Academic Outcomes in Children with Congenital Heart Defects: A Population-based Cohort Study

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Abstract

**Background**—Most studies evaluating neurocognitive outcomes in children with congenital heart defects (CHD) have focused on high-risk patients or used specialized, resource-intensive testing. To determine the association of CHD with academic outcomes and compare outcomes according to severity of CHD, we linked state educational records with a birth defects registry and birth certificates.

**Methods and Results**—We performed a retrospective cohort study using data from the North Carolina Birth Defects Monitoring Program, North Carolina Department of Public Instruction, and North Carolina Department of Health and Human Services vital records. We performed logistic regression, adjusting for maternal education, race/ethnicity, enrollment in public pre-Kindergarten, and gestational age, to determine the association of CHD with not meeting standards on reading and math end-of-grade examinations in 3rd grade in 2006–2012. Of 5624 subjects with CHD and 10,832 with no structural birth defects, 2807 (50%) and 6355 (59%) were linked, respectively. Children with CHD had 1.24 times the odds of not meeting standards in either reading or math (95% CI 1.12–1.37), with 44.6% of children with CHD not meeting standards in at least one of these areas compared to 37.5% without CHD. Although children with both critical and non-critical CHD had poorer outcomes, those with critical CHD were significantly more likely to receive exceptional services compared to the non-critical group (adjusted OR 1.46, 95% CI 1.15–1.86).

**Conclusions**—Children with all types of CHD have poorer academic outcomes compared to their peers. Evaluation for exceptional services should be considered in children with any type of CHD.

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Disclosures: None
As infant morbidity and mortality for children with congenital heart defects (CHD) has decreased over the past 40 years, there has been an increased focus on improving the overall quality of life for these children.\textsuperscript{1, 2} One essential component of improving the lives of these children is understanding their neurocognitive outcomes.\textsuperscript{3} Indeed, the American Heart Association in 2012 issued guidelines for the surveillance, screening, evaluation, reevaluation, and management of such outcomes in children with CHD.\textsuperscript{4}

To date, however, most studies evaluating neurocognitive outcomes in children with CHD have focused only on high-risk patients or have used specialized, resource-intensive testing. Based on rigorous developmental and psychological testing methods such as the Bayley Scales of Infant Development, Wechsler Intelligence Scale for Children, Psychomotor Development Index, or the Developmental Test of Visual-Motor Integration, we know that children with critical heart defects such as hypoplastic left heart syndrome or transposition of the great arteries who require surgery in infancy are at increased risk of poor neurocognitive outcomes in childhood.\textsuperscript{5–14} However, CHD patients requiring surgery in infancy represent only a subset of all CHD patients, and performing such testing on the entire population of children with CHD is not feasible or cost-effective. Furthermore, the results of these tests do not necessarily translate into the “real-world” outcomes that are of greatest interest to parents, most notably school performance. Thus, there are important knowledge gaps regarding neurocognitive outcomes among children with less severe forms of CHD and regarding the school performance of children with CHD.

By linking state educational records with birth defects registries and birth certificates, we can address these knowledge gaps by conducting large-scale neurocognitive studies in patients with known birth defects.\textsuperscript{15–17} The purpose of our study, therefore, was to use state educational records to determine the association of CHD with academic outcomes and to compare such outcomes according to severity of CHD. We hypothesized that children with CHD would have poorer academic performance than children without CHD, and that children with more severe forms of CHD would have poorer academic performance than children with less severe forms.

**Methods**

**Study Design**

We performed a population-based retrospective cohort study using data from the North Carolina Birth Defects Monitoring Program (NCBDMP), the North Carolina Department of Public Instruction (NCDPI), and the North Carolina Department of Health and Human Services vital records. Since 1987, the NCBDMP has collected information about major structural birth defects in live births identified up to one year of age via an active, population-based surveillance system.\textsuperscript{18} For classification of heart defects, the NCBDMP uses the system developed by the Centers for Disease Control and Prevention based on the
British Paediatric Association codes, a system that has been shown to be superior to International Classification of Diseases, Ninth Revision, for the identification of heart defects. The NCDPI collects information on end-of-grade testing, academic promotion, and receipt of exceptional services (individualized educational plans for children with disabilities) for all children in public schools in North Carolina. In North Carolina, end-of-grade testing in reading and math is administered to all public school students in 3rd through 8th grades, with students being required to demonstrate grade level proficiency in grades 3, 5, and 8 for academic promotion. Because the study used existing data only, it was considered exempt by the North Carolina Department of Public Health Institutional Review Board, and only individuals authorized by the North Carolina Department of Public Health had access to confidential information.

