Choroidal Thickness in Relation to Birth Parameters in 11- to 12-Year-Old Children: The Copenhagen Child Cohort 2000 Eye Study

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See the appendix for the members of the Copenhagen Child Cohort 2000 Study Group.

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PURPOSE. To examine choroidal thickness in a population-based child cohort in relation to birth parameters.

METHODS. The Copenhagen Child Cohort 2000 Eye Study examined 1406 children aged 11 to 12 years using enhanced depth imaging spectral-domain optical coherence tomography (EDI-OCT), ocular biometry and measurement of height, weight, refraction, and self-reported pubertal development status. Birth parameters were obtained from the Danish Medical Birth Registry.

RESULTS. The subfoveal choroid in low birth weight children (<2500 g, n = 51, mean 324 ± 76 μm) was thinner than in normal birth weight children (2500–4500 g, n = 1194, mean 361 ± 78 μm), the difference being -37 (CI95% -60 to -15) μm, P = 0.001 after adjusting for age, sex, height, Tanner stage by sex, axial length, anterior chamber depth, and spherical equivalent refractive error. The subfoveal choroid in high birth weight children (>4500 g, n = 48, mean 351 ± 63 μm) was comparable with normal birth weight children, P = 0.44. The subfoveal choroid was thinner in preterm children, however the difference was not significant (-18 [-37 to 2] μm, P = 0.08). Small for gestation children had thinner subfoveal choroid (-19 [-37 to -1] μm, P = 0.04) compared with appropriate for gestation children. Longer birth length was associated with a thicker subfoveal choroid (2 [1-4] μm/cm, P = 0.005). Macular choroidal thickness at 16 extrafoveal locations was measured in a subset of children and found to have the same associations with birth weight as the subfoveal choroidal thickness.

CONCLUSIONS. In 11- to 12-year-old children, thinner choroids were associated with lower birth weight, lower birth length, and being small for the gestational age.

Keywords: children choroidal thickness, birth weight, gestational age, population-based

Low birth weight can result from preterm birth and intrauterine growth restriction, and is associated with coronary artery disease, arterial hypertension, diabetes, and other systemic risk markers for cardiovascular disease risk in adulthood. Studies have also shown associations with ocular characteristics, such as shorter axial length, smaller foveal avascular zone, reduced foveal pit depth, abnormal macular and retinal nerve fibre layers, larger cup-disc ratio, and narrower retinal arterioles. Studies suggest that lower birth weight is associated with the development of myopia, whereas others have not found such association.

Choroidal thickness has been reported to be associated with age-related macular degeneration (AMD), retinal vein occlusion, diabetes and diabetic retinopathy, myopia, and axial length. In the Copenhagen Child Cohort 2000 Eye Study, we have previously found that body height and puberty are associated with thicker subfoveal choroid in girls. Data from recent studies in children have indicated that choroidal morphology and association with age differ from what have been observed in adults. It is unclear if birth parameters such as low birth weight and preterm birth have long-term effects on choroidal development in children. This is of increasing interest as the subfoveal choroid seems to be intricately involved in myopia development in young animals. The purpose of the current study was to examine the associations between birth parameters and choroidal thickness in the population-based Copenhagen Child Cohort 2000 Eye Study. We hypothesized that low birth weight and preterm birth are associated with a thinner subfoveal choroid and examined choroidal thickness in relation to birth weight, gestational age, size for gestational age, and body length at birth.

METHODS

The Copenhagen Child Cohort 2000 Eye Study is a population-based, observational study of children born in the year 2000 in
Informed consent was obtained from the children’s parents or legal guardians prior to the examinations. We have previously reported the association between subfoveal choroidal thickness and body height and puberty in girls in this study.25,26 A total of 1632 children attended the core mental health examination in 2011 to 2012. Of these, 1406 (86.2%) also chose to participate in the eye study. Exclusion criteria included previous eye trauma (n = 9), congenital malformation of the eye (n = 1), corrected visual acuity lower than 80 Early Treatment Diabetic Retinopathy Study (ETDRS) letters at 4m distance (Snellen 0.8; n = 14), inability to cooperate with axial length measurement (n = 11), inability to obtain optical coherence tomography (OCT) scans of acceptable quality (n = 13), and inability to cooperate with the eye examination (n = 35). This led to 83 children being excluded from the analysis, thus leaving 1323 children. Only right eyes were included. The study was approved by the local medical ethics committee and performed in accordance with the Helsinki Declaration. Informed consent was obtained from the children’s parents or legal guardians prior to the examinations. We have previously reported the association between subfoveal choroidal thickness and body height and puberty in girls in this cohort.25

