Maternal and Infant Factors Associated With Excess Kindergarten Costs

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ABSTRACT. *Objective.* **To estimate the excess educational costs at kindergarten from infant and maternal factors that are reported routinely at birth.**

Methods. **Birth and school records were analyzed for all children who were born in Florida between September 1, 1990, and August 31, 1991, and entered kindergarten from 1996 through 1999 (*N* = 120 554). Outcome measure was cost to state, derived from base allocation for students in regular classrooms plus multiplier weights for those who were assigned to 8 mutually exclusive special education categories or who repeated kindergarten.**

Results. **More than one quarter of the study cohort was found to be assigned to special education classes at kindergarten. Regression model estimates indicated that children who were born at <1000 g (*n* = 380) generated 71% higher costs in kindergarten than children who were born at ≥2500 g. Children who were born at 1000 to 1499 g (*n* = 839) generated 49% higher costs. Other birth conditions, independent of birth weight, were associated with higher kindergarten costs: family poverty (31%), congenital anomalies (29%), maternal education less than high school (20%), and no prenatal care (14%). Because of their prevalence, family poverty and low maternal education accounted for >75% of excess kindergarten costs. If 9% of infants who weighed between 1500 and 2499 g (*n* = 1027) could be delivered at 2500 g, then the state of Florida potentially could save $1 million in kindergarten costs. Savings of a similar magnitude might be achieved if 3% of mothers who left school without a diploma (*n* = 1528) were to graduate.**

Conclusions. **Any policy recommendation aimed at reducing education costs in kindergarten must take into consideration 3 factors: the prevalence of risk conditions whose amelioration is desired, the potential cost savings associated with reducing those conditions, and the costs of amelioration. Projecting these costs from information that is available at birth can assist school districts and state agencies in allocating resources.** ***Pediatrics*** **2004;114: 720–728;** ***developmental disabilities, epidemiology, special education, economics, very low birth weight, longitudinal studies, risk factors.***

ABBREVIATIONS. DOE, Department of Education; IDEA, Individuals With Disabilities Education Act.

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States and public school districts are required by federal law to provide educational services for children with disabilities. This mandate can have significant financial implications, as nearly 6 million students—1 of 8—require special education classes.[1] For the 1999–2000 school year, states spent ~$50 billion on special education services.[2] The total excess cost associated with assigning students to special education is estimated to be 2.3 times higher on average than the cost of students with no special needs.[3] These additional expenditures entail difficult financial decisions. The federal government covers ~7.5% of the total additional expenditure for special education students. States must either raise taxes or reduce other expenditures to fund the mandated special education costs. Increases in special education placement often lead to reductions in spending on regular-education students.[4]

Although sociodemographic factors at birth have been found to be the most important predictor of placement in special education, adverse perinatal conditions also play a significant role.[5–8] This study builds on earlier analyses of special education placement of children in Florida elementary schools[5,9,10] and quantifies the fiscal implications of maternal and infant conditions at birth on state education costs.

In addition to special education, repeating a grade is a contributor to excess kindergarten costs. Although grade retention decisions are more discretionary than are special education placements, these local decisions have fiscal bearing on the state as well as on the school district that makes the retention decision.[11] Given the recent push at both the state and national levels to reduce the prevalence of social promotion,[12,13] grade retention may be a major determinant of excess costs and needs to be considered alongside special education placement costs.[14]

To date, little research has been conducted on the relationship between perinatal conditions and educational costs. Previous studies have estimated a total cost associated with a particular birth condition, usually low birth weight or preterm birth; these studies combine expenditures on health care, child care, and special education[15–17] Reviews of these economic impact studies have not distinguished proximate costs (extended neonatal intensive care unit stays) from distal costs (reduced earning capacity).[18,19] Little is known about the earliest determinants of excess educational costs. One US study analyzed a single determinant of special educational costs, low birth weight.[20] The authors used the 1988 National Health Interview Survey data set, which, although representative of the then-current US low birth weight rate of 7.5%, was limited to <8000 students aged 6 to 15. The present study differs from this earlier study of special education costs in several respects: 1) the present study considers the effects of a wider array of biomedical and sociodemographic conditions on excess educational costs; 2) cost estimates include the additional cost associated with grade retention, which tends to parallel average special education costs; 3) it examines an entire state's population so that comparisons may be made to other state education systems; 4) a larger sample size permits attention to be focused on rare but extremely costly special education conditions and more adverse birth conditions as well as more commonplace ones; and 5) it uses more current data and therefore is more reflective of current finance allocation decisions faced by states.

