Retinal Nerve Fiber Layer Thickness in Children: The Gobi Desert Children Eye Study

Chun-Yan Wang,1 Yan-Fei Zheng,1 Bin Liu,1 Zi-Wei Meng,1 Fei Hong,1 Xiao-xia Wang,1 Xiao-Juan Wang,1 Lagan Du,1 Ian Y. Wang,2 Dan Zhu,1 Yong Tao,3 Qi Sheng You,4 and Jost B. Jonas4,5

1The Affiliated Hospital of Inner Mongolia Medical University, Hohhot, Inner Mongolia, China
2Department of Ophthalmology, The University of Hong Kong, Hong Kong, China
3Department of Ophthalmology, Beijing Chaoyang Hospital, Capital Medical University, Beijing, China
4Beijing Institute of Ophthalmology and Visual Sciences Key Laboratory, Beijing Tongren Hospital, Capital Medical University, Beijing, China
5Department of Ophthalmology, Medical Faculty Mannheim of the Ruprecht-Karls-University Heidelberg, Mannheim, Germany

Correspondence: Dan Zhu. The Affiliated Hospital of Inner Mongolia Medical University, No.1 Tongdaobei Street, Hohhot, Inner Mongolia 010050, China; zhudan1968@163.com; Qi Sheng You, Beijing Institute of Ophthalmology, Beijing Tongren Hospital, 17 Houguou Lane, Chongnei Street, Beijing 100005, China; qishengbio@163.com.
Submitted: August 1, 2018
Accepted: October 3, 2018

PURPOSE. Because there is a paucity of population-based data on retinal nerve fiber layer thickness (RNFLT) for children, we measured the RNFLT and its associations in schoolchildren.

METHODS. The population-based Gobi Desert Children Eye Study included all schoolchildren aged 6 to 21 years living in Ejina, Inner Mongolia. The children underwent a comprehensive ocular examination with cycloplegic refraction and spectral-domain optical coherence tomography of the optic nerve head. The peripapillary RNFLT was measured on the optical coherence tomography images of a circular scan with a diameter of 3.4 mm.

RESULTS. Out of 1565 participants, RNFLT data were available for 1440 (92.5%) children. The mean global RNFLT was 101.3 ± 9.2 μm in right eyes. The RNFLT was thickest in the temporal inferior sector (157.3 μm), followed by the temporal superior sector (143.8 μm), the nasal inferior sector (109.7 μm), the nasal superior sector (106.9 μm), temporal sector (85.2 μm), and the nasal sector (61.7 μm). In multivariate analysis, the RNFLT decreased with higher myopic refractive error (P < 0.001), male sex (P = 0.001), higher intraocular pressure (P = 0.002), and lower birth weight (P = 0.03). It was not significantly associated with age (P = 0.19), body mass index (P = 0.57), mean arterial blood pressure (P = 0.33), pulse rate (P = 0.28), and subfoveal choroidal thickness (P = 0.11).

CONCLUSIONS. The RNFLT in children showed a regional distribution, with the thickest part in the temporal inferior sector and the thinnest part located in the nasal sector. The overall RNFLT significantly decreased with higher myopic refractive error and male sex. In schoolchildren, in contrast to adults, the RNFLT did not decrease with older age. These findings may be considered when interpreting RNFLT data in children.

Keywords: retinal nerve fiber layer thickness, optical coherence tomography, optic nerve, optic nerve head, glaucoma