Cohorts

All children born in the years 1998–2003 and identified with CHD via ICD-9 codes in the NCBDMP were linked to the educational records from NCDPI and birth certificate records from North Carolina. Staff at NCDPI matched records from the NCBDMP and school records using a deterministic linkage algorithm in SAS, using child’s first and last name, date of birth, and sex as matching variables. Matches were verified using the last 4 digits of the child’s social security number. Children with known chromosomal anomalies were excluded because these children often have other severe developmental disabilities that would likely impact the outcomes of interest. Cases of CHD were further subclassified as “critical” or “non-critical” according to diagnosis. In a manner consistent with similar analyses in this population, a case was deemed “critical” if a child had one or more of the following: coarctation of the aorta, d-transposition of the great arteries, double outlet right ventricle, Ebstein anomaly, hypoplastic left heart syndrome, interrupted aortic arch, pulmonary atresia, single ventricle, tetralogy of Fallot, total anomalous pulmonary venous return, tricuspid atresia, or truncus arteriosus. A non-CHD group was generated by a random sampling of North Carolina birth certificates of children born 1998–2003 who were not known to have any birth defects, and these records were similarly linked with the educational records from the NCDPI. Reasons for inability to link include migration out of the state, not being in public school in the 3rd grade, taking alternate testing instead of standardized testing, change in name, or death prior to 3rd grade.

Outcomes of Interest

Our primary outcome of interest was performance, reported as achievement levels, on the reading and math end-of-grade examinations administered in North Carolina public schools at the end of 3rd grade in years 2006 to 2012. Achievement scores were classified as either a level 1–2, indicating the student has limited or partial command of the NC grade level content matter, or a 3–4 indicating a solid or superior command of grade level content. We dichotomized achievement scores as “Does Not Meet Grade-Level Proficiency Standard” (Level 1–2) vs. “Meets Grade-Level Proficiency Standard” (Level 3–4). Performance in the 3rd grade was chosen because a) this period is the earliest that standardized mathematics and reading comprehension examinations are administered in North Carolina and b) performance in the 3rd grade is a well-established predictor of long-term success, including graduating.
from high school. Our secondary outcomes of interest included retention at the end of 3rd grade and receipt of exceptional services in the 3rd grade.

**Statistical Analyses**

After describing the distribution of confounders among the cohorts, we estimated the odds of each of our outcomes and 95% confidence intervals among children with CHD compared to children without a structural birth defect using logistic regression in our primary analysis. In subsequent secondary analyses, we stratified our analyses by critical vs non-critical CHD comparing outcomes among those with critical CHD or non-critical CHD vs. those without structural birth defects, and those with critical CHD vs. those with non-critical CHD. Finally, we modeled our outcomes of interest among those children with and without additional non-cardiac defects vs. those without any structural birth defects. In each model we performed a complete case analysis and included the following covariates of interest chosen a priori: maternal education level (obtained from the birth certificate), race/ethnicity (obtained from the birth certificate), enrollment in public pre-Kindergarten (obtained from NCDPI records), and gestational age (obtained from the birth certificate). All analyses were performed using SAS 9.3 (Cary, NC).

**Results**

Of the 5624 subjects with CHD and 10,832 with no structural birth defects, 2807 (50%) and 6355 (59%) were linked, respectively, to 3rd grade educational records and comprise our study cohorts. Among the CHD group, those who did not link with a 3rd grade educational record were more likely to be Hispanic or non-Hispanic white than those who did link, and the two CHD groups were similar in respect to sex, maternal education, and gestational age. In comparing the linked CHD group with the cohort of children without structural birth defects, the two groups were similar with respect to sex and percentage enrollment in public pre-Kindergarten. Those with CHD were less likely to be non-Hispanic white, less likely to have mothers who completed high school by the time of delivery, and were born on average 2 weeks earlier than those without CHD. (Table 1) Among the CHD cohort, the most common diagnoses were atrial septal defect and ventricular septal defect. (Table 2)

In the comparison of those with CHD vs. those without any known structural birth defects, those with CHD had poorer outcomes. (Table 3) Children with CHD were more likely not to meet standards in both reading and math, with 44.6% of those in the CHD group not meeting standards in at least one of these areas as compared to 37.5% in the non-CHD group. Similarly, those with CHD were more likely to have received exceptional services (20.5% vs. 12.5%). Though a higher percentage of children with CHD were retained in the 3rd grade, this did not meet statistical significance.