The purpose of the present study was to estimate state expenditures at kindergarten from infant and maternal medical and sociodemographic factors that are known at birth. This analysis is limited to kindergarten costs because of the desire to use the most current data possible, and kindergarten special education outcomes are highly correlated with later special education outcomes. In so doing, it seeks to enlarge understanding of the fiscal implications of adverse maternal and infant birth conditions at entry to public school.

METHODS

Children who were born in Florida between September 1, 1990, and August 31, 1991, would have been expected to enter kindergarten in the 1996–1997 academic year. However, to capture children who were enrolled electively in kindergarten 1 year later than expected as well as children who were required to repeat kindergarten, we examined all kindergarten records between 1996 and 1999.

The birth cohort was generated from records in the Florida Department of Health Vital Statistics database. Birth records were linked to school records obtained from the Florida Department of Education (DOE) databases for the relevant academic years. Of the 197 659 infants who were born in Florida during 1990–1991, 125 430 (63.5%) were matched successfully with DOE records.

All records that had any missing values on the variables of interest were eliminated from the matched sample ($N = 4897$). To ascertain the representativeness of the matched birth-to-school cohort, we compared the distribution of 12 predictor variables in the 1996–1999 kindergarten study sample with the total vital statistics 1990–1991 birth cohort (Table 1). The kindergarten sample was not substantively different from the total birth population, with 1 exception: the school-age sample had a higher proportion of children who were poor at birth compared with the original birth cohort (37.1% vs 30.6%). This discrepancy arises from the fact that low-income families are less likely to send their children to private schools or to leave the state.[21] Nevertheless, because of the potential for selection bias, all estimations for poverty and non-poverty subpopulations were repeated to ensure that the central findings were not sensitive to the overrepresentation of poverty families in the analysis data set. In addition, a set of cost-estimate simulations was conducted using study and population means for each predictor variable.

Variables

Outcome Variable

The dependent variable was set to the state expenditure on the student through his or her completion of kindergarten, expressed in 2001–2002 dollars. Costs were measured using state school finance system formulas. Costs were derived from the student's primary exceptionality code in the student's Federal/State Indicator record in the DOE database. A child's primary exceptionality code identifies the disability requiring the greatest allocation of personnel resources in cases in which >1 disability is diagnosed. Each exceptionality generates a different amount of state funding to the school district. Students who were retained in grade and who also had an exceptionality were counted twice, once in each category. Retained students who were classified with 1 exceptionality in their first year of kindergarten and who were classified with a different exceptionality in their second year of kindergarten were coded with the weights (cost multipliers) associated with each exceptionality.

Predictor Variables

Infants were classified into 4 mutually exclusive birth weight groups: <1000 g, 1000 to 1499 g, 1500 to 2499 g, and ≥2500 g). Congenital anomaly and gender were dichotomous dummy variables. Children were divided into the racial/ethnic categories of white, black, Hispanic, and other (predominately Asian but including those identified as mixed race or Native American). Two time points for poverty were used. Poverty at birth was determined by verifying mother's eligibility for Medicaid during pregnancy. Poverty at kindergarten was determined by verifying child's participation in the school's free or reduced price lunch program. Eligibility for free or reduced price lunch is based on both family income and family size and like Medicaid-funded pregnancy services includes families whose income is <185% of the federal poverty level.

Mothers' previous pregnancy experience was divided into 3 categories: previous adverse pregnancy outcome (including any elective or spontaneous terminations or child death occurring after a live birth), no previous pregnancy experience, and 1 or more previous successful pregnancies. Number of prenatal care visits, derived from the birth certificate, was categorized into 3 levels: no prenatal care, 1 to 4 prenatal visits, and 5 or more prenatal visits. These cutpoints correspond roughly with the Adequacy of Prenatal Care Utilization Index.[22] Complications of labor and delivery and maternal marital status were dichotomous dummy variables. Maternal education was classified into 3 levels: mothers who did not graduate from high school, mothers who graduated from high school, and mothers who attended college for 1 or more years. Maternal age consisted of 4 categories: younger adolescents (11–17 years), older adolescents (18–19), women 20 to 35 years of age, and women older than 35 years.

Statistical Methods

Because there were a finite number of observed combinations of conditions generating excess cost, it was not appropriate to model cost as a continuous dependent variable. However, because the observed cost groupings could be ranked, an ordered multinomial-choice probit model was used for statistical analysis.[23] Ordered probit models are an extension of logistic regression that allows multiple categorical outcomes to be rank ordered. In this study, the probit model was used to relate the predictor variables to a rank ordering of cost outcomes. In total, 62 discrete values of cost were observed. For model tractability, these values were collapsed to 12 cost categories. The results presented are invariant to the choice of the number of cost categories.