A clinical assessment of the retinal nerve fiber layer (RNFL) is of high importance for the diagnosis and monitoring of optic nerve diseases, particularly for glaucoma.1–5 Examination of the RNFL is also useful for the diagnosis of systemic diseases, such as cerebral stroke, multiple sclerosis, and Alzheimer’s disease.7–10 Qualitative or semiquantitative methods for evaluating the RNFL previously included ophthalmoscopy, color fundus photography or red-free fundus photography, all of which have been supplemented or almost completely replaced by spectral-domain optical coherence tomography (SD-OCT), which allows the measurement of the RNFL with a spatial resolution of about 5 to 10 μm.11,12 By using SD-OCT to measure the RNFL in children, we revealed that a lower RNFL thickness was associated with lower visual function in eyes with optic nerve hypoplasia, congenital glaucoma, optic neuritis, and autosomal dominant optic atrophy.13–15 Other studies showed that the RNFL was abnormally thin in children with type 1 diabetes without typical signs of diabetic retinopathy, in children with Marfan syndrome, and in children with an attention deficit hyperactivity disorder.16–18 These investigations demonstrated the potential value of the measurement of RNFL thickness in the management of some pediatric ocular and systemic diseases.

Despite its importance for the diagnosis of optic nerve diseases in children, most studies on the RNFL have been directed on adults so that there has been a paucity of data on the normal thickness of the RNFL in children. It holds true in particular for population-based studies that, due to the population-based selection of their study participants, have the lowest risk of a recruitment or referral bias. Therefore, we conducted this study to evaluate RNFL thickness by using SD-OCT and its associations in children, which were recruited for the study in a population-based manner.

METHODS

The Gobi Desert Children Eye Study was a population-based schoolchildren cohort study performed in Ejina, Inner Mongo-
Ejina is an oasis city located in the Gobi Desert. The living conditions and the climate differ markedly between Ejina and Eastern Chinese metropolitan regions where most of the previous population-based studies in children in China have been carried out so far. This Gobi Desert Children Eye Study, adhered to the Declaration of Helsinki and was approved by the institutional review board of Inner Mongolia Medical University. A written informed consent was obtained from the parents of all children participating in the study. The study has been reported in detail previously. In short, the baseline study was carried out in 2013, and a 3-year follow-up study was performed in 2016. Only the data assessed at the baseline examination were used in the current study. In 2013, the study included all three schools in Ejina, which were the Ejina primary school (911 students), the Ejina middle school (765 students), and the Ejina minority school (235 students), with altogether 1911 children. All the participants underwent a comprehensive ocular examination, and the parents of the children were interviewed with a structured questionnaire.

The questions in the questionnaire addressed the profession, level of education, income and ethnic background of the parents, birth age, birth weight, type of delivery of the children, and whether oxygen was supplied after birth. Other questions asked included the number of school days per week; sleeping time and duration of sleep; time, duration, and type of travelling to and from school; time spent outdoors at school and at home; type of activities when being outdoors; time spent indoors with reading or writing for school work, reading at pleasure, working on the computer, or when watching television; and time spent during indoor sports or during other indoor activities. In addition, anthropometric parameters, such as body height and weight, blood pressure, and the heart rate, were measured. The ophthalmologic examinations included an assessment of uncorrected and best-corrected visual acuity, binocular vision, cycloplegic refractionometry, slit lamp-based examination of the anterior segment, noncontact tonometry, examination of the ocular motility and presence of strabismus, color photography of the macula and optic nerve head, and SD-OCT of the macula and optic nerve head (Spectralis; Heidelberg Engineering Co., Heidelberg, Germany).

By using the software of the OCT device, we measured the thickness of the RNFL on a circular scan with a diameter of 3.4 mm, which was centered on the optic disc. All automatic segmentations of the RNFL performed by the OCT were checked and adjusted manually when necessary. The global mean thickness of RNFL and the sectorial mean RNFL thicknesses were recorded for the nasal, nasal superior, temporal superior, temporal, temporal inferior, and nasal inferior sectors. A horizontal OCT section running through the center of the fovea was obtained by the enhanced depth imaging mode and was used for the measurement of subfoveal choroidal thickness, which was defined as the distance between the hyperreflective line of Bruch’s membrane and the hyperreflective line of the inner surface of the sclera.

The body mass index (BMI) was calculated as the ratio of body weight (expressed in kg) divided by the square of body height (expressed in meters). The mean arterial blood pressure, refractive error, and intraocular pressure. The spherical equivalent of the refractive error, the mean arterial blood pressure, refractive error, and intraocular pressure. The P values represented the results of two-sided tests, with values less than 0.05 considered statistically significant.