We then performed separate analyses comparing children with critical CHD and non-critical CHD separately to those without known structural birth defects. (Table 4) Of the 2807 with CHD, 463 (16.5%) had critical CHD and 2344 had only non-critical CHD. Both those with critical CHD and non-critical CHD were more likely than children without structural birth defects to not meet standards in at least reading or math (adj. OR = 1.43 and 1.20 respectively) and to have received exceptional services (adj. OR = 2.24 and 1.51...
respectively). While there were slightly higher percentages of children with critical CHD and non-critical CHD being retained in the 3rd grade as compared to those without any structural birth defects, these differences did not meet statistical significance. When we compared those with critical CHD to those with non-critical CHD, we found that those with critical CHD were slightly more likely to fail reading or math and much more likely to receive exceptional services. There was no difference in 3rd grade retention.

In our final analyses we sub-divided those with CHD into those without any other structural birth defects and those with other non-cardiac defects. (Table 5) Of the 2807 with CHD, 2215 did not have any additional structural birth defects and 592 did (21.1%). Compared to those without any structural birth defects, both groups were more likely not to meet standards in reading or math (adj. OR = 1.19 and 1.48) and to receive exceptional services (adj. OR = 1.46 and 2.40) with the larger effect sizes in the group with additional non-cardiac defects. Those with only CHD were not more likely than children without any known structural birth defects to be retained in 3rd grade, but those with CHD and additional structural birth defects were (adj. OR = 1.73). When we compared those with CHD with additional non-cardiac defects to those with only CHD, we found that those with additional non-cardiac defects were slightly more likely to fail reading or math and much more likely to receive exceptional services. There was no difference in 3rd grade retention.

**Discussion**

In this study, the largest of its kind to study educational outcomes in children with CHD, we found that children with CHD have poorer performance on end-of-grade testing in reading and math in the 3rd grade and have higher receipt of exceptional services. Interestingly, this poorer performance in reading and math was seen in both the critical and non-critical CHD cohorts, yet children with non-critical CHD were less likely to receive exceptional services than those with critical CHD.

While this study confirms the findings of prior studies that children with critical heart defects have poorer neurocognitive outcomes than children without birth defects, it raises the notion that children with milder defects may, too, have significant challenges. Historically, it has been believed that the majority of children with mild or moderate CHD would not have any developmental disabilities. Indeed, in the 2012 American Heart Association guidelines for the evaluation and management of neurodevelopmental outcomes in children with CHD, the only heart defects deemed to place a child at “high risk” for a developmental disorder or disability were those with cyanosis or that required surgery during infancy. In our study, there were similar rates of not meeting standards in reading or math (~45%) between the critical and non-critical CHD groups and similar rates of being retained in the 3rd grade (~3%). However, 25% of the children with critical CHD were receiving exceptional services, but only 20% of those with non-critical CHD were receiving such services. It appears that the academic challenges faced by children with non-critical CHD may be underappreciated.

Prior studies using educational records to examine outcomes in children with CHD have found similar results to ours. In a study of 256 patients in Arkansas, Mulkey et al. found that children with CHD had lower scores on school-age achievement tests and an 8-fold increase
in the receipt of special education services. As this study was limited to children who had surgery in the first year of life, comparisons regarding outcomes for children with milder forms of CHD are not possible. In a recent CDC study of the use of special education services among children in Metropolitan Atlanta, Riehle-Colarusso et al. found that children with CHD were 50% more likely to receive such services as compared to children without birth defects, with children with critical CHD having only a slightly higher likelihood as compared to those with non-critical CHD. This study did not examine school testing or grade retention. Finally, in an evaluation of children in Georgia who had undergone surgery for CHD, Oster et al. found that children with a history of CHD surgery had poorer performance on math and social studies testing than their peers without CHD, but that there was no difference between those in the higher surgical risk categories compared to those in the lower.