Ordered probit regression coefficients cannot meaningfully be interpreted directly. Therefore, coefficient estimates were used to predict into which of the 12 cost categories each student would fall depending on the value of each predictor variable when the others were held constant. The numbers of students who were predicted to fall into each group were used to estimate the average kindergarten cost by risk factor.

All regression models make the assumption that all regression errors are independent. However, because student disability classification and retention decisions are made at the district level, it may be that errors were correlated within school districts. Failure to account for this correlation would lead to downward-biased measures of standard errors. Standard errors (and the reported P values) therefore were adjusted to account for clustering as well as heteroscedasticity. As a result, the reported significance levels are conservative.

RESULTS

Slightly more than 3% of the 1990–1991 birth cohort ($n = 4021$) was found to have been assigned to

TABLE 1. Comparison of Kindergarten Study Sample (N = 120 533) With Total Birth Vital Statistics Data Set (N = 195 474)

Risk Factor	Kindergarten Study Sample 1996–1999		Total Birth Vital Statistics Cohort 1990–1991*	
	n	%	*n*	%
Child				
Birth weight				
<1000 g	380	0.3	660	0.3
1000–1499 g	839	0.7	1283	0.7
1500–2499 g	7342	6.1	11 562	5.9
≥2500 g	111 972	92.9	181 867	93.1
Congenital anomaly				
Yes	1576	1.3	2613	1.3
None	118 957	98.7	191 833	98.7
Gender				
Male	62 217	51.6	99 996	51.2
Female	58 316	48.4	95 476	48.8
Race				
Black	30 123	25.0	42 135	21.6
Hispanic	19 942	16.5	31 700	16.2
Other	1641	1.4	3428	1.8
White	68 827	57.1	118 211	60.5
Poverty at birth				
No	75 870	63.0	135 598	69.4
Yes	44 663	37.1	59 876	30.6
Poverty at kindergarten				
No	52 054	43.2	—	—
Yes	68 479	56.8	—	—
Mother				
Previous pregnancy experience				
Adverse	35 985	29.8	57 393	29.4
None	35 898	29.8	62 412	31.9
Successful	48 650	40.4	75 669	38.7
Prenatal care visits				
1–4	5629	4.7	8395	4.4
≥5	112 121	93.0	177 149	93.3
None	2783	2.3	4376	2.3
Complications of labor or delivery				
Yes	38 920	32.3	62 961	32.4
None	81 613	67.7	131 493	67.6
Maternal age, y				
11–17	7431	6.2	10 292	5.3
18–19	11 148	9.3	16 222	8.3
20~35	94 484	78.4	155 430	79.6
≥36	7470	6.2	13 424	6.9
Maternal marital status				
Yes	78 164	64.9	133 508	68.3
No	42 369	35.2	61 959	31.7
Maternal education				
Less than high school	33 884	28.1	47 758	24.6
High school graduate	49 260	40.9	75 107	38.6
Greater than high school	37 389	31.0	71 581	36.8

* The combined numbers across all levels of some risk factors do not equal 195 474 because of missing values.

1 of 7 special education categories at kindergarten, excluding gifted and speech and language remediation (Table 2). An additional 28 016 (23.2%) children were assigned to speech or language remediation, a provisional student exceptionality but by far the largest component of special education counts at kindergarten. Independent of exceptionality, 4817 (4.0%) children were retained in grade.

The average per-pupil kindergarten cost was based on the state allocation of $3428 to school districts for kindergarten though third grade students in 2001–2002 before any increments owing to assignment to special education classes. The base cost for each of the 120 533 students was adjusted by including the weighted cost associated with each special education category or retention in grade. The resulting average annual per-pupil cost was calculated to be $4424. Examining the special education categories to which each child in a risk factor subgroup was assigned, an average cost for each risk factor group was then calculated (Table 3). Several predictor variables were associated with large (10% or greater) additional per-pupil costs in kindergarten: children who were born weighing <2500 g (and especially children who weighed <1500 g and <1000 g), children who were born with congenital anomalies, children whose mother did not complete high school, male children, and children whose mother had no prenatal care.