**RESULTS**

Out of 1911 eligible children, 1565 (81.9%) students participated in the study. Among these children, RNFL data were available for 1440 (92.5%) students (51.2% boys). The mean age of these 1440 students was 11.9 ± 3.5 years (range, 6–21 years), with 1103 (76.6%) children being of Han Chinese ethnicity and 337 (23.4%) of Mongolian ethnicity or other minority ethnicity. The mean BMI of the 1440 participants was 19.0 ± 3.9 kg/m² (range, 11–47 kg/m²), the mean pulse rate was 88 ± 12/minute (range, 53–130/minute), and the mean reported birth weight was 3.3 ± 0.5 kg (range, 1.2–5.8 kg). The mean subfoveal choroidal thickness measured in the right eyes was 282 ± 49 μm (range, 91–417 μm). The mean refractive error (right eyes) was −1.18 ± 2.02 diopters (range, −12.75 diopters to 6.63 diopters) and the mean intraocular pressure measured 17.1 ± 3.39 mm Hg (range, 7.8–32.3 mm Hg). The prevalence of myopia, defined as a refractive error of ≤−0.5 diopters in the more myopic eye, was 58.1%.

Compared with the students with available measurements of the RNFL thickness, the children without RNFL thickness were significantly older (13.1 ± 2.7 vs. 11.9 ± 3.5 years; P < 0.001) and had a higher proportion of non-Han Chinese ethnicity (53.5% vs. 23.4%; P < 0.001). Both groups did not differ significantly in sex (girls, 51.2% versus boys, 48.8%); P = 0.58), intraocular pressure (17.2 ± 3.7 vs. 17.1 ± 3.4 mm Hg; P = 0.81), mean refractive error (right eyes) was −1.32 ± 2.05 vs. −1.18 ± 2.02 diopters; P = 0.46), and prevalence of myopia (62.8% vs. 58.1%; P = 0.30).

The mean global RNFL thickness was 101.3 ± 9.2 μm in the right eyes and 101.2 ± 9.3 μm in the left eyes, without a significant difference between right and left eyes (P = 0.83). The RNFL was thickest in the temporal inferior region (157.3 ± 21.8 μm), followed by the temporal superior sector (143.8 ± 19.5 μm), the nasal inferior sector (109.7 ± 25.1 μm), the nasal superior sector (106.9 ± 22.0 μm), the temporal sector (85.2 ± 14.3 μm), and, finally, the nasal region (61.7 ± 20.4 μm). This regional distribution of the RNFL thickness did not differ between girls and boys (Fig. 1). The mean global RNFL thickness was significantly higher in girls than in boys (101.8 ± 9.2 vs. 100.8 ± 9.3 μm; P = 0.045) and did not differ between children of Han Chinese ethnicity and children of non-Han ethnicity (101.1 ± 9.0 vs. 101.8 ± 9.8 μm; P = 0.22).

Comparing the sectorial RNFL thickness between girls and boys revealed that the RNFL was significantly thicker in girls than in boys in the temporal inferior sector (160.2 ± 20.8 vs. 154.7 ± 22.4 μm; P < 0.001), the temporal region (88.0 ± 15.1 vs. 82.5 ± 12.9 μm; P < 0.001), the nasal sector (62.1 ± 13.4 vs. 60.37 ± 13.13 μm; P = 0.04), and in the nasal superior...
region (108.1 ± 21.3 vs. 105.3 ± 21.1 μm; \( P = 0.01 \)), whereas both sexes did not differ significantly in RNFL thickness in the temporal superior (143.4 ± 19.3 μm vs. 144.3 ± 19.8 μm; \( P = 0.39 \)) and in the nasal inferior region (108.5 ± 23.4 μm vs. 110.6 ± 23.6 μm; \( P = 0.10 \)).

In univariate linear regression analysis, larger global RNFL thickness was significantly associated with younger age (\( P < 0.001 \)), female sex (\( P = 0.045 \)), larger BMI (\( P = 0.02 \)), lower pulse rate (\( P = 0.004 \)), higher mean arterial blood pressure (\( P = 0.01 \)), lower birth weight (\( P = 0.03 \)), higher intraocular pressure (\( P = 0.003 \)), lower refractive error (\( P < 0.001 \)), and thinner subfoveal choroidal thickness (\( P < 0.001 \)). It was not significantly correlated with ethnic background (\( P = 0.22 \)) and gestation duration (\( P = 0.89 \)) (Table 1). In the multivariate analysis model, RNFL thickness was taken as the dependent variable, and all those parameters that were significantly (\( P < 0.05 \)) associated with RNFL thickness in the univariate analysis were taken as independent variables. We then dropped step-by-step those independent variables that were no longer significantly associated with RNFL thickness. In the final model, thinner RNFL thickness was significantly associated with higher myopic refractive error (standardized coefficient beta, 0.35; \( P < 0.001 \)), male sex (beta, 0.08; \( P = 0.001 \)), higher intraocular pressure (beta, 0.08; \( P = 0.002 \)), and lower birth weight (beta, 0.06; \( P = 0.03 \)), whereas BMI (\( P = 0.57 \)), mean arterial blood pressure (\( P = 0.35 \)), pulse rate (\( P = 0.28 \)), age (\( P = 0.19 \)), and subfoveal choroidal thickness (\( P = 0.11 \)) were no longer correlated with RNFL thickness (Figs. 1, 2).

**DISCUSSION**

In the schoolchildren participating in the Gobi Desert Children Eye Study, the thickness of the RNFL decreased with a higher myopic refractive error and male sex, whereas it was not significantly correlated with age, BMI, arterial blood pressure, and subfoveal choroidal thickness. The RNFL thickness was significantly thickest in the temporal inferior region, followed by the temporal superior sector, the nasal inferior sector, the nasal superior region, and, finally, the temporal sector and nasal region.

The value of the mean globalRNFL thickness of 101.3 ± 9.2 μm in the school children of our study population was comparable with the measurements obtained in previous studies. In the population-based Beijing Eye Study on Chinese adults with an age of 50+ years, the mean RNFL thickness, as measured by the iVue spectral domain OCT (OptoVue, Inc., Freemont, CA, USA), was 103.2 ± 12.6 μm.\(^{25}\) In an international multicenter hospital-based study on 18+ year olds that applied the RTVue OCT device (OptoVue, Inc.), Girkin and colleagues\(^{26}\) measured a mean RNFL thickness of

---

**TABLE 1.** Univariate Analysis of Associations Between The RNFL Thickness and Systemic and Ocular Parameters in the Gobi Desert Children Eye Study

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Nonstandardized Coefficient B</th>
<th>Standard Error</th>
<th>Standardized Coefficient beta</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive error, diopters (cycloplegic spherical equivalent)</td>
<td>1.58</td>
<td>0.11</td>
<td>0.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Subfoveal choroidal thickness, μm</td>
<td>0.03</td>
<td>0.01</td>
<td>0.15</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, y</td>
<td>-0.35</td>
<td>0.07</td>
<td>-0.13</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intraocular pressure, mm Hg</td>
<td>-0.22</td>
<td>0.07</td>
<td>-0.08</td>
<td>0.003</td>
</tr>
<tr>
<td>Pulse rate, per min</td>
<td>0.06</td>
<td>0.02</td>
<td>0.08</td>
<td>0.004</td>
</tr>
<tr>
<td>Mean arterial blood pressure, mm Hg</td>
<td>-0.07</td>
<td>0.03</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td>BMI, kg/m(^2)</td>
<td>-0.15</td>
<td>0.06</td>
<td>-0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>Birth weight, kg</td>
<td>0.001</td>
<td>0.00</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Sex, boys/girls</td>
<td>0.08</td>
<td>0.49</td>
<td>0.06</td>
<td>0.045</td>
</tr>
<tr>
<td>Ethnic group, Han Chinese vs. non-Han Chinese</td>
<td>0.71</td>
<td>0.58</td>
<td>0.05</td>
<td>0.22</td>
</tr>
<tr>
<td>Gestation length, d</td>
<td>0.003</td>
<td>0.02</td>
<td>0.004</td>
<td>0.89</td>
</tr>
</tbody>
</table>
101.9 ± 9.8 μm in Europeans (n = 219), 103.8 ± 8.5 μm in Japanese (n = 126), 104.1 ± 11.1 μm in African Americans (n = 126), 108.5 ± 8.8 μm in Indians (n = 76), and 112.4 ± 9.8 μm in Hispanics (n = 77). In the population-based Singapore Chinese Eye Study that used the Cirrus OCT (Carl Zeiss Meditec, Jena, Germany) and examined 542 adults with an age of 40 to 80 years, the mean RNFL thickness was 97.6 ± 9.1 μm.27 In the Anyang Childhood Eye Study on Chinese children with an age of 12 years, the mean RNFL thickness, as determined with the iVue OCT (OptoVue, Inc.), measured 103.8 ± 9.0 μm (Table 2).28 The comparison of the results obtained in the various studies suggested that the RNFL thickness did not vary markedly between schoolchildren and adults of various ethnic backgrounds.

The topographic distribution pattern of the RNFL thickness (temporal inferior > temporal superior > nasal inferior > nasal superior > temporal > nasal) mostly agreed with previous reports.25,26,29 The Singapore Chinese Eye Study found a thicker RNFL in the inferior sector (127 ± 16 μm) than in the superior sector (123 ± 16 μm), the temporal sector (72 ± 11 μm), and, finally, the nasal sector (69 ± 11 μm).30 In the Beijing Eye Study, the mean RNFL thickness was largest in the temporal inferior quadrant (153 ± 21 μm), followed by the temporal superior sector (138 ± 21 μm), the nasal inferior sector (118 ± 24 μm), the nasal superior sector (106 ± 21 μm), the temporal sector (76 ± 13 μm), and, finally, the nasal quadrant (73 ± 15 μm).30 The distribution pattern of the RNFL thickness, as measured clinically, agrees with histomorphometric measurements of the RNFL thickness in enucleated human eyes.31 In a histomorphometric study by Dichtl and coworkers,32 the RNFL thickness, assessed in 22 normal human eyes at the optic disc border showed a double hump configuration, with the highest mean thickness in the inferior quadrant (266 ± 64 μm), followed by the superior quadrant (240 ± 57 μm), the nasal quadrant (220 ± 70 μm), and, finally, the temporal quadrant (170 ± 58 μm). The regional distribution of the thickness of the RNFL also agreed with the distribution of the ophthalmoscopic visibility of the RNFL, with the regional distribution of the diameter of the retinal arterioles (being widest in the temporal inferior vascular arcade, followed by the temporal superior vascular arcade, the nasal superior vascular arcade, and, finally, the nasal inferior vascular arcade) and with the physiologic configuration of the optic disc neuroretinal rim that, following the so-called ISNT (inferior-superior-nasal-temporal) rule, is significantly widest in the inferior sector, followed by the superior sector, the nasal sector, and finally, the temporal sector.33-35 The regional distribution of the RNFL thickness also corresponded with regional differences in the mean thickness of the retinal ganglion cell axons in the retrobulbar part of the optic nerve.