The rationale as to why children with CHD may be at risk for poor neurocognitive outcomes is complex. There are many theories to explain this increased risk, including hypoxia, use of cardiac bypass, and type of anesthesia, with these effects particularly pronounced in the immature neonatal brain. However, children with milder forms of CHD do not typically have hypoxia or surgical risk factors in infancy. What children with non-critical CHD may share with their critical CHD counterparts, however, is a similar genetic predisposition for certain outcomes. The impact of genotype on survival and clinical outcomes has been well established. Now, however, it has been suggested that certain genotypes may be associated not only with CHD but also with neurodevelopment. Homsy et al studied the exome sequencing of 1213 CHD parent-offspring trios and found that there were shared genetic contributions for CHD and neurodevelopmental disabilities. Similar genetic predisposition to certain neurodevelopmental outcomes among differing cardiac phenotypes may help explain our findings.

This study is not without its limitations. First, our study is limited to children who attend public schools. Children in private schools or home schools are not tracked via these educational methods, and we thus have no data on that subset of the population. Self-selection of public school by families of children with CHD for the purposes such as obtaining exceptional services or due to financial constraints already on these families from chronic illness may skew our results. Second, we do not have information on children who are not able to take the end-of-grade testing. Children who are not able to take the standard end-of-grade testing may be placed in alternative testing. While we know what portion during this timeframe underwent alternate testing (11% of children with CHD and 3% of children with no structural birth defects), data on the outcomes of such testing is not available and thus these children were not included in our cohorts. Finally, the NCBDMP collects information regarding the diagnosis of CHD, but we have no information regarding surgical interventions or clinical outcomes. Thus, we are not able to investigate whether certain types of treatments, surgeries, or other interventions may be associated with educational outcomes; such investigations are certainly warranted in future studies.

By linking three large databases in North Carolina, we were able to address important knowledge gaps regarding the neurocognitive outcomes of children with CHD. These children face significant challenges in school performance, and these challenges are not
limited to only that subset with critical CHD. Parents and providers of children with all types of CHD should be cognizant of the academic obstacles these children may face and should consider evaluations for exceptional services.

Acknowledgments

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References


<table>
<thead>
<tr>
<th><strong>What is Known</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Children with congenital heart disease (CHD) are at risk for poor neurocognitive outcomes.</td>
</tr>
<tr>
<td>• Current American Heart Association guidelines recommend routine neurocognitive screening only for those children with critical CHD, i.e. those with cyanosis or who required surgery during infancy.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>What the Study Adds</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Children with CHD have poorer performance on end-of-grade testing in reading and math in the 3rd grade compared to children without birth defects.</td>
</tr>
<tr>
<td>• Poor testing performance is seen not only in children with critical CHD but also in those with non-critical CHD.</td>
</tr>
<tr>
<td>• Children with non-critical CHD may benefit from better recognition and treatment of potential neurocognitive deficits</td>
</tr>
</tbody>
</table>
Table 1

<table>
<thead>
<tr>
<th></th>
<th>Congenital Heart Defects (N=2807)</th>
<th>No Structural Birth Defects (N=6355)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>0.66</td>
</tr>
<tr>
<td>Male</td>
<td>1423 (51%)</td>
<td>3190 (50%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1384 (49%)</td>
<td>3165 (50%)</td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>1518 (54%)</td>
<td>3684 (58%)</td>
<td></td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>889 (32%)</td>
<td>1812 (29%)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>314 (11%)</td>
<td>573 (9%)</td>
<td></td>
</tr>
<tr>
<td>Other/Missing</td>
<td>86 (3%)</td>
<td>286 (5%)</td>
<td></td>
</tr>
<tr>
<td>Maternal Education</td>
<td></td>
<td></td>
<td>0.007</td>
</tr>
<tr>
<td>Did not complete high school</td>
<td>702 (25%)</td>
<td>1424 (22%)</td>
<td></td>
</tr>
<tr>
<td>Completed high school</td>
<td>2102 (75%)</td>
<td>4919 (77%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>3 (0.1%)</td>
<td>12 (0.2%)</td>
<td></td>
</tr>
<tr>
<td>Public Pre-K</td>
<td></td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>Yes</td>
<td>164 (6%)</td>
<td>326 (5%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2643 (94%)</td>
<td>6029 (95%)</td>
<td></td>
</tr>
<tr>
<td>Gestational Age [Mean(SD)]</td>
<td>36.5 (4.2)</td>
<td>38.7 (2.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Missing</td>
<td>1</td>
<td>2</td>
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</table>
Table 2
Phenotypes of congenital heart defects among children with third grade reading or math test scores in NC between 2006–2012.