The study protocol has been described previously.25 In short, participants were inquired about current and past ophthalmic history. Past medical history, including postnatal screening and history of retinopathy of prematurity (ROP), and information about current medication use were obtained from the parents. Height without shoes was measured to the nearest centimeter. Weight, self-reported Tanner puberty stage, and blood pressure were assessed as previously reported.25 Visual acuity and best-corrected visual acuity were determined using ETDRS charts (4 meter original series; Precision-Vision, La Salle, IL, USA) and an abbreviated refraction protocol where refractioning was pursued only until the participant saw 80 ETDRS letters or better. The study design gave priority to representativity and recruitment over cycloplegia, which was not included. Noncycloplegic objective refraction by an automated refractometer (Retinomax K-plus 2; Right MFG. CO., LTD., Tokyo, Japan) was used to guide refractioning. Subjective refraction was performed by adding positive power (+0.5 diopters [D]) consecutively to the objective refraction until a loss of at least three letters was observed, followed by removal of positive lens power until the maximal visual acuity was achieved. Ocular axial length and anterior chamber depth were measured using an interferometric device (IOL-Master, version 3.0.1.0294; Carl Zeiss Meditec, La Jolla, CA, USA) and calculated as the average of at least five and three scans, respectively.

Choroidal spectral-domain OCT was made in enhanced-depth imaging mode (EDI; Spectralis HRA+OCT; Heidelberg Engineering, Heidelberg, Germany). Scanning procedures included a transfoveal 7-line horizontal scan and a 4-line transfoveal radial scan, both in high resolution and spanning 30° using the built-in eye tracking feature to enable automated real-time averaging of 25 B-scans. The foveal center was assumed to be present on the scan with the deepest fovea and the most prominent reflex at the bottom of the foveal pit.25 Transverse magnification was adjusted using participants’ axial length and the Heidelberg Spectralis HRA+OCT-specific scaling method described by Delori et al.58 Choroidal thickness was measured using the manufacturer’s software (Heidelberg Eye Explorer, version 1.6.1.0; Heidelberg Engineering) to manually place the two available segmentation lines at Bruch’s membrane and the choroidoscleral border, respectively. The adjustment was made by an experienced operator (XQL). Intragrader variability was assessed by remeasuring the horizontal choroidal scan in 30 randomly selected children. When a suprachoroidal space was visible, the segmentation line was fitted to the border between the suprachoroidal space and the sclera. Scans with a signal-to-noise ratio poorer than 25 dB were rejected. The choroidoscleral border was visible and the subfoveal choroidal thickness measurable in all children who fulfilled the criteria for inclusion in the present study.25