### Table 2. RNFL Thickness in Previous Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Age, y</th>
<th>Ethnicity</th>
<th>RNFL Thickness, μm (Ethnicity)*</th>
<th>RNFL Measurement Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing Eye Study</td>
<td>1654</td>
<td>50+</td>
<td>Chinese</td>
<td>103.2 ± 12.6</td>
<td>iVue SD OCT (OptoVue, Inc., Fremont, CA, USA)</td>
</tr>
<tr>
<td>International multicenter clinic-based study by Girkin et al.</td>
<td>219</td>
<td>18+</td>
<td>European</td>
<td>101.9 ± 9.8</td>
<td>RTVue</td>
</tr>
<tr>
<td></td>
<td>126</td>
<td></td>
<td>Japanese</td>
<td>103.8 ± 8.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>126</td>
<td></td>
<td>African American</td>
<td>104.1 ± 11.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76</td>
<td></td>
<td>Indian</td>
<td>108.5 ± 8.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>77</td>
<td></td>
<td>Hispanics</td>
<td>112.4 ± 9.8</td>
<td></td>
</tr>
<tr>
<td>Singapore Chinese Eye Study</td>
<td>542</td>
<td>40-80</td>
<td>Chinese</td>
<td>125.0 ± 15.9</td>
<td>Cirrus SD-OCT</td>
</tr>
<tr>
<td>Anyang Childhood Eye Study</td>
<td>1955</td>
<td>12</td>
<td>Chinese</td>
<td>103.8 ± 9.0</td>
<td>iVue SD OCT</td>
</tr>
<tr>
<td>Histopathologic study</td>
<td>22</td>
<td>-</td>
<td>170–266 (varied in quadrants)</td>
<td>101.3 ± 9.2</td>
<td>Spectralis SD-OCT (Heidelberg Engineering, Heidelberg, Germany)</td>
</tr>
<tr>
<td>The Gobi Desert Children Eye Study</td>
<td>1100</td>
<td>6-21</td>
<td>Chinese</td>
<td>101.8 ± 9.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>340</td>
<td></td>
<td>Mongolians</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Data displayed as mean ± SD.
with the thicker axons located in the inferior and superior regions and the thinnest axons located in the temporal region. The explanation for the sectorial uneven distribution of the RNFL thickness might be related to the retinal anatomy, with the foveola being located about 0.5 inferior to a horizontal line drawn through the center of the optic disc. It leads to more retinal surface area and more retinal cells in the region inferior to the horizontal optic disc axis as compared with the region superior to the horizontal optic disc axis.

The present investigation on schoolchildren did not reveal a decrease in the RNFL thickness with older age, whereas previous studies had reported on a loss of RNFL thickness with older age in study populations aged 40+ years or 50+ years. In the Beijing Eye Study on Chinese adults aged 50+ years, the age-related decrease in the thickness of the RNFL was approximately 0.26 μm per year of life. This figure of a yearly loss of about 0.3% of the RNFL thickness agrees with findings obtained in histomorphometric studies that demonstrated an age-related loss in the number of optic nerve fibers of about 0.3% per year of life. The age-related loss in RNFL thickness also corresponds to the age-dependent loss in the visibility of the RNFL as observed clinically and on fundus photographs. Interestingly, a similar yearly loss of 0.3% was reported for the count retinal rods and cones and of retinal pigment epithelium cells. One may assume that the age-related loss of retinal ganglion cell axons or RNFL thickness may not be linear but that the age-related loss may start beyond an age of 21 years, which was the oldest age in our study population. In a similar manner, the RNFL thickness in the children of our study did not decrease with higher BMI or with higher blood pressure. This finding is in contrast to studies on adults in which the prevalence of localized RNFL defects was increased and the overall RNFL thickness was reduced in individuals with arterial hypertension and obesity.

It has remained elusive why the RNFL was thicker in the girls than in the boys in our study population after adjusting for parameters such as refractive error and birth weight. Interestingly, girls and boys also differ in the ocular biometric parameters, with girls, besides being more myopic, have a relatively shorter axial length and a relatively steeper corneal curvature (i.e., shorter corneal curvature radius). It has remained unclear whether the thicker RNFL thickness measurements in the girls versus boys in our study population were due to differences in the biometric optical properties of the eyes, even after adjusting for refractive error, or whether girls indeed had a thicker RNFL. It would then imply that girls may also have more optic nerve fibers.

