Prevalence and characteristics of myopic retinopathy in an adult Chinese American population: The Chinese American Eye Study

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Purpose: To provide estimates of the prevalence and characteristics of myopic retinopathy in a population based sample of adult Chinese Americans.

Methods: The Chinese-American Eye Study (CHES) is a population-based study in which Chinese-Americans aged 50 years and older residing in 10 contiguous census tract in Monterey Park, CA were invited to undergo a comprehensive eye exam, including subjective and objective refraction, stereoscopic fundus photography of both eyes. Myopic retinopathy was assessed in a masked manner by trained graders. Specifically, myopic retinopathy was defined as the presence of one or more of the following lesions staphyloma, lacquer cracks, patchy or diffused atrophy, intrachoroidal cavitation, tilted optic disc, tessellation, peripapillary atrophy and exudative myopia. Eyes with spherical equivalent ≤ -0.5D, > -1D), peripapillary atrophy (8.2%), staphyloma (6.3%), diffused atrophy ≤ -1D, > -6D) and high myopia (≥ -6D) were evaluated for myopic retinopathy. One eye (eye with the more myopic refractive error) from each participant was included in this analysis. Frequency distributions stratified by refractive error and axial length were calculated. Differences were assessed using chi square testing.

Results: Of the 1,590 participants meeting the selection criteria and with gradable fundus photographs, 1,328 participants were graded for myopic retinopathy. The overall prevalence of myopic retinopathy among eyes was 33.7% (95%CI 31.2%-36.2%). The prevalence of specific lesions were Tessellation (32.4%), tilted disc (29.8%), peripapillary atrophy (8.2%), staphyloma (6.3%), diffused atrophy (5.0%), lacquer cracks (2.9%), intrachoroidal cavitation (2.4%), patchy atrophy (1.1%), and exudative myopia (0.2%). The prevalence of myopic retinal changes in persons with mild (≤ -0.5D, > -1D), moderate (≤ -1D, > -6D) and high myopia (≥ -6D) were 17%, 46% and 83% respectively. The prevalence of myopic retinal changes in persons with varying degrees of axial elongation were: <23mm – 11%, ≥ 23.0, <24.5mm – 26%, ≥ 24.5, <26mm – 56%, ≥26mm – 82%. No age- or gender-related differences were observed.

Conclusions: These data provide the first population-based estimates of myopic retinopathy in Chinese Americans. The prevalence of myopic retinopathy in Chinese Americans is higher than that observed in other East Asian populations.

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classification and grading system for myopic retinopathy was developed by the META-PM Study Group. Here, we investigated the frequency of retinal lesions in a Dutch cohort of high myopes using this protocol.

Methods: Persons with high myopia (SE ≤ -6 D, age ≥ 25 years) were recruited for the MYST study by eye care providers from university and community hospitals from the Netherlands, and by public media. Participants were examined at a single research center where they underwent an extensive ophthalmologic examination. We performed 35° fundus photography (Topcon TRC 50EX with a Sony DVC-950P digital camera; 0.44 megapixel) after pharmacological mydriasis and measured axial length (Lenstar, Haag-Streit International). We graded fundus photographs according to the international classification and grading system for myopic retinopathy from the META-PM study group. We investigated frequencies of retinal lesions, and evaluated differences between sex and axial length. Inter-observer reliability for the graded lesions was calculated using Cohen’s kappa statistics.

Results: We included 517 cases with high myopia, of which 508 had gradable fundus photographs. Myopic peripapillary atrophy was the most common abnormality (83%), followed by tessellated fundus (62%), posterior staphyloma (41%), and peripapillary intrachoroidal cavitation (26%).

Myopic macular lesions (MML) were observed in 17% of the cases. The cases with MML had eyes with a greater axial length (mean 29.6 mm vs 26.7 mm, P < 0.001), but did not differ in age (mean 41.7 years vs 41.8 years, P = 0.98) than those without MML. Diffuse and patchy chorioretinal atrophy were the most common MML (69% and 23% respectively). Intra-observer kappa values ranged from 0.56 for tessellated fundus to 0.84 for MML.

Conclusions: Retinal lesions are highly frequent in high myopes. Macular pathology was less frequent than optic disc lesions, and was related to axial length. The international grading and classification system can be used with good reproducibility to grade retinal pathology high myopes of European descent.

Commercial Relationships: Corina Brussee, None; Gabriëlle H. Buitendijk, None; Henriet Springelkamp, None; Martine Snabel, None; Gregorys P. Luyten, None; Gwyneth A. Van Rijn, None; Camiel J. Boon, None; Annette Geerards, None; Virginie J. Verhoeven, None; Caroline C. Klaver, None

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Presentation Time: 3:45 PM–5:30 PM
Projected generational increase in myopic retinopathy in the United States
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Purpose: Vitale et al (2009) used NHANES data to estimate a 66% