Longitudinal Associations between Neurodevelopment and Psychosocial Health Status in Patients with Repaired D-Transposition of the Great Arteries

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Objective To examine associations between measurements of neurodevelopment and psychosocial health status at age 8 and 16 years in patients with repaired dextro-transposition of the great arteries.

Study design In the 16-year follow-up of the Boston Circulatory Arrest Study, 137 parents completed the Child Health Questionnaire—Parent Form-50, of whom 135 had completed the Child Health Questionnaire—Parent Form-50 when their child was age 8 years. Psychosocial and physical summary scores were used to assess change in health status from age 8 to 16 years. A comprehensive battery of neurodevelopmental testing was performed at ages 8 and 16 years to examine associations with adolescent health status.

Results Lower psychosocial summary scores of 16 year old subjects with dextro-transposition of the great arteries were highly associated with numerous concurrent domains of neurodevelopmental function, most notably with higher (worse) scores on the Conners' Attention Deficit Hyperactivity Disorder/Diagnostic and Statistical Manual-4th Edition Scales (parent: $r = -0.62$, $P < .001$; adolescent: $r = -0.43$, $P < .001$) and the Behavior Rating Inventory of Executive Function Global Executive Composite (parent: $r = -0.66$, $P < .001$; adolescent: $r = -0.39$, $P < .001$). Psychosocial and physical summary scores tracked from ages 8 to 16 years ($r = 0.44$ and 0.47, respectively, $P < .001$ for each). Higher (worse) scores of multiple attention measures at age 8 years predicted worse psychosocial summary scores at age 16 years.

Conclusions Attention deficits at age 8 years were highly predictive of worse psychosocial health status in adolescence. Further studies are needed to assess whether treatment of childhood attention deficit hyperactivity disorder could improve adolescent well-being. *(J Pediatr 2018;■■:■■-■■).*

Survival for children with critical congenital heart disease (CHD) has improved with innovations in cardiac surgical and medical management over the past 3 decades, but with a high prevalence of neurodevelopmental deficits in this population.[1,2] The adolescent years are a time when such neurodevelopmental impairment may be expected to especially impact a child's health-related quality of life (HRQoL), which has been shown to be overall impaired in CHD patients.[3-5] The psychosocial health status of adolescents with CHD has become an important issue, with CHD guidelines and parent advocacy groups emphasizing psychosocial in addition to medical needs.[6-8]

Individuals with dextro-transposition of the great arteries (D-TGA) are one of the best-studied CHD populations. D-TGA is the second most common critical congenital heart defect, causing diminished cerebral oxygen delivery both in fetal life and at birth.[9,10] Surgical correction via the arterial switch operation (ASO) is now performed in the neonatal period,[11] with high event-free survival.[12,13] We have previously reported on health status at 8 years of age as measured by the Child Health Questionnaire (CHQ) in a cohort of patients with D-TGA who were enrolled in early infancy in the Boston Circulatory Arrest Study (BCAS). This work demonstrated that neurodevelopmental

ADHD	Attention deficit hyperactivity disorder
ASO	Arterial switch operation
BCAS	Boston Circulatory Arrest Study
CADS-A	Conners' ADHD/ Diagnostic and Statistical Manual-4th Edition Scales—Adolescent
CADS-P	Conners' ADHD/ Diagnostic and Statistical Manual-4th Edition Scales—Parent
CBCL	Child Behavior Checklist
CHD	Congenital heart disease
CHQ	Child Health Questionnaire
CHQ-PF50	Child Health Questionnaire—Parent Form-50
D-TGA	Dextro-transposition of the great arteries
HRQoL	Health-related quality of life

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performance (intelligence, academic achievement) is impaired and associated with worse concurrent psychosocial health status in children with repaired D-TGA.[14]

Understanding the determinants of HRQoL, or health status,[15] in adolescents after infant congenital heart surgery is essential to providing life-long care to this patient population. Very few studies to date have examined factors associated with longitudinal psychosocial and physical health status in adolescents with CHD.[16] In addition to presenting the association between concurrent neurodevelopmental impairment and health status at age 16 years, we evaluated whether neurodevelopmental deficits at age 8 years were predictive of subsequent psychosocial health status at age 16 years.