In our study, as in previous investigations, the RNFL thickness decreased with higher myopic refractive error. In the Singapore Chinese Eye Study on adult Singaporeans, the mean RNFL thickness decreased with longer axial length (beta, –1.83; P < 0.001) after adjusting for parameters such as age (beta, –0.20; P = 0.001) and optic disc area (beta, 4.22; P < 0.001). The thinning of the RNFL with more myopic refractive error or longer axial length may be explained by axial elongation-associated changes in the posterior fundus. Recent studies have shown that axial elongation leads to the development and enlargement of parapapillary gamma zone, defined as the parapapillary region without Bruch’s membrane, while the macular region is mostly unaffected by axial elongation. Due to geometric reasons, with an enlarged peripapillary surface area, the gamma zone-associated enlargement of the parapapillary surface area may explain the thinning of the RNFL in the parapapillary region of axially elongated eyes. An additional reason may be that the diameter of the OCT scanning circle may be larger in myopic eyes so that the RNFL may be measured more distant to the optic disc center in the myopic versus hyperopic eyes.

The limitations of our study should be discussed. First, as for any population-based study, the participation rate is of major importance. In the Gobi Desert Children Eye Study, the response rate of 81.9% was reasonable so that potential differences between participants and nonparticipants might not have led to a major selection bias. Second, the oasis city of Ejina in West China is not representative for whole China, so that it has remained unclear whether the results of our study can be generalized to the population of all China. Third, because the eyes of the study participants varied in their axial length, the diameter of the RNFL thickness measurement circle assumed to be interindividually constant at 3.4 mm differed between the eyes examined. It suggests that depending on the axial length of the eyes examined, different parts of the RNFL were assessed. Because it is possible that the eyes of these children were still growing (elongating axially), the 3.4-mm-diameter circular scan might have been placed at an increasing linear distance from the optic disc where the RNFL was thinner. This potential confounding variable, if operative, would have introduced an apparent decrease of RNFL thickness with increased age. Thus, either this confounding variable was not operative (i.e., eyes were not elongating) or there was an offsetting real increase of RNFL thickness over time. We did not obtain ocular biometry measurements, most importantly, axial length; therefore, we cannot rule out the possibility that this confounding variable has affected our conclusion. As the axial length increases with age and depends on other parameters, such as sex and region of location, the lack of correction of the dependence of the measurement circle diameter on axial length might have masked real differences in anatomy. Thus, the reliance on a nominal (as opposed to an absolute) scan circle dimension is a further limitation of the study. However, this limitation existed in the majority of studies determining and comparing the RNFL using the measurement circle.

In conclusion, similar to results in adults, the RNFL thickness in children followed a double-hump configuration that was paralleled by the physiologic shape of the neuroretinal rim of the optic disc, the ophthalmoscopic visibility of the RNFL, the regional distribution of the width of the retinal arterioles, and the regional distribution of the thickness of the retinal ganglion cell axons in the retrolubar part of the optic nerve. The RNFL thickness significantly decreased with increasing myopic refractive error and was higher in girls than in boys. Within our study population consisting of schoolchildren, the RNFL did not decrease in thickness with older age, suggesting that the age-related loss of RNFL and retinal ganglion cell axons may set in at an older age. These findings may be considered when interpreting the RNFL thickness in children.

Acknowledgments
Supported by the 1351 Talent Training Program (no. CYXX-2017-21), Beijing Talents Fund (2015000021223ZK22), and the Chinese National Natural Science Foundation (no. 81400422, 81560165). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Disclosure: C.-Y. Wang, None; Y.-F. Zheng, None; B. Liu, None; Z.-W. Meng, None; F. Hong, None; X.-x. Wang, None; X.-J. Wang, None; L. Du, None; I.Y. Wang, None; D. Zhu, None; Y. Tao, None; Q.S. You, None; J.B. Jonas, None

References
1. Bowd C, Zangwill LM, Weinreb RN, Medeiros FA, Belghith A. Estimating optical coherence tomography structural measure-
Retinal Nerve Fiber Layer Thickness in Children