On the basis of the regression model, several risk categories were strong predictors of excess kindergarten costs (Fig 1): children <1000 g generated sub-

TABLE 2. Distribution of 1990–1991 Birth Cohort in 2 Excess Kindergarten Cost Categories: Special Education and Retention

Excess Cost Category	*n*	%
Physically impaired	416	0.3
Sensory impaired	158	0.1
Profoundly mentally handicapped	120	0.1
Trainable mentally handicapped	244	0.2
Educable mentally handicapped	1098	0.9
Learning disabled	1181	1.0
Emotionally handicapped	804	0.7
Speech and language impaired	28 016	23.2
Retained in grade*	4817	4.0

* Students retained in grade included children also assigned to special education.

stantially increased costs ($3150 on average) relative to children ≥2500 g. This pattern was also true for 1000- to 1499-g children, who were estimated to generate an average of $2150 more in costs to the state. Congenital anomalies and complications of labor and delivery both were associated with increased costs in kindergarten, averaging an estimated $1300 and $200 more per child, respectively. Children whose mother had <5 or no prenatal care visits also had higher costs compared with children whose mother had 5 or more prenatal visits, $600 and $300 dollars more per child, respectively.

Maternal and family characteristics also influenced kindergarten costs. Family poverty (a constructed variable indicative of both poverty at birth and poverty at kindergarten) was associated with an average excess cost of $1350. Children of mothers who did not complete high school exhibited $900 in excess costs. Costs associated with the individual risk factors in Fig 1 may be interpreted cautiously as additive. Thus, a student whose family is in poverty and whose mother did not complete high school would incur $2250 in excess kindergarten costs compared with a student whose family is not in poverty and whose mother attended college.

Total excess costs to the state associated with all risk factors were estimated at ~$160 million (Fig 2). The distribution by risk factor illustrates the frequently observed inverse relationship between high cost and low frequency. For example, birth weight <1000 g at $3150 per case was by far the most expensive risk factor, but it was a rare event, affecting 660 individuals in the total birth cohort. Therefore, the $2 million in excess costs associated with birth weight <1000 g amounted to little more than 1% of the total excess kindergarten costs. Because family poverty and low maternal education affect so many children in Florida, those 2 medium-cost risk factors alone accounted for more than three quarters of the total excess state costs for kindergarten.

To compare different pathways to saving a given amount of kindergarten costs, we set an arbitrary target of saving $1 million. The specific dollar figures

TABLE 3. Average Kindergarten Cost* Associated With 12 Risk Factors

Risk Factor	Average Kindergarten Cost in Dollars	Difference in Cost From Lowest Risk Group (*P* Value of Difference)
Birth weight <1000 g	6979	60% more than >2500 g ($P = 0.00$)
Birth weight 1000–1499 g	5740	31% more than >2500 g ($P = 0.00$)
Birth weight 1500–2499 g	4870	11% more than >2500 g ($P = 0.00$)
Birth weight >2500 g	4375	
Congenital anomaly	5197	18% more than no congenital anomaly ($P = 0.00$)
No congenital anomaly	4413	
Male	4729	15% more than female ($P = 0.00$)
Female	4101	
White	4502	13% more than Other ($P = 0.00$)
Black	4469	12% more than Other ($P = 0.00$)
Hispanic	4085	3% more than Other ($P = 0.05$)
Other (primarily Asian)	3980	
Poverty at birth	4681	9% more than no Medicaid ($P = 0.00$)
No poverty at birth	4275	
Poverty at kindergarten	4569	8% more than not school age poverty ($P = 0.00$)
No poverty at kindergarten	4222	
Successful previous pregnancy	4520	5% more than no previous pregnancy ($P = 0.00$)
Adverse previous pregnancy	4436	3% more than no previous pregnancy ($P = 0.00$)
No previous pregnancy	4286	
No prenatal visits	4817	10% more than 5 or more prenatal visits ($P = 0.00$)
1–4 prenatal visits	4731	8% more than 5 or more prenatal visits ($P = 0.01$)
5 or more prenatal visits	4386	
Complications of labor/delivery	4507	3% more than no complications ($P = 0.00$)
No complications of labor or delivery	4384	
Maternal age 11–17	4555	4% more than mother 20–35 ($P = 0.37$)
Maternal age 18–19	4590	4% more than mother 20–35 ($P = 0.20$)
Maternal age 36+	4407	0% more than mother 20–35 ($P = 0.67$)
Maternal age 20–35	4396	
Marital status married	4528	4% more than unmarried ($P = 0.09$)
Marital status unmarried	4368	
Maternal education less than high school	4676	12% more than > high school ($P = 0.00$)
Maternal education high school graduate	4400	5% more than > high school ($P = 0.00$)
Maternal education more than high school	4215	

* The average per-pupil cost for the 2001–2002 kindergarten year was $4424.

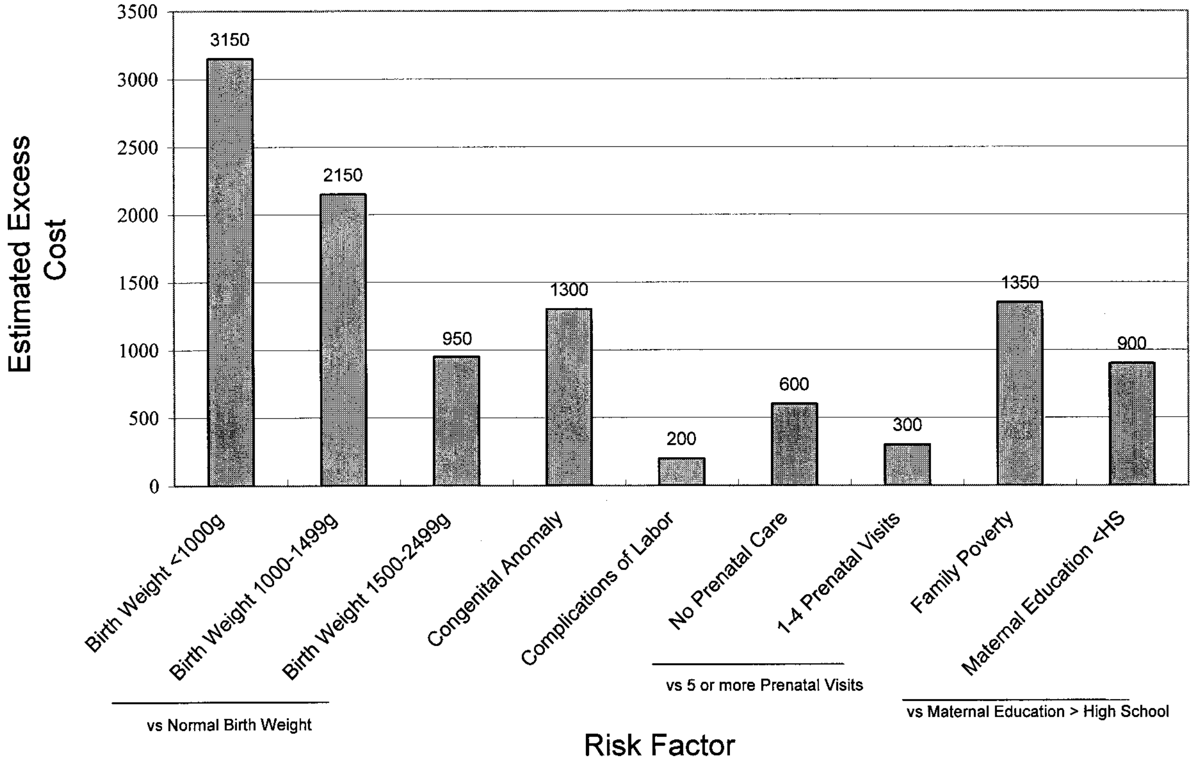

Fig 1. Estimated excess kindergarten cost associated with selected risk factors (relative to reference category).

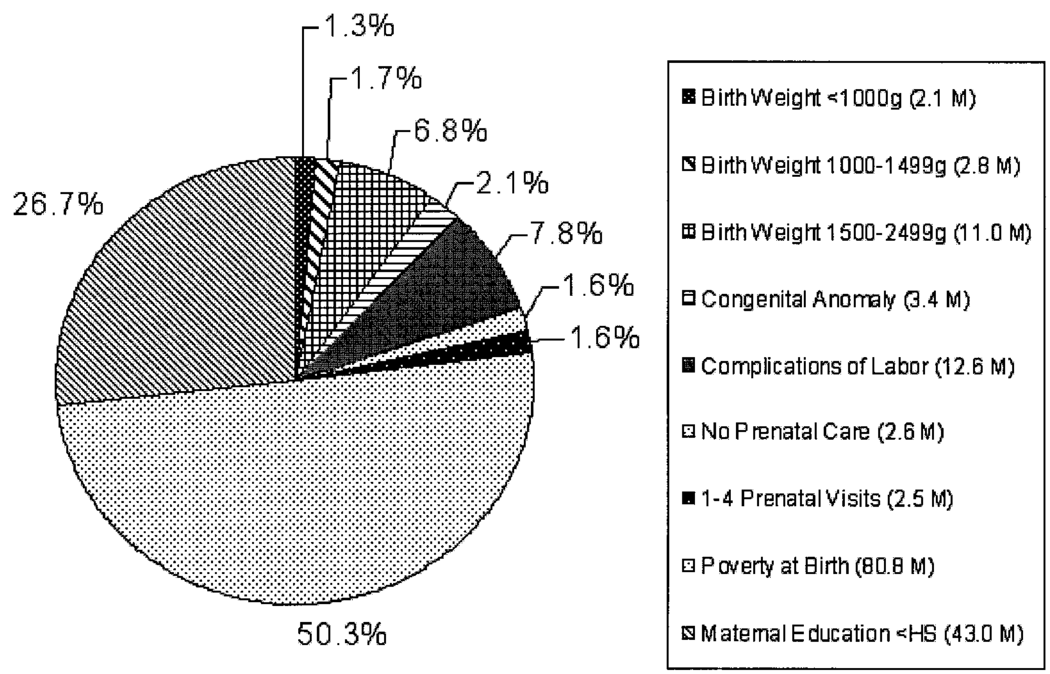

Fig 2. Distribution of total excess kindergarten costs ($160.8 million) by risk factor.

understate the total costs associated with specific risk factors over a student's entire scholastic career because of the very high correlation between kindergarten exceptionalities and exceptionalities later in school. These comparisons, therefore, are illustrative of the tradeoffs between risk factors and should not be interpreted as actual cost savings associated with changing a risk factor. For completeness, the comparisons are based on interpolations from the entire birth 1990–1991 population rather than the subset of students present in both the birth cohort and the kindergarten school records. We anticipate that state officials would use the entire birth population to estimate potential excess school costs.

The percentage of children who would need to be moved from their risk factor category to the reference group category (those with the lowest risk) was calculated (Fig 3). For predictor variables with multiple levels (birth weight, prenatal care, and maternal education), the percentage that would need to be moved to the next lowest risk category as well as the lowest risk category was also estimated. We know from Fig 1 that infants <1000 g added the greatest amount to the base cost of kindergarten ($3150 per child). The largest per-child cost savings would be achieved if these infants could be moved to ≥2500 g. However, because there were relatively few of these children, to save $1 million in kindergarten costs per birth cohort would require moving 48% of the set of infants of <1000 g to normal birth weight. To move these infants to the next heavier birth weight category (1000–1499 g), arguably a much more plausible scenario, would require >100% of the <1000 g population to save $1 million in kindergarten excess costs per birth cohort. The costs of such an improvement, even if the medical techniques and social interventions were available, likely would be prohibitive. However, only 9% of children who weighed 1500 to 2499 g would need to be moved to the normal birth weight category to reach the same level of cost savings, as would a 7% reduction in the rate of labor and delivery complications. Savings of a similar magnitude might be achieved if 3% of mothers who left school without a diploma were to graduate. Recall that children who generate the largest per-pupil excess costs are not the same children who generate the majority of the total excess costs.

Modest to moderate reductions in other factors within the purview of public policy were associated with substantial cost savings. For instance, reducing family poverty by just 1.2% could result in a cost savings of $1 million per cohort kindergarten. If a 10% shift of families out of poverty could be achieved, then a savings of $8.3 million might be realized. Providing 5 or more prenatal visits to 40% of the set of mothers who currently receive no prenatal care conceivably could yield an estimated $1 million reduction per birth cohort. However, these estimates are not intended to be construed as causal predictions.

DISCUSSION

The proportion of students in the general population who require special education is steadily increasing, both nationally and in Florida.[1,24] The Individuals With Disabilities Education Act (IDEA), as amended in 1997, mandates that all students with demonstrated special education needs receive a free public education that is appropriate for their condition.[25] Given the obligation of states and localities to educate these students in a free and appropriate manner, this trend indicates that education costs will continue to rise over time. Understanding the precursors of special education placement may improve states' and school districts' abilities to plan for the increased fiscal burdens and educational needs associated with students with disabilities. This study suggests that information in the birth vital statistics record can be used by school districts and states for fiscal planning.

The most costly individual risk conditions—the 2 lowest birth weight categories (<1000 g and 1000–1499 g) and congenital anomalies—are also probably the most difficult to modify. However, they are also the conditions of lowest frequency. Any policy recommendation guided by a desire to reduce excess costs in kindergarten must take into consideration 3 factors: the prevalence of conditions whose amelioration is desired, the potential cost savings associated with reducing those risk conditions, and the costs of bringing about an amelioration. It is well beyond the scope of the present report to provide even rough estimates of the costs associated with reducing very low birth weight or family poverty rates, for instance. Therefore, this study cannot adjudicate between the most cost-effective means of reducing kindergarten costs. However, we were able to estimate cost reductions for each risk factor, and because we knew the prevalence of these conditions, we could plausibly describe different pathways to cost reductions. These estimates of cost pathways provide policy makers with sufficient information so that they can begin to perform reasonable cost-benefit tests among different policy options.