<table>
<thead>
<tr>
<th>Condition</th>
<th>N=2,807*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic Stenosis</td>
<td>72 (2.6%)</td>
</tr>
<tr>
<td>Atrial Septal Defect</td>
<td>1,554 (55.4%)</td>
</tr>
<tr>
<td>Atrioventricular Septal Defect</td>
<td>34 (1.2%)</td>
</tr>
<tr>
<td>Coarctation of Aorta</td>
<td>143 (5.1%)</td>
</tr>
<tr>
<td>Double Outlet Right Ventricle</td>
<td>48 (1.7%)</td>
</tr>
<tr>
<td>Ebstein Anomaly</td>
<td>9 (0.3%)</td>
</tr>
<tr>
<td>Hypoplastic Left Heart Syndrome</td>
<td>33 (1.2%)</td>
</tr>
<tr>
<td>Interrupted Aortic Arch</td>
<td>7 (0.3%)</td>
</tr>
<tr>
<td>Pulmonary Atresia</td>
<td>38 (1.4%)</td>
</tr>
<tr>
<td>Pulmonary Stenosis</td>
<td>320 (11.4%)</td>
</tr>
<tr>
<td>Single Ventricle</td>
<td>20 (0.7%)</td>
</tr>
<tr>
<td>Tetralogy of Fallot</td>
<td>157 (5.6%)</td>
</tr>
<tr>
<td>Total Anomalous Pulmonary Venous Return</td>
<td>15 (0.5%)</td>
</tr>
<tr>
<td>Transposition of Great Arteries</td>
<td>61 (2.2%)</td>
</tr>
<tr>
<td>Truncus Arteriosus</td>
<td>24 (0.9%)</td>
</tr>
<tr>
<td>Tricuspid Atresia</td>
<td>23 (0.8%)</td>
</tr>
<tr>
<td>Ventricular Septal Defect</td>
<td>1327 (47.3%)</td>
</tr>
</tbody>
</table>

* Children may have more than one congenital heart defect.
Table 3
3rd grade educational outcomes for children with congenital heart defects vs. children without a known structural birth defect.

<table>
<thead>
<tr>
<th></th>
<th>No Structural Birth Defects (ref)</th>
<th>Congenital Heart Defect</th>
<th>OR* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End-of-grade tests: Does not meet standards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>N=6302 31.3%</td>
<td>N=2780 39.9%</td>
<td>1.38 (1.21–1.53)</td>
</tr>
<tr>
<td>Math</td>
<td>N=6326 21.1%</td>
<td>N=2798 25.5%</td>
<td>1.14 (1.01–1.28)</td>
</tr>
<tr>
<td>Either</td>
<td>N=6341 37.5%</td>
<td>N=2803 44.6%</td>
<td>1.24 (1.12–1.37)</td>
</tr>
<tr>
<td>Both</td>
<td>N=6287 14.8%</td>
<td>N=2775 20.8%</td>
<td>1.37 (1.20–1.56)</td>
</tr>
<tr>
<td><strong>3rd grade retention</strong></td>
<td>N=6341 2.0%</td>
<td>N=2803 2.8%</td>
<td>1.31 (0.97–1.79)</td>
</tr>
<tr>
<td><strong>Receipt of Exceptional Services</strong></td>
<td>N=6341 12.5%</td>
<td>N=2803 20.5%</td>
<td>1.64 (1.44–1.86)</td>
</tr>
</tbody>
</table>

*Adjusted for maternal education, race/ethnicity, public pre-K enrollment, and gestational age. Sample size varied for each comparison and is indicated by the N in each cell.
### Table 4

3rd grade educational outcomes for children with critical vs. non-critical congenital heart defects