Methods

The study methods of the BCAS and neurodevelopmental findings of its participants from the perioperative period through age 16 years have previously been described.[17-21] In brief, patients with D-TGA were assigned to a support method consisting of either predominantly deep hypothermic circulatory arrest or predominantly low-flow cardiopulmonary bypass during the ASO. Criteria for enrollment in the BCAS included diagnosis of D-TGA with intact ventricular septum or ventricular septal defect, ASO by age 3 months, birth weight ≥2.5 kg, no recognizable syndrome or extracardiac anomalies of greater than minor severity, no previous cardiac surgery, and no anomaly requiring aortic arch reconstruction or additional open-surgical procedures. Subjects with D-TGA in the current study were enrolled in the BCAS in early infancy and had an in-person evaluation at age 16 years (range 13-17 years). Subjects living outside the country were excluded.

In addition to a published CHQ normative sample from the general population,[22] a referent group of healthy adolescents aged 13-17 years was recruited locally. We excluded referent subjects with any form of CHD requiring surgical correction, lack of reading fluency in English by primary caregiver, and criteria employed in the National Institutes of Health-funded project, "The NIH MRI study of normal brain development," which includes any condition that affects the well-being of the brain or indicates suboptimal brain functioning or learning disorder.[23]

This protocol was approved by the Institutional Review Board. Informed consent was obtained from parents and guardians, and assent was obtained from all subjects.

The Child Health Questionnaire—Parent Form-50 (CHQ-PF50) was used to assess health status when subjects were approximately 16 years old, and previously when subjects were 8 years old. This 50-item parental questionnaire is a validated and comprehensive multidimensional assessment tool. It is designed to measure health status in children and adolescents and provides summary scores on 2 dimensions, psychosocial and physical, as well as several subscales. The questionnaire is generic, allowing for comparison of health status among healthy children and children with various medical conditions.[22]

Subjects underwent an in-person neurodevelopmental evaluation at age 8 and 16 years using a comprehensive battery of standardized tests. Domains assessed at age 16 years included achievement (Wechsler Individual Achievement Test, Second Edition[24]), memory (Children's Memory Scale[25]), visual-perceptual skills (Test of Visual-Perceptual Skills—Revised[26]), attention (Conners' Attention Deficit Hyperactivity Disorder [ADHD]/Diagnostic and Statistical Manual-IV Scales—Parent and Adolescent, CADS-P and CADS-A[27]), executive function (Behavior Rating Inventory of Executive Function—Parent and Self-Report[28,29]), and social intelligence (Reading the Mind in the Eyes Test[30]; Autism Spectrum Quotient[31]). Domains previously assessed at age 8 years included intelligence (Wechsler Intelligence Scale for Children, Third Edition[32]), achievement (Wechsler Individual Achievement Test, Second Edition[24]), verbal fluency (Verbal Fluency Task of the McCarthy Scales[33]), attention (Conners' Parent and Teacher Rating Scales[34,35]; Child Behavior Checklist, CBCL[36]; Teacher Report Form[37]; Tests of Variables of Attention[38]), and executive function (Wisconsin Card Sort Test[39]; Trail-Making Test[40]).

Statistical Analyses

The primary outcome was the psychosocial summary score of the CHQ-PF50. Comparisons of patients with D-TGA to the referent group on demographic measures were made using Fisher exact tests for categorical variables and 2-sample *t* tests for continuous measures. The age 16-year psychosocial summary and physical summary scores of patients with D-TGA and their subscale scores were compared with a referent sample using linear regression adjusting for age at CHQ assessment, sex, and concurrent family social class and to the 13- to 15-year CHQ normative sample using 2-sample *t* tests. Family social class was measured by the Hollingshead Four Factor Index of Social Status.[41] Associations of health status scores at age 16 years with demographic and medical variables were examined using linear regression adjusting for concurrent social class.

A central focus of our study was to characterize associations between age 16-year health status scores, particularly psychosocial summary scores, with neurodevelopmental testing performed at age 8 and 16 years. Partial Pearson correlation coefficients adjusting for concurrent social class were used to examine associations of neurodevelopmental measures at age 16 years with concurrent health status. Partial Pearson correlation coefficients adjusting for social class at age 8 years were used to examine associations of neurodevelopmental measures at age 8 years with health status at age 8 years and age 16 years. The associations between psychosocial summary and physical summary scores at age 8 compared with age 16 years were examined using both paired-sample *t* tests and Pearson correlation coefficients. Box plots were constructed to examine the distribution of age 16-year psychosocial summary and physical summary scores based on age 8-year score tertile. Trends in age 16-year scores across age 8-year tertiles were assessed using the Jonckheere-Terpstra trend test, with equality

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of variances assessed using the Levene homogeneity of variability test.

Results

Of 171 subjects with D-TGA enrolled in infancy in the BCAS cohort, 6 died before age 16 years, and 6 lived out of the country and were excluded from the age 16-year evaluation. Of the remaining 159 subjects, 16 (10%) declined to participate and 4 (3%) could not be located. The remaining 139 subjects (87%) were enrolled and completed the neurodevelopmental testing. Of these, 137 parents completed the CHQ-PF50 when their child was 16 years of age, of whom 135 parents had also completed the CHQ-PF50 when their child was 8 years of age. The referent group consisted of 87 local healthy adolescents, of whom the parents of 85 completed the CHQ-PF50.

Subjects with D-TGA were 16.1 ± 0.5 (mean ± SD) years of age at CHQ assessment. Most were non-Hispanic Caucasian (91%). They weighed 3.6 ± 0.4 kg at birth, were 39.8 ± 1.3 weeks in gestational age, and had their first operation at 9.9 ± 11.8 days of age. Since the 8-year assessment, 7% (9/137) had any cardiac surgery and 18% (24/137) had any cardiac catheterization. Meanwhile, 4% (6/137) had any cardiac catheterization complication. Other demographic information on this cohort has been previously reported.[21] The referent subjects were slightly younger (15.2 ± 1.1 years, $P < .001$), less likely to be male (55% vs 77%, $P = .001$), and of a higher social class (53.5 ± 9.2 vs 45.9 ± 12.2, $P < .001$) than the subjects with D-TGA, though the groups did not differ in race, weight at birth, or gestational age.

Compared with local referents, parents of participants with D-TGA rated their 16-year-old children as having worse overall psychosocial and physical health status ($P < .001$ and $P = .01$, respectively) after adjusting for age, sex, and concurrent social class (Table I). Scores were significantly worse, compared with those of the local referent group, on subscale measures of emotional well-being, behavioral problems, general health, and parental impact. In contrast, parent reports on subjects with D-TGA did not differ significantly from those of the CHQ normative sample in their assessment of overall psychosocial or physical health status as reflected by psychosocial summary and physical summary scores at age 16 years (Table I). However, the subjects with D-TGA were scored significantly higher than the normative sample on subscales measuring physical limitations/pain, behavioral problems, and parental impact.

Within the group with D-TGA, health status summary scores at age 16 years, adjusting for concurrent social class, were associated with few demographic and medical variables in linear regression analyses. Lower age 16-year psychosocial summary scores were associated with older age at ASO ($\beta = -0.13 \pm 0.06$, $P = .04$), any cardiac surgery since the age 8-year assessment ($\beta = -7.6 \pm 2.9$, $P = .009$), and any cardiac catheterization since the age 8-year assessment ($\beta = -4.5 \pm 1.9$, $P = .02$). Lower age 16-year physical summary scores were associated with being non-white ($\beta = -4.2 \pm 1.9$, $P = .03$), older age at ASO ($\beta = -0.10 \pm 0.05$, $P = .03$), and any cardiac catheterization complication ($\beta = -5.5 \pm 2.7$, $P = .04$). Neither summary score was associated with other medical history variables such as birth weight; gestational age; Apgar at 1 minute; treatment group assignment; duration of deep hypothermic circulatory arrest, cardiopulmonary bypass, or total support times at first operation; duration of intensive care unit or hospital stay at first operation; or seizures.

Relationships in the D-TGA cohort of psychosocial summary and physical summary scores at age 16 years with concurrent measures of neurodevelopmental function were also examined (Table II). Lower psychosocial summary scores were highly associated with higher (worse) CADS-P and CADS-A ADHD Index T scores (CADS-P: $r = -0.62$, $P < .001$; CADS-A:

Table I. Comparisons of psychosocial summary and physical summary scores and CHQ-PF50 subscale scores of patients with D-TGA, referent healthy adolescents, and the CHQ-PF50 13- to 15-year normative sample

CHQ-PF50 Scales	D-TGA Age 8 y (n = 135)	D-TGA Age 16 y (n = 137)	Local referent sample (n = 85)	CHQ-PF50 normative sample (n = 96)	*P* value* comparing D-TGA age 16 y with D-TGA age 8 y	*P* value† comparing D-TGA age 16 y with referent sample	*P* value‡ comparing D-TGA age 16 y to normative sample
Psychosocial summary	50.5 ± 9.0	51.9 ± 8.7	57.2 ± 4.2	50.0 ± 8.9	.10	<.001	.10
Physical summary	53.6 ± 6.4	53.5 ± 6.5	55.8 ± 4.9	53.0 ± 8.8	.87	.01	.61
Subscales							
Physical functioning	96.5 ± 8.9	96.4 ± 9.7	97.5 ± 8.4	96.5 ± 12.8	.78	.37	.92
Role/social—emotional/behavior	90.5 ± 20.7	94.4 ± 16.1	100.0 ± 0.0	92.3 ± 20.7	.04	.003	.38
Role/social—physical	98.0 ± 9.3	97.2 ± 11.2	99.4 ± 4.0	92.1 ± 21.6	.48	.16	.02
Bodily pain	85.3 ± 18.5	87.2 ± 18.2	86.4 ± 16.2	81.8 ± 17.9	.27	.97	.03
Behavior	72.6 ± 17.3	83.4 ± 13.8	90.4 ± 9.1	76.3 ± 17.6	<.001	<.001	<.001
Mental health	78.2 ± 11.3	79.9 ± 13.1	85.8 ± 7.2	76.6 ± 12.9	.25	<.001	.06
Self esteem	82.9 ± 16.1	74.7 ± 20.1	84.1 ± 15.2	76.8 ± 15.1	<.001	.006	.39
General health perceptions	68.3 ± 16.2	70.0 ± 16.2	86.6 ± 12.4	72.8 ± 14.6	.28	<.001	.17
Parent impact—emotional	74.9 ± 21.7	74.2 ± 22.7	88.6 ± 12.0	77.3 ± 21.4	.70	<.001	.30
Parent impact—time	88.8 ± 17.3	91.5 ± 16.3	96.5 ± 11.9	85.4 ± 20.9	.10	.03	.01

Values are mean ± SD.
Higher scores are better for all summary and subscale measures.
**P* values were determined by paired-sample *t* tests.
†*P* values were determined by linear regression adjusting for age at CHQ assessment, sex, and concurrent social class.
‡*P* values were determined by 2-sample *t* tests.

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Table II. Relationships of neurodevelopmental outcomes of adolescents with D-TGA at age 16 years with concurrent psychosocial summary and physical summary scores

Neurodevelopmental outcomes, age 16 y	Psychosocial summary scores, age 16 y	Physical summary scores, age 16 y
Achievement		
WIAT-II Reading Composite	0.14 (0.11)	0.14 (0.10)
WIAT-II Math Composite	0.21 (0.02)	0.20 (0.02)
WIAT-II Listening Comprehension	0.19 (0.03)	0.23 (0.006)
Memory		
CMS General Memory	0.24 (0.005)	0.26 (0.003)
Visual-Perceptual Skills		
TVPS-R Visual Closure	0.19 (0.03)	0.18 (0.04)
TVPS-R Composite	0.14 (0.10)	0.17 (0.05)
Attention		
CADS-P ADHD Index T	−0.62 (<0.001)	−0.07 (0.39)
CADS-A ADHD Index T	−0.43 (<0.001)	−0.08 (0.39)
Executive Function		
BRIEF Global Executive Composite	−0.66 (<0.001)	−0.07 (0.41)
BRIEF-SR Global Executive Composite	−0.39 (<0.001)	−0.11 (0.21)
Social Intelligence		
Reading the Mind in the Eyes Test	0.20 (0.03)	0.09 (0.31)
Autism Spectrum Quotient	−0.33 (<0.001)	−0.09 (0.33)

BRIEF, Behavior Rating Inventory of Executive Function—Parent; *BRIEF-SR*, Behavior Rating Inventory of Executive Function—Self-Report; *CMS*, Children's Memory Scale; *TVPS-R*, Test of Visual-Perceptual Skills—Revised; *WIAT-II*, Wechsler Individual Achievement Test, Second Edition. Values are partial Pearson *r* (*P* value).

P values were determined by partial Pearson correlation coefficients adjusting for concurrent social class.

Lower scores are better for the attention and executive function tasks as well as the Autism Spectrum Quotient. Higher scores are better for all other tasks.

$r = -0.43$, $P < .001$) and Behavior Rating Inventory of Executive Function Global Executive Composite scores (parent: $r = -0.66$, $P < .001$; self-report: $r = -0.39$, $P < .001$). Lower psychosocial summary scores were associated with worse concurrent scores on math achievement, listening comprehension, memory, visual closure (ie, matching of an incomplete target image to the correctly completed image), and social intelligence, and lower physical summary scores were associated with lower concurrent scores on math achievement, listening comprehension, memory, and visual closure.

Within the cohort with D-TGA, summary measures of psychosocial and physical health did not differ significantly between ages 8 and 16 years (**Table I**). At age 16 years compared with age 8 years, scores were significantly higher on the emotional well-being and behavioral problems subscales, though lower on the self-esteem subscale. Psychosocial summary and physical summary scores at age 8 and 16 years were positively associated ($r = 0.44$ and $r = 0.47$, respectively; $P < .001$ for each; **Figure**, A and B). There was a significant trend toward higher age 16-year scores when moving from the lowest to highest age 8-year score tertile ($P < .001$ for both psychosocial summary and physical summary). For psychosocial summary score, there was substantial variability in age 16-year score amongst the lowest tertile of 8-year scorers (**Figure**, C). Significant differences in variability of the age 16-year score across the age 8-year tertiles were observed (psychosocial summary: $P < .001$, physical summary: $P = .03$).

Among associations between neurodevelopmental function at age 8 years and health status at age 16 years, higher (worse) scores on measures of attention at age 8 years were associated with lower psychosocial summary scores at age 16 years (**Table III**). Most notably, lower psychosocial summary scores were associated with higher (worse) Conners' Parent Rating Scales Restless-Disorganized and Hyperactive-Immature T scores ($r = -0.39$, $P < .001$ and $r = -0.41$, $P < .001$, respectively) and CBCL and Teacher Report Form Attention Problems T scores ($r = -0.41$, $P < .001$ and $r = -0.30$, $P < .001$, respectively). Lower scores on intelligence measures at age 8 years were also associated with lower psychosocial summary scores at age 16 years. Among the measures of neurodevelopmental function collected at age 8 years, only higher (worse) CBCL Attention Problems T scores were associated with lower physical summary scores at age 16 years ($r = -0.26$, $P = .003$).

Although some associations between neurodevelopmental function and concurrent psychosocial summary and physical summary at age 8 years in this cohort have been reported previously,[14] they are expanded upon for reference in **Table IV** (available at www.jpeds.com).

Discussion

Our data suggest that at age 16 years, adolescents with repaired D-TGA have parent-reported psychosocial and physical health status that is worse than that of a local referent group of healthy adolescents, but similar to that of the CHQ normative sample. Building upon our previous work demonstrating associations between neurodevelopmental measures and psychosocial health status in elementary school children with D-TGA,[14] we demonstrated that significant associations persist between concurrent neurodevelopmental outcomes and psychosocial health status at age 16 years, particularly with regard to attention and executive function. Psychosocial summary scores between elementary school (age 8 years) and high school (age 16 years) were significantly correlated; however, the children in the lowest tertile of psychosocial summary scores at age 8 years showed the greatest variability in age 16-year scores. Neurodevelopmental impairments at age 8 years predicted subsequent psychosocial health at age 16 years, with deficits in attention being the strongest predictors of future lower psychosocial health status. The associations of attention and executive function with concurrent psychosocial health status have previously been described in children with social stressors and noncardiac medical illnesses,[42-45] as well as in children with CHD, including tetralogy of Fallot[46] and single ventricle patients who underwent Fontan procedures.[15]

Our finding that deficits in attention in elementary school strongly predict worse psychosocial health status in adolescents with CHD has the potential to positively impact the long-term care of these patients. ADHD is reported to be 3 to 4 times more common in patients with CHD compared with the general population,[47] with a prevalence of 19% in patients with

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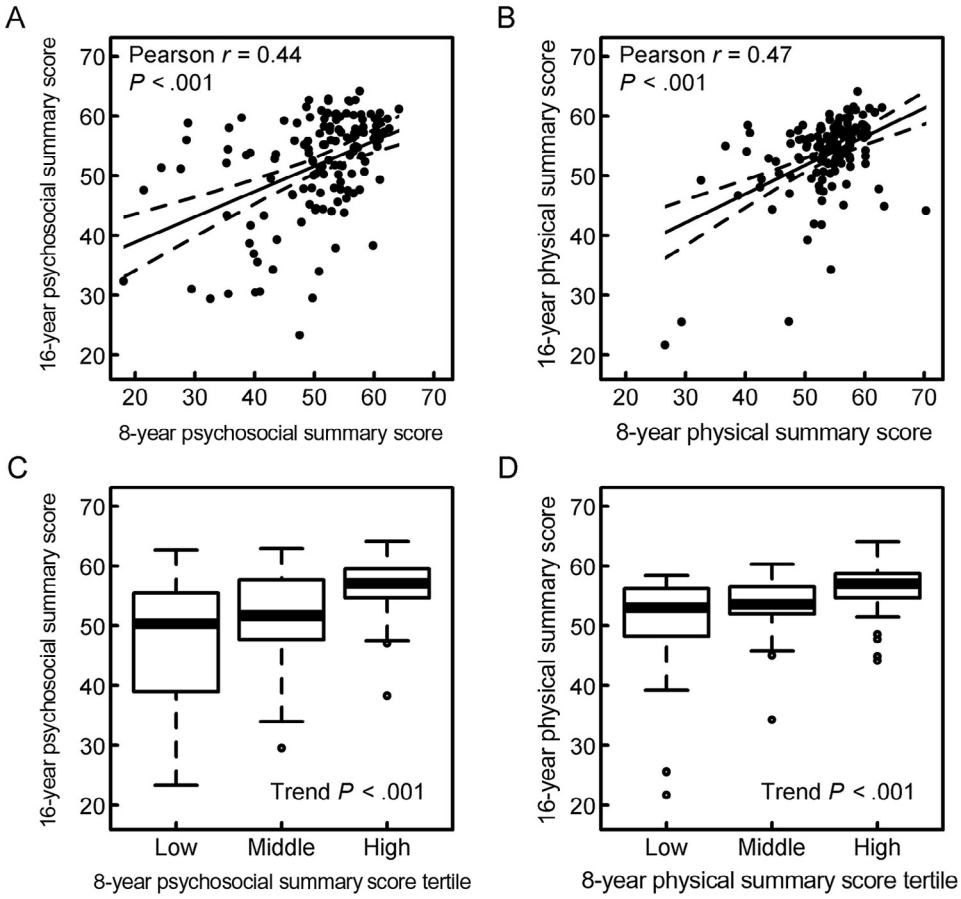

Figure. Tracking of health status from age 8 to 16 years. Scatter plot of **A,** psychosocial summary and **B,** physical summary scores at ages 8 vs 16 years. Boxplots of **C,** psychosocial summary and **D,** physical summary scores depicting distribution of 16-year scores based on 8-year score tertiles.