In addition to subfoveal choroidal thickness being measured in all children, macular choroidal thickness was measured at multiple locations in all children with low (n = 51) and high birth weight (n = 48) and in children with pre- (n = 63) and post-term birth (n = 65), respectively, as well as in a random sample of 70 full-term children with normal birth weight. In this subset of children choroidal thickness was measured in 16 peripheral locations of the macula in eight directions on four transfoveal radial scans, at 1 and 3 mm from the foveal center.
**TABLE 1. Characteristics in Study Population by Birth Weight**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low (&lt;2500 g)</th>
<th>Normal (2500–4500 g)</th>
<th>High (&gt;4500 g)</th>
<th>P</th>
<th>Children With Missing Birth Weight Data*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (%)</td>
<td>51 (3.9%)</td>
<td>1194 (92.4%)</td>
<td>48 (3.7%)</td>
<td>0.002</td>
<td>30</td>
</tr>
<tr>
<td>Boys/girls in %</td>
<td>65/55</td>
<td>75/77</td>
<td>52/48</td>
<td>0.002</td>
<td>25/67</td>
</tr>
<tr>
<td>Age, y</td>
<td>11.7 ± 0.4</td>
<td>11.7 ± 0.4</td>
<td>11.6 ± 0.4</td>
<td>0.26</td>
<td>11.7 ± 0.4</td>
</tr>
<tr>
<td>Height, cm</td>
<td>152 ± 8</td>
<td>152 ± 7</td>
<td>155 ± 7†</td>
<td>0.001</td>
<td>153 ± 7†</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>43.3 ± 10.5</td>
<td>42.6 ± 8.9</td>
<td>46.5 ± 8.7†</td>
<td>0.001</td>
<td>42.1 ± 6.6</td>
</tr>
<tr>
<td>Tanner, stage</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>0.73</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Axial length, mm</td>
<td>23.10 ± 0.82</td>
<td>23.17 ± 0.76</td>
<td>23.52 ± 0.72†</td>
<td>0.006</td>
<td>23.19 ± 0.79</td>
</tr>
<tr>
<td>Anterior chamber, mm</td>
<td>3.51 ± 0.23</td>
<td>3.51 ± 0.24</td>
<td>3.56 ± 0.21</td>
<td>0.51</td>
<td>3.46 ± 0.24</td>
</tr>
<tr>
<td>Refractive error, D</td>
<td>0.02 ± 1.07</td>
<td>0.07 ± 0.84</td>
<td>0.17 ± 0.73†</td>
<td>0.65</td>
<td>−0.05 ± 1.50</td>
</tr>
<tr>
<td>Visual acuity, letters</td>
<td>88 ± 3</td>
<td>89 ± 3</td>
<td>89 ± 3</td>
<td>0.19</td>
<td>89 ± 3</td>
</tr>
<tr>
<td>Gestational age, d</td>
<td>253 ± 20†</td>
<td>279 ± 10</td>
<td>285 ± 11†</td>
<td>&lt;0.0001</td>
<td>280 ± 9</td>
</tr>
<tr>
<td>Birth length, cm</td>
<td>45 ± 4†</td>
<td>52 ± 2</td>
<td>56 ± 2†</td>
<td>&lt;0.0001</td>
<td>No data</td>
</tr>
<tr>
<td>Birth weight, g</td>
<td>2125 ± 343†</td>
<td>3550 ± 464</td>
<td>4818 ± 292†</td>
<td>&lt;0.0001</td>
<td>No data</td>
</tr>
</tbody>
</table>

Demographic characteristics analyzed using one-way ANOVA or χ² test (sex, Tanner) and presented with mean ± SD or median (interquartile range; Tanner).

* All characteristics except the sex-distribution were comparable with those of the children from whom birth weight data were available (P > 0.05).

† Significant (P ≤ 0.05) differences compared with normal birth weight children.

**RESULTS**

Birth weight data were available in 1293 children of whom 51 (3.9%) were of low birth weight and 48 (3.7%) of high birth weight (Table 1). The birth weight distribution of the Copenhagen Child Cohort 2000 cohort was comparable with the general birth weight distribution in Denmark, where the incidence of low birth weight was 3.4% and the incidence of high birth weight was 4.3% in the year 2000.41 Of the 1309 children for whom gestational age data were available, 63...
Table 2. Subfoveal Choroidal Thickness in Relation to Birth Parameters

<table>
<thead>
<tr>
<th>Birth weight</th>
<th>Crude Data*</th>
<th>Age and Sex Adjusted</th>
<th>Multivariate Adjustment†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low, n = 51</td>
<td>324 ± 76</td>
<td>−38 (−60 to −17) µm, 0.0005</td>
<td>−37 (−60 to −15) µm, 0.001</td>
</tr>
<tr>
<td>Normal, n = 1194</td>
<td>361 ± 78</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>High, n = 48</td>
<td>351 ± 63</td>
<td>−4 (−26 to 18) µm, 0.73</td>
<td>−9 (−32 to 14) µm, 0.44</td>
</tr>
<tr>
<td>Gestational age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preterm, n = 63</td>
<td>343 ± 76</td>
<td>−20 (−40 to −1) µm, 0.04</td>
<td>−18 (−37 to 2) µm, 0.08</td>
</tr>
<tr>
<td>Full-term, n = 1183</td>
<td>360 ± 78</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Post-term, n = 63</td>
<td>372 ± 71</td>
<td>14 (−6 to 34) µm, 0.16</td>
<td>15 (−5 to 35) µm, 0.13</td>
</tr>
<tr>
<td>Size for gestational age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small, n = 79</td>
<td>339 ± 80</td>
<td>−23 (−40 to −5) µm, 0.01</td>
<td>−19 (−37 to −1) µm, 0.04</td>
</tr>
<tr>
<td>Appropriate, n = 962</td>
<td>363 ± 79</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Large, n = 243</td>
<td>352 ± 70</td>
<td>−9 (−20 to 2) µm, 0.10</td>
<td>−7 (−19 to 4) µm, 0.21</td>
</tr>
<tr>
<td>Birth length, n = 1289</td>
<td>2 (1 to 4) µm/cm, 0.0007</td>
<td>2 (1 to 4) µm/cm, 0.005</td>
<td></td>
</tr>
</tbody>
</table>

