, Summer 1989, pp. 261-281.

Slobojan, Alan. "Descriptive Cost Analysis of Special Education." Journal of Education Finance, Summer, 1987, pp. 99-106.

Stewart, Ann L., A. P. Lipscomb, and E. O. R. Reynolds, "Outcome for Infants of Very Low Birthweight: Survey of World Literature," The Lancet, May 9, 1981, pp. 1038-1041.

The Infant Health and Development Program, "Enhancing the Outcomes of Low-Birth-Weight, Premature Infants," JAMA, Vol. 263, No. 22, June 13, 1990, pp. 3035-3042.

U. S. Bureau of the Census, Statistical Abstract of the United States, 1990, (110th edition.) Washington, D. C, 1990.

U. S. Department of Education, Division of Innovation and Development, Office of Special Education Programs, Twelfth Annual Report to Congress on the Implementation of the Education of the Handicapped Act: 1990, Washington, D. C.

U. S. Department of Education, Division of Innovation and Development, Office of Special Education Programs, Eleventh Annual Report to Congress on the Implementation of the Education of the Handicapped Act: 1989, Washington, D. C.

U. S. Department of Education, Division of Innovation and Development, Office of Special Education Programs, Tenth Annual Report to Congress on the Implementation of the Education of the Handicapped Act: 1988, Washington, D. C.

U. S. Department of Health and Human Services, National Center for Health Statistics, Health, United States, 1989. Hyattsville, Maryland: Public Health Service, 1990a.

U. S. Department of Health and Human Services, National Center for Health Statistics, Vital and Health Statistics: Design and Estimation for the National Health Interview Survey, 1985-94, Series 2: Data Evaluation and Methods Research, No. 110, Hyattsville, Maryland: Public Health Service, 1990b.

U. S. Office of Technology Assessment, Congress of the U. S., "Neonatal Intensive Care for Low Birthweight Infants: Costs and Effectiveness," Health Technology Case Study 38, Washington, D.C., U. S. Government Printing Office, 1987.

U. S. Office of Technology Assessment. Healthy Children: Investing In the Future. Washington, D.C.: U. S. Government Printing Office, February, 1988a.

U. S. Office of Technology Assessment. Healthy Children: Investing In the Future--Summary. Washington, D. C.: U. S. Government Printing Office, February, 1988b.

Table 1

Means and Standard Deviations for 6 to 15 Year Olds, 1988[1]

VARIABLE	Sample Mean	Sample Standard Deviation	Weighted (Population) Mean
Two Parent Family@	.566	.496	.602
SMSA@	.755	.430	.755
NE@	.180	.384	.178
West@	.209	.406	.213
South@	.345	.475	.343
Hispanic@	.094	.291	.110
Black@	.174	.379	.150
Female@	.491	.500	.493
Head of Household's Education (years)	13.25	2.65	13.20
Poverty@	.164	.370	.187
Age	10.63	2.86	10.46
Low Birthweight	.075	.262	.071
Special Ed.-Any Kind@	.073	.260	.072
Special Ed.-Developmental@ Delay, Learning Disabled or Emotionally Disturbed	.065	.246	.064
N	6788	6788	6788

[1]Variables indicated by @ are dichotomous and equal to one if true for child. The sample summary statistics weight each child in the sample equally. The weighted means use population weights contained in the data set, and reflect means for the U.S. population.

Table 2

The CHS-Derived Simple Probability of Being Enrolled in Special Education

A. Special Education of Any Kind

1. Total Probability	7.3%
2. Probability If Low Birthweight Neonate	11.3%
3. Probability If Normal Birthweight Neonate	6.9%
4. Excess Probability [(2-3)/3]	64.0%

B. Learning Disabled, Emotional Problems or Developmental Delay

1. Total Probability	6.5%
2. Probability If Low Birthweight Neonate	9.3%
3. Probability If Normal Birthweight Neonate	6.3%
4. Excess Probability [(2-3)/3]	48.0%

Table 3

Probability of Attending Special Education Multivariate Logit Estimation

	Dependent Variable			
	EQUATION A Special Ed - Any Kind		EQUATION B Special Ed - Developmental Delay, Learning, Disabled, or Emotionally Disturbed	
Independent Variable	(1) Logit Coefficient [OLS-type coefficient]	(2) Standard Error	(3) Logit Coefficient [OLS-type coefficient]	(4) Standard Error
Intercept	-1.892	(.356)***	2.121	(.377)***
Two Parent Family	-.524 [-.035]	(.101)***	-.514 [-.031]	(.106)***
SMSA	.198 [.013]	(.116)*	.274 [.016]	(.123)**
NE	-.246 [-.016]	(.147)*	-.180 [-.011]	(.153)
West	-.285 [-.019]	(.143)**	-.265 [-.016]	(.151)*
South	-.144 [-.010]	(.119)	-.130 [-.008]	(.125)
Hispanic	-.512 [-.034]	(.194)***	-.641 [-.038]	(.212)***
Black	-.583 [0.039]	(.142)***	-.583 [.035]	(.149)***
Female	-.739 [-.049]	(.100)***	-.748 [-.045]	(.106)***
Head of Household's Education	-.040 [-.003]	(.020)**	-.052** [-.003]	(.021)**
Age of Child	.042 [.003]	(.017)**	.060 [.004]	(.018)***
Family Below Poverty Level	.409 [.027]	(.129)***	.396 [.024]	(.136)***
Low Birthweight	.523 [.035]	(.154)***	.401 [.024]	(.167)***
N		6788		6788
-2 Log Likelihood ratio	3385.4		3120.28	

*Significant at 10% level
**Significant at 5% level
***Significant at 1% level

Table 4

Estimated Costs of Special Education Related to Low Birthweight, Constant 1989-90 Dollars

A. All Types of Special Education

	Simple Estimate	Multivariate Estimate
(1) Differential enrollment rate between normal and low birthweight children*	4.4%	3.5%
(2) Number of low birthweight children ages 6 to 15**	2,435,300	2,435,300
(3) Number of children in special education programs ((1) times (2))	107,153	85,236
(4) Incremental per pupil cost of special education (see text)	$4,350	$4,350
(5) Total cost ((4) times (3))	$466.1 million	$370.8 million

B. Learning Disabled, Emotional Problems or Developmental Delay

	Simple Estimate	Multivariate Estimate
(1) Differential enrollment rate between normal and low birthweight children*	3.0%	2.4%
(2) Number of low birthweight children ages 6 to 15**	2,435,300	2,435,300
(3) Number of children in special education programs ((1) times (2))	73,059	58,447
(4) Incremental per pupil cost of special education (see text)	$4,350	$4,350
(5) Total cost ((4) times (3))	$317.8 million	$254.2 million

* From Tables 2 and 3.

** Assumes 34.3 million 6 to 15 year olds (source: U. S. Bureau of the Census, 1990) and that 7.1 percent of all children in survey are born with low birthweight (Table 1).