D-TGA by adolescence in our cohort.[21,48] Our findings support prior work demonstrating that clinical severity of ADHD is negatively correlated with psychosocial health status, regardless of underlying medical condition.[49] In the general population, childhood ADHD can increase the risk of several adverse outcomes in adolescence, including graduation failure and juvenile justice system involvement.[50] Neurodevelopmental impairment and subsequent poor psychosocial health in adolescents with CHD may portend lower socioeconomic well-being in adulthood based on data in general population.[51-55] Importantly, our findings have potential implications for clinical care. Pharmacologic treatment of ADHD has been shown to improve psychosocial HRQoL over time,[56] and its use is considered safe in children with CHD.[57] However, further research is needed to evaluate whether identification and treatment of ADHD in elementary age children with CHD can improve their psychosocial well-being into adulthood.

The findings of this study should be interpreted in light of several limitations. We are unable to determine causality in the relationship between neurodevelopmental measures and psychosocial health status. Similarly, our study design did not allow us to reach an inference about whether treatment of ADHD in the interim between ages 8 and 16 years improved HRQoL. In addition, older age at ASO was associated with lower age 16-year psychosocial summary and physical summary scores; older age has been colinear with diagnosis of ventricular septal defect and worse neurodevelopmental outcomes in our cohort, limiting causal inference.[18-21] The CHQ is a generic instrument, rather than a cardiac-specific tool such as the Pediatric Cardiac Quality of Life Inventory[58] or Pediatric Quality of Life Inventory.[59] Moreover, this study used a subjective questionnaire, with answers provided by parents as a proxy for assessment of quality of life in adolescents. We chose to use the parental questionnaire because there are no summary scores or published US normative sample for the Child Health Questionnaire—Child Form-87 report.[22] Although it is possible that health perceptions of children may differ from those of parents, moderate to strong correlations have been demonstrated between adolescent self-report and parent-proxy report of HRQoL, though the strength of association diminishes as patients grow older.[60] Our findings are consistent with other studies reporting superior or equivalent HRQoL in patients with D-TGA compared with published normative control groups,[61] but impaired HRQoL compared with locally

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Table III. Relationships of neurodevelopmental outcomes of children with D-TGA at age 8 years with their future psychosocial summary and physical summary scores at age 16 years

Neurodevelopmental outcomes, age 8 y	Psychosocial summary scores, age 16 y	Physical summary scores, age 16 y
Intelligence		
WISC-III		
Verbal IQ	0.21 (0.02)	0.11 (0.21)
Performance IQ	0.11 (0.19)	0.14 (0.10)
Full-Scale IQ	0.19 (0.03)	0.14 (0.11)
Achievement		
WIAT-II Reading Composite	0.14 (0.10)	0.09 (0.30)
WIAT-II Math Composite	0.13 (0.14)	0.11 (0.19)
Verbal Fluency		
Verbal Fluency Task: Sum of F, A, S	0.08 (0.36)	0.17 (0.06)
Attention		
CPRS		
Restless-Disorganized T	−0.39 (<0.001)	−0.11 (0.23)
Hyperactive-Immature T	−0.41 (<0.001)	−0.13 (0.13)
CTRS		
Hyperactivity T	−0.24 (0.008)	−0.08 (0.37)
Daydream-Attention Problem T	−0.25 (0.005)	−0.01 (0.89)
CBCL: Attention Problems T	−0.41 (<0.001)	−0.26 (0.003)
TRF: Attention Problems T	−0.30 (<0.001)	−0.09 (0.31)
ToVA (Average of Times 1 & 2)		
Omission	−0.17 (0.05)	−0.08 (0.36)
Commission	−0.09 (0.30)	0.08 (0.40)
Response Time	−0.19 (0.04)	−0.09 (0.33)
Variability	−0.15 (0.10)	0.06 (0.49)
Executive Function		
Wisconsin Card Sort Test Perseverative Errors	0.16 (0.07)	−0.01 (0.87)
Trail-Making Test: Change in Time to Complete	−0.16 (0.06)	−0.15 (0.08)