The study has several limitations. Thirty-seven percent of the birth cohort could not be matched to school records. Nonmatches could occur for at least 4 reasons: 1) the child died before reaching age 5; 2) the child moved out of state after birth; 3) the child attended kindergarten in a private school; or 4) DOE records and birth records could not be linked because of name changes or incorrectly entered identifiers. Historically, ~20% of children who are born in Florida leave the state before school age, and ~12% attend private kindergarten. Therefore, ~5% of the potential sample was students who conceivably could have been matched but who were not. However, the study sample closely resembles the overall population along most dimensions, with the notable exception that poverty at birth is higher for the study sample than for the overall population. This divergence likely is attributable to the increased incidence of higher-income families' sending their children to private kindergarten. Separate versions of the analysis limited to only Medicaid or non-Medicaid births led to similar relative rankings of the risk factors, strongly suggesting that incomplete matching of the data did not bias our inferences.

Two dummy variables extracted from birth vital statistics were given a value of 1 when any 1 of a long list of conditions or diagnoses was present. Complications of labor and delivery combined conditions with very different risks. For example, precipitous labor may have no relationship with a possible need for future special education, and premature labor may be captured in the model by birth weight. Similarly, coding of congenital anomalies on the birth certificate is known to be incomplete; and the dummy variable combines anomalies that place physical limitations on the child, ones that affect neurologic function, and others that have no clinically plausible relationship to future special education needs (eg, isolated polydactyly, accessory nipple, vascular hamartoma). Disaggregating these

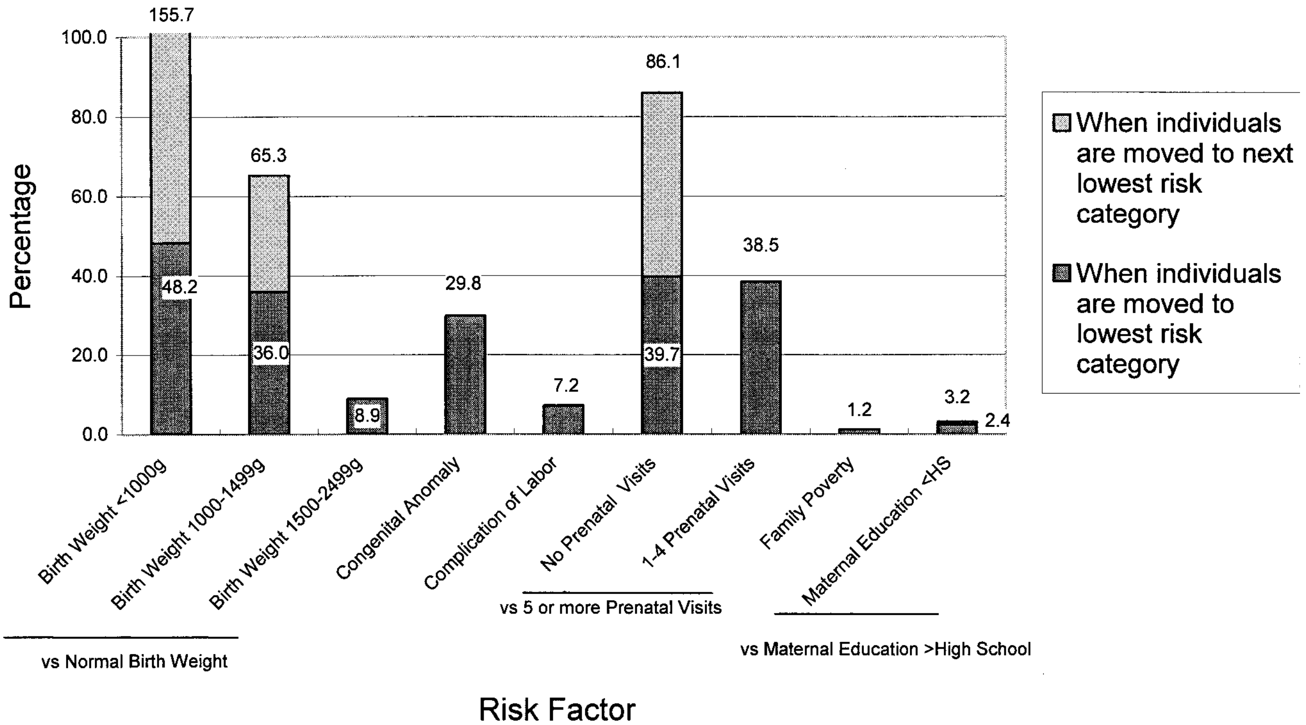

Fig 3. Percentage reduction in number of individuals with risk factor necessary to save $1 million in kindergarten costs.

composite variables is beyond the scope of the present study but will be undertaken in a future analysis.

