A preliminary study of astigmatism and early childhood development

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PURPOSE To determine whether uncorrected astigmatism in toddlers is associated with poorer performance on the Bayley Scales of Infant and Toddler Development, 3rd edition (BSITD-III).

METHODS Subjects were 12- to 35-month-olds who failed an instrument-based vision screening at a well-child check. A cycloplegic eye examination was conducted. Full-term children with no known medical or developmental conditions were invited to participate in a BSITD-III assessment conducted by an examiner masked to the child's eye examination results. Independent samples *t* tests were used to compare Cognitive, Language (Receptive and Expressive), and Motor (Fine and Gross) scores for children with moderate/high astigmatism (>2.00 D) versus children with no/low refractive error (ie, children who had a false-positive vision screening).

RESULTS The sample included 13 children in each group. The groups did not differ on sex or mean age. Children with moderate/high astigmatism had significantly poorer mean scores on the Cognitive and Language scales and the Receptive Communication Language subscale compared to children with no/low refractive error. Children with moderate/high astigmatism had poorer mean scores on the Motor scale, Fine and Gross Motor subscales, and the Expressive Communication subscale, but these differences were not statistically significant.

CONCLUSIONS The results suggest that uncorrected astigmatism in toddlers may be associated with poorer performance on cognitive and language tasks. Further studies assessing the effects of uncorrected refractive error on developmental task performance and of spectacle correction of refractive error in toddlers on developmental outcomes are needed to support the development of evidence-based spectacle prescribing guidelines. (J AAPOS 2018;■:1-5)

Astigmatism causes persistent blur for both near and distant stimuli and can negatively affect visual development. When present in early childhood, the optical blur caused by uncorrected astigmatism can result in amblyopia.[1-9] Previous studies have shown that astigmatism-related amblyopia can develop by the preschool years[3,10] or earlier.[2]

Several studies suggest that uncorrected astigmatism is associated with poorer performance on assessments of development and learning in preschoolers and school-age children. Orlansky and colleagues[11] reported lower scores on several measures of academic readiness in 3- to 5-year-olds with astigmatism (≥0.50 D) compared to preschoolers with no astigmatism. Roch-Levecq and colleagues[12] reported that 35 ametropic 3- to 5-year-olds (23 with compound hyperopic astigmatism, 7 with mixed astigmatism, 5 with hyperopia; astigmatism criteria ≥2.00 D in 3-year-olds, ≥1.50 D in 4- and 5-year-olds) had significantly lower mean scores on tests of visual motor performance, but not verbal performance, compared to a sample of 35 emmetropic children. After 6 weeks of spectacle wear, performance on visual motor tasks in ametropic children improved to the level of emmetropic children. However, since subanalyses by type of refractive error were not reported, it is impossible to determine whether the apparent treatment effect was associated with correction of hyperopia, astigmatism, or both. Garber[13] found lower teacher-assigned reading scores in 5th and 6th graders with ≥2.00 D of uncorrected astigmatism but found no significant association between astigmatism and reading scores on standardized tests in 2nd graders. Harvey and colleagues[14,15] documented lower oral reading fluency and visual motor skills in 3rd through 8th grade

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Funding support: The Virginia G. Piper Charitable Trust and Research to Prevent Blindness.

Submitted November 10, 2017.

Revision accepted March 14, 2018.

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1091-8531/$36.00

https://doi.org/10.1016/j.jaapos.2018.03.004

students with bilateral astigmatism (≥1.00 D) when tested without spectacle correction, although performance was comparable to their peers with no/low refractive error when spectacle correction was worn.

No previous studies have specifically assessed the effect of uncorrected astigmatism on performance of developmental tasks in children <3 years of age. However, a large population-based study of children 6-72 months of age found that parents of children with astigmatism of ≥1.50 D were significantly more likely than other parents to report concerns about their child's development, and that this effect was greatest in children >36 months of age.[16] We conducted a preliminary study to determine whether there is evidence of an association between astigmatism and developmental task performance in toddlers 12-35 months of age.

Subjects and Methods

Participants were children 12 to 35 months of age who failed an automated vision screening (Spot Vision Screener, Welch Allyn Inc, Skaneateles Falls, NY) conducted during a pediatric well-child check from October 2016 through September 2017. Children were invited to receive a follow-up eye examination at the University of Arizona Visual Development Lab to determine whether they were eligible for participation in a spectacle pilot study (results not reported here) or eligible for participation in a developmental pilot study (the present study). Our target sample size for the developmental study was 30 children (15 with astigmatism, 15 with no/low refractive error). However, because the spectacle pilot study was the primary study, recruitment for the developmental study proceeded only until the spectacle study recruitment was complete.