* Group mean ± SD.
† Adjusted for age, sex, height, Tanner stage by sex, axial length, anterior chamber depth, and spherical equivalent refractive error.

(4.8%) were preterm and 63 (4.8%) were post-term (data not tabulated). One child was born extremely preterm (<28 weeks) and was of extremely low birth weight (<1000 g), while a second preterm child was in the very low birth weight category (1000 to <1500 g) and the remaining 49 low birth weight children were in the moderately low birth weight range (1500 to <2500 g). All but one of the preterm children were born between gestational weeks 32 and less than 37 (moderate to late preterm). All parents denied knowledge of ROP having been diagnosed or ROP having been treated.

At the time of the 11- to 12-year examination, the birth weight groups were of comparable age and pubertal development (Tanner stages) and showed no significant difference in anterior chamber depth, refractive error, or visual acuity (Table 1). Longer axial length was observed in children with high birth weight (0.35 mm; CI95 0.13–0.57 mm, P = 0.002, data not tabulated) compared with normal birth weight children, whereas the axial length was comparable between low and normal birth weight children (P = 0.52, data not tabulated). Children with high birth weight were primarily boys (75%) and were significantly taller (3 cm; CI95 1–5 cm, P = 0.003, data not tabulated) and heavier (4 g; CI95 1–6 g, P = 0.005, data not tabulated) than children of normal birth weight at the time of examination. When adjusting for age, sex, height, and weight, there was no significant difference in the axial length in high compared with normal or low birth weight children (P = 0.14, data not tabulated). Low birth weight children were also comparable with normal birth weight children in sex distribution, height, and weight.

Intrarater repeatability was high with an intraclass correlation coefficient (ICC) of 0.996. The mean difference between subfoveal thickness measurements one and two was 1.8 ± 7.9 µm, P = 0.22, range −17 to 14 µm. Similar remeasurements of nasal and temporal choroidal thickness at 1 and 3 mm from the foveal center, respectively, showed no significant difference (nasal 1 mm: −1.4 ± 14.6 µm, P = 0.61, ICC 0.985; nasal 3 mm: 0.3 ± 13.1 µm, P = 0.91, ICC 0.966; temporal 1 mm: −0.6 ± 9.4 µm, P = 0.74, ICC 0.966; temporal 3 mm: −2.5 ± 10.3, P = 0.19, ICC 0.991). Mean subfoveal choroidal thickness in children with low, normal, and high birth weight was 324, 361, and 351 µm, respectively (Table 2), with a comparable variance (P = 0.22) and an age and sex-adjusted difference of −38 µm in low birth weight children compared with normal birth weight children (P = 0.0005, Table 2). In the multivariate analysis adjusting for age, sex, height, Tanner stage by sex, axial length, anterior chamber depth, and spherical equivalent refractive error, the mean subfoveal choroid in low birth weight children was 37 µm thinner (CI95 −60 to −15 µm, P = 0.001, Table 2; Fig. 2) than in normal birth weight children. There was no statistical difference in choroidal thickness between high and normal birth weight children (P = 0.44, Table 2; Fig. 2).

Grouped by gestational age, the age- and sex-adjusted subfoveal choroid in preterm children was thinner than in full-term children (−20 µm, CI95 −40 to −1 µm, P = 0.04, Table 2). This effect sank below the level of significance, however, in the multivariate model (CI95 −37 to 2 µm, P = 0.08, Table 2). There was no difference in subfoveal choroidal thickness between post- and full-term children (P = 0.13, Table 2).

Children born small, appropriate, and large for gestational age had mean subfoveal choroidal thicknesses of 339, 363, and 352 µm, respectively (Table 2). Small for gestational age children had thinner age- and sex-adjusted subfoveal choroids compared with appropriate for gestational age children (P = 0.044, Table 2).
3-mm zone

<table>
<thead>
<tr>
<th>Location</th>
<th>Unadjusted Birth Weight Group Means ± SD</th>
<th>Mean Difference Between Birth Weight Groups (CI95)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low, n = 51</td>
<td>Normal, n = 59</td>
</tr>
<tr>
<td></td>
<td>324 ± 76</td>
<td>356 ± 71</td>
</tr>
<tr>
<td>Superior</td>
<td>344 ± 75</td>
<td>376 ± 64</td>
</tr>
<tr>
<td>Nasosuperior</td>
<td>319 ± 79</td>
<td>358 ± 66</td>
</tr>
<tr>
<td>Nasal</td>
<td>280 ± 78</td>
<td>318 ± 74</td>
</tr>
<tr>
<td>Nasoinferior</td>
<td>306 ± 77</td>
<td>342 ± 75</td>
</tr>
<tr>
<td>Inferior</td>
<td>330 ± 80</td>
<td>356 ± 77</td>
</tr>
<tr>
<td>Temporoinferior</td>
<td>324 ± 77</td>
<td>348 ± 70</td>
</tr>
<tr>
<td>Temporal</td>
<td>322 ± 73</td>
<td>352 ± 66</td>
</tr>
<tr>
<td>Temporosuperior</td>
<td>346 ± 75</td>
<td>373 ± 63</td>
</tr>
</tbody>
</table>

Overall mean 288 ± 59 328 ± 55 309 ± 52

Choroidal differences between birth weight groups were adjusted for age, sex, height, Tanner stage by sex, axial length, anterior chamber depth, and spherical equivalent refractive error.

* P ≤ 0.01 after Bonferroni correction.
† P ≤ 0.05 after Bonferroni correction.

This difference remained significant in the multivariate analysis (−19 μm; CI95: −37 to −1 μm, P = 0.04, Table 2). There was no difference in subfoveal choroidal thickness between large and appropriate for gestational age children (P = 0.21, Table 2).

Body length at birth, which was available in 1289 children, was positively associated with subfoveal choroidal thickness, which increased by 2 μm/cm (CI95: 1–4 μm/cm; P = 0.005, Table 2) after multivariate adjustments. Excluding one extremely preterm child who was 24 cm at birth (range in the rest of the cohort: 40–60 cm) from the analysis showed a comparable result (2 μm/cm, CI95: 0–4 μm/cm, P = 0.02). There was no significant interaction between sex and birth parameters on the subfoveal choroidal thickness (P > 0.05, not tabulated).

In a subset of 158 children, macular choroidal thickness was measured at 16 locations in addition to the subfoveal location described in the analyses above (Fig. 1; Table 3). Mean choroidal thickness was numerically thinner at all locations and significantly so at 15 of the total of 17 locations in children with low birth weight compared with children with normal birth weight (Table 3; Fig. 3), adjusted for age, sex, height, Tanner stage by sex, axial length, anterior chamber depth, and spherical equivalent refractive error. The difference was largest 1-mm nasosuperiorly of the fovea (−48 μm, CI95: −75 to −24 μm, P ≤ 0.01, Table 3). Children with high birth weight had thinner choroids at several superior macular locations compared with children with normal birth weight, the largest difference being located 1-mm nasosuperiorly (−34 μm, CI95: −60 to −9 μm, P ≤ 0.01, Table 3). All 17 locations taken together, the macular choroids in both low and high birth weight children were significantly thinner than in normal birth weight children (P ≤ 0.01, Table 3).

Preterm children had thinner macular choroids than full-term children at multiple extrafoveal locations, the maximal...
difference being found 1-mm nasosuperiorly of the fovea (−37 μm, CI 95% 51 to 40) vs 14 μm, CI 95% 43 to 0) (P < 0.01 after Bonferroni correction). Overall, the macular choroid in preterm children was thinner than in full-term children (P < 0.01, Table 4). There was no significant difference between full- and post-term children at any location.