Arguably, some pregnant women who had 5 or more prenatal visits still may not have received adequate prenatal care, whereas pregnant women who had <5 prenatal visits may have received adequate care (eg, those who delivered preterm). Nonetheless, the trichotomization of no prenatal care, 1 to 4 visits, and 5 or more visits was a reasonable first approximation of prenatal care utilization.

Because several special education conditions typically are not identified until later grades in elementary school (and retention rates increase with grade level), this study does not provide a comprehensive quantification of cumulative excess costs as a result of special education placement and retention. Rather, it identifies those birth conditions that have the largest fiscal impact at entry into public school. Other components of spending for special education, such as the contribution of local taxing entities, were not available for analysis. Therefore, the results of this study represent lower bound estimates of the impact of selected risk factors on excess kindergarten costs.

An attribute of the present study that is both a strength and a weakness relative to earlier studies of the educational costs of low birth weight is its kindergarten endpoint: many students who receive a diagnosis later as having a disability are missed in the present study. Conversely, a first year of schooling endpoint suggests that any effects found in the present study can reasonably be thought of as lower bound estimates of the incremental annualized special education costs of certain birth conditions. Although delayed identification of need is a risk with setting an early endpoint, there may be an offsetting effect with certain early special education assignments such as speech and language remediation, for which after 1 to 3 years of therapy, the child's expressive speech delays as a result of oral-motor coordination problems are resolved.

The study does have direct implications for policies associated with maternal health care, as well as health care and early intervention programs for premature and sick children. Policies that increase access to health care for low-income mothers already exist. The results of this study indicate that 5 or more prenatal visits are associated with lower kindergarten costs, suggesting that educational costs would likely be magnified were it not for continued presence of subsidized health care during pregnancy for low-income families. Prenatal care utilization also probably has a small effect on some complications of labor and delivery, whereas we know definitively that maternal consumption of folic acid in the first trimester reduces the incidence of neural tube defects and that improved preconception management of glucose levels in women with diabetes reduces the incidence of some types of congenital anomalies.

The increased costs associated with male gender reflect the well-documented overrepresentation of boys in special education classes.[1] In addition to the fact that male infants tend to be less mature than female infants at a given birth weight, current research into the preponderance of boys in special education points to higher levels of conflict between boys and their kindergarten teachers.[26,27]

The possibility cannot be ruled out that the associations observed between perinatal risk factors and excess kindergarten costs may be the result of unobserved variables. For example, women who are motivated to complete the recommended number of prenatal visits or to graduate high school may also be motivated to provide their children with a stimulating home environment, which in turn may be the actual mechanism by which children become prepared for kindergarten. Another important unobserved variable is participation in early intervention programs, which have been shown to benefit the academic performance of low birth weight infants.[28,29] Maternal education has been shown consistently to influence children's intelligence, which in turn is predictive of school performance.[30–32] Low birth weight children exhibit higher prevalence of developmental delays, resulting in more frequent assignment to special education.[33,34] Low income children experience poorer health, which interferes with school attendance.[35,36]

Early intervention programs outside the scope of this analysis include IDEA Part C services for children with developmental delays or disabilities up to age 3 and IDEA Part B services for special needs children aged 4 and 5. There is growing evidence that high-intensity, high-quality early intervention programs can reduce the percentage of children who are assigned to special education classes.[37,38] Assigning more children to effective early intervention programs potentially could save money by decreasing the need for more expensive remediation services in public school. Additional cost savings might also be realized because only approximately one third of eligible 3-year-old children are currently enrolled in center-based school readiness programs such as Head Start.[39]

In light of declining revenues, states increasingly have to triage different subpopulations for early intervention. Setting priorities will depend in part on prevalence of conditions and expected return on investment. In the area of maternal and child health, policy makers may have to balance commitments to high-cost, low-prevalence groups (eg, infants <1000 g) and low-cost, high-prevalence groups (eg, pregnant adolescents). Each state faces a unique set of constraints. This study demonstrates that linking birth vital statistics to school records offers policy makers a way to project kindergarten costs from annual birth cohorts.

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Weber B. *New York Times*. July 8, 2004

Noted by JFL, MD