CPRS, Conners' Parent Rating Scales; *CTRS*, Conners' Teacher Rating Scales; *ToVA*, Tests of Variables of Attention; *TRF*, Teacher Report Form; *WISC-III*, Wechsler Intelligence Scale for Children, Third Edition.
Values are partial Pearson *r* (*P* value).
P values were determined by partial Pearson correlation coefficients adjusting for social class at 8 years.
Lower scores are better for the attention and executive function tasks. Higher scores are better for all other tasks.

recruited healthy referents.[13] Lower educational and socioeconomic status in the general US population, as well as inclusion of children with neurodevelopmental disabilities, may have resulted in lower parent rating of child HRQoL in the CHQ normative sample.[62] In addition to a normative sample, we chose to use local healthy referents, who had neurodevelopmental outcomes and general health status superior to that of subjects with D-TGA. The local reference sample provides an optimal regionally matched benchmark to aim for in the care of adolescents with D-TGA and other congenital heart defects.

This study provides further evidence to support efforts to identify and treat ADHD in children with D-TGA and other forms of CHD to improve their long-term psychological well-being. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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Table IV. Relationships of neurodevelopmental outcomes of children with D-TGA at age 8 years with concurrent psychosocial summary and physical summary scores

Neurodevelopmental outcomes, age 8 y	Psychosocial summary scores, age 8 y	Physical summary scores, age 8 y
Intelligence		
WISC-III		
Verbal IQ	0.15 (0.08)	0.15 (0.08)
Performance IQ	0.15 (0.09)	0.11 (0.19)
Full-Scale IQ	0.16 (0.06)	0.15 (0.08)
Achievement		
WIAT-II Reading Composite	0.17 (0.06)	0.07 (0.44)
WIAT-II Math Composite	0.16 (0.06)	0.14 (0.12)
Verbal Fluency		
Verbal Fluency Task: Sum of F, A, S	0.16 (0.06)	0.09 (0.32)
Attention		
CPRS		
Restless-Disorganized T	–0.68 (<0.001)	–0.07 (0.43)
Hyperactive-Immature T	–0.62 (<0.001)	–0.05 (0.55)
CTRS		
Hyperactivity T	–0.43 (<0.001)	–0.04 (0.64)
Daydream-Attention Problem T	–0.35 (<0.001)	–0.07 (0.46)
CBCL: Attention Problems T	–0.65 (<0.001)	–0.21 (0.02)
TRF: Attention Problems T	–0.44 (<0.001)	–0.16 (0.09)
ToVA (Average of Times 1and 2)		
Omission	–0.19 (0.03)	–0.01 (0.95)
Commission	–0.06 (0.54)	0.17 (0.05)
Response Time	–0.24 (0.006)	–0.15 (0.09)
Variability	–0.13 (0.15)	0.09 (0.34)
Executive Function		
Wisconsin Card Sort Test Perseverative Errors	–0.01 (0.90)	0.14 (0.10)
Trail-Making Test: Change in Time to Complete	–0.14 (0.10)	–0.08 (0.36)

CPRS, Conners' Parent Rating Scales; *CTRS*, Conners' Teacher Rating Scales; *ToVA*, Tests of Variables of Attention; *TRF*, Teacher Report Form; *WIAT-II*, Wechsler Individual Achievement Test, Second Edition; *WISC-III*, Wechsler Intelligence Scale for Children, Third Edition.
Values are partial Pearson *r* (*P* value).
P values were determined by partial Pearson correlation coefficients adjusting for concurrent social class.
Lower scores are better for the attention and executive function tasks. Higher scores are better for all other tasks.

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