Eligibility criteria for the developmental study were as follows: completed eye examination, including cycloplegic retinoscopy; born after at least 38 weeks' gestation; no perinatal complications; no previous spectacle wear; no ocular abnormalities; no known medical or developmental problems; fluent English-speaking parents or guardians; refractive error meeting criteria for moderate/high astigmatism (>2.00 D, either eye)[17] or no/low refractive error group (12- to 30-month-olds: ≤2.50 D anisometropia, ≤4.50 D hyperopia, ≤2.00 D astigmatism, ≤3.50 D myopia; 31- to 35-month-olds: ≤2.00 D anisometropia, ≤4.00 D hyperopia, ≤2.00 D astigmatism, ≤3.00 D myopia).[17] Children in the no/low refractive error group were children who had a false-positive vision screenings as determined by gold standard cycloplegic examination.

Referring clinics were two large multiphysician practices with several clinics throughout the community (Banner-University and El Rio Community Health Center, Tucson, AZ). Written informed consent was obtained from a parent or guardian prior to the eye examination and again prior to developmental testing. This study complied with the Declaration of Helsinki, was approved by the Institutional Review Board of the University of Arizona and conformed to the requirements of the US Health Insurance Portability and Accountability Act of 1996.

Procedures

Eye examinations included cover-uncover and alternate cover testing, assessment of pupils and anterior segment, cycloplegic retinoscopy (conducted at least 30 minutes after instillation of 1 drop of proparacaine 0.5% and cyclopentolate 0.5%), and fundus examination. The examinations were conducted by a pediatric ophthalmologist (JMM) or optometrist (ALD, JDT). Children with significant refractive error were prescribed spectacles (12- to 30-month-olds: >2.50 D anisometropia, >4.50 D hyperopia, >2.00 D astigmatism, >3.50 D myopia; 31- to 35-month-olds: >2.00 D anisometropia, >4.00 D hyperopia, >2.00 D astigmatism, >3.00 D myopia).[17] Children prescribed spectacles were invited to participate in a 3-month spectacle trial (results not reported here). Children who met the criteria for the developmental study (above) were invited to participate. Some children participated in both the spectacle and developmental studies, but developmental testing always preceded dispensing of spectacles.

The Bayley Scales of Infant and Toddler Development (3rd ed, BSITD-III)[18,19] assessment was conducted after the eye examination on a subsequent day. The BSITD-III is a norm-referenced developmental assessment that is individually administered. The test includes five scales. In the present study, we included the three main scales: Cognitive, Language, and Motor scales. The Social-Emotional and Adaptive Behavior scales, which depend on parent report rather than the examiner's assessment of the child's behavior, were excluded. The items administered for each scale depend on the child's age. Some examples of items include "assembling an ice cream cone puzzle within 90 seconds" and "pairing colored discs to matching colored crayons" for the Cognitive scale, "points to 5 body parts" and "using at least one word to make wants known" for the Language scale (Receptive and Expressive Communication subscales, respectively), and "placing at least 3 coins into a slot" and "taking at least 2 steps backward unassisted" for the Motor scale (Fine and Gross Motor subscales, resp.).[18,19]

An education specialist with extensive experience conducting BSITD-III assessments (ERM) conducted the assessments according to the BSITD-III administration manual.[18] The specialist was masked to the results of the child's eye examination. Prior to entering the assessment room, parents were reminded by a research assistant not to tell the specialist whether their child was prescribed spectacles.

Data Analysis

Subjects were assigned to groups based on cycloplegic retinoscopy measurements into no/low refractive error (≤2.00 both eyes) and moderate/high astigmatism groups (>2.00 D either eye). Preliminary analyses compared groups on sex, mean age, spherical equivalent refractive error, and magnitude of anisometropia. The primary analyses were independent sample *t* tests comparing groups on BSITD-III Cognitive, Language, and Motor composite scores. Analyses also compared scaled scores on the Language subscales (Receptive and Expressive Communication) and Motor subscales (Fine and Gross Motor). Both composite and scaled scores are age-based norm referenced scores.