**DISCUSSION**

In this population-based cohort of children we found that having a low birth weight, being small for gestational age or being shorter at birth were associated with having a thinner subfoveal choroid at 11 to 12 years of age. The macular choroid was also thinner at extrafoveal locations in children of low birth weight or preterm birth, compared with normal birth weight and birth at full term, respectively.

Strengths of this study include a population-based design and estimates of gestational age being based primarily on first trimester ultrasonography. Additionally, anthropometric data including pubertal development status and ocular axial length data were included. Limitations include cycloplegic refraction and intraocular pressure not having been obtained. We used a manual procedure to define the thickness of the choroid on EDI-OCT scans because no commercialized automated segmentation software was available at the time of analysis. Measurement of choroidal thickness outside the foveal center was only made in a subset of children.

The children with low and normal birth weight in the current study were comparable in anthropometric and ocular characteristics, including axial length, anterior chamber depth, refractive error, and body height at the time of examination, and the analyses were performed adjusting for additional variables that may affect choroidal thickness. Consequently, our findings indicate that having a thinner choroid relates to lower birth weight, per se, beyond what can be explained by differences in age, axial elongation, myopic shift, or general anthropometric characteristics in children with low birth weight.

Previously, Moreno et al. measured choroidal thickness in infants and found that subfoveal choroidal thickness increased after birth in preterm infants but without reaching the thickness of full-term infants of the same postmenstrual age. Another study of 31 preterm and 30 full-term children aged 4 to 10 years reported that at one location 3-mm temporal of the fovea the mean choroid was thinner in preterm children, whereas no effect of gestational age or birth weight was found on subfoveal choroidal thickness. The discrepancies may be related to the larger sample size (n = 1293) and consequently higher statistical power in our study and to differences in categorization availability of birth parameter data.

In the present study, we also found associations of size for gestational age and birth length with subfoveal choroidal thickness, supporting the hypothesis that intrauterine growth conditions may have lasting effects on the choroidal thickness. Low birth weight and preterm birth were associated with a thinner macular choroid, especially in the nasosuperior and superior macula in our study, but not significantly so in the temporal macula as has previously been reported.

Limited data are available on the development of the macular choroid during childhood and only from cross-sectional studies, some of which suggest that choroidal thickness increases with age. Others that it decreases with age. In adults, an association between a thinner choroid and increasing age has been reported repeatedly in cross-sectional studies. Also in adults, a thinner subfoveal choroid is related to longer axial length and more myopic refraction and in high myopia also to lower visual acuity. Animal studies support the significance of the choroid in emmetropization and myopia development. However, it is not known if a thinner choroid in
childhood influences the development of myopia later in life as no longitudinal study of choroidal thickness and myopia in children has been published.

The association between preterm birth or low birth weight and the development of myopia in otherwise ophthalmologic healthy children remains disputed. Some population-based studies indicating comparable refraction properties of choroidal thickness at birth or appeared later. The thinner choroid of preterm children may primarily involve the anterior part of the eye.45

The choroid superior of the fovea was relatively thin in high birth weight children. This was contrary to the effect we expected of neonatal macrosomia and previous reports describing a longer axial length and a thicker retina/retinal nerve fiber layer. Our study cannot determine whether the trait was present at birth or appeared later. The thinnest choroid in children in the present study may also suggest an upper limit for maximal choroidal expansion during normal development.

To the best of our knowledge, the present study is the first to report choroidal thickness differences between normal and high birth weight children. Interestingly, two separate studies reported the surprising association between high birth weight and risk of AMD.46 The latter is associated with a thin choroid.44

However, previous report on choroidal growth in childhood and the generally thicker choroid at the superior/temporosuperior locations in children along with the lack of thickness difference in other locations between normal and high birth weight children in the present study may also suggest an upper limit for maximal choroidal expansion during normal development.

In summary, being smaller at birth was associated with having a thinner choroid at the age of 11 to 12 years in this population-based cohort of children. The findings indicate the existence of a persistent effect of intrauterine growth retardation and unfavorable birth parameters on the development of the choroid in childhood.

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References

Choroidal Thickness and Birth Parameters


**APPENDIX**

**The Copenhagen Child Cohort 2000 Study Group**

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