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=6302 (31.3%)</td>
<td>N=456 (40.8%)</td>
<td>N=2324 (39.8%)</td>
<td>1.59 (1.29–1.96)</td>
<td>1.34 (1.19–1.50)</td>
<td>1.18 (0.95,1.47)</td>
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<tr>
<td>End-of-grade tests: Does not meet standards</td>
<td>N=6326 (21.1%)</td>
<td>N=461 (28.1%)</td>
<td>N=2337 (25.0%)</td>
<td>1.48 (1.18–1.86)</td>
<td>1.07 (0.95–1.22)</td>
<td>1.38 (1.08,1.75)</td>
</tr>
<tr>
<td>Math</td>
<td>N=6341 (37.5%)</td>
<td>N=463 (45.6%)</td>
<td>N=2340 (44.4%)</td>
<td>1.43 (1.17–1.76)</td>
<td>1.20 (1.08–1.34)</td>
<td>1.19 (1.12,1.47)</td>
</tr>
<tr>
<td>Either</td>
<td>N=6287 (14.8%)</td>
<td>N=454 (23.3%)</td>
<td>N=2321 (20.4%)</td>
<td>1.82 (1.43–2.32)</td>
<td>1.28 (1.11–1.47)</td>
<td>1.41 (1.09,1.82)</td>
</tr>
<tr>
<td>Both</td>
<td>N=6341 (2.0%)</td>
<td>N=463 (2.8%)</td>
<td>N=2340 (2.8%)</td>
<td>1.44 (0.80–2.60)</td>
<td>1.29 (0.93–1.80)</td>
<td>1.10 (0.59,2.03)</td>
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<tr>
<td>3rd grade retention</td>
<td>N=6341 (12.5%)</td>
<td>N=463 (25.1%)</td>
<td>N=2340 (19.6%)</td>
<td>2.24 (1.70–2.81)</td>
<td>1.51 (1.87–1.73)</td>
<td>1.46 (1.15,1.86)</td>
</tr>
<tr>
<td>Exceptional Services</td>
<td>N=6341 (12.5%)</td>
<td>N=463 (25.1%)</td>
<td>N=2340 (19.6%)</td>
<td>2.24 (1.70–2.81)</td>
<td>1.51 (1.87–1.73)</td>
<td>1.46 (1.15,1.86)</td>
</tr>
</tbody>
</table>

* Adjusted for maternal education, race/ethnicity, public pre-K enrollment. Sample size varied for each comparison and is indicated by the N in each cell.
<table>
<thead>
<tr>
<th></th>
<th>CHD with non-cardiac defects vs. CHD only</th>
<th>CHD only vs. No Structural Birth Defects</th>
<th>CHD with non-cardiac defects vs. No Structural Birth Defects</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>OR* (95% CI)</td>
<td>OR* (95% CI)</td>
<td>OR* (95% CI)</td>
</tr>
<tr>
<td><strong>End of grade tests: Does not meet standards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>1.70 (1.39–2.05)</td>
<td>1.32 (1.18–1.47)</td>
<td>1.31 (1.07–1.59)</td>
</tr>
<tr>
<td>Math</td>
<td>1.36 (1.10–1.68)</td>
<td>1.08 (0.95–1.23)</td>
<td>1.24 (1.00–1.54)</td>
</tr>
<tr>
<td>Either</td>
<td>1.48 (1.22–1.79)</td>
<td>1.19 (1.06–1.33)</td>
<td>1.24 (1.02–1.51)</td>
</tr>
<tr>
<td>Both</td>
<td>1.71 (1.36–2.15)</td>
<td>1.28 (1.11–1.47)</td>
<td>1.36 (1.08–1.71)</td>
</tr>
<tr>
<td>3rd grade retention</td>
<td>1.73 (1.03–2.93)</td>
<td>1.21 (0.87–1.70)</td>
<td>1.24 (0.73–2.11)</td>
</tr>
<tr>
<td>Exceptional Services</td>
<td>2.40 (1.95–2.97)</td>
<td>1.46 (1.27–1.68)</td>
<td>1.72 (1.39–2.14)</td>
</tr>
</tbody>
</table>

* Adjusted for maternal education, race/ethnicity, public pre-K enrollment. Sample size varied for each comparison and is indicated by the N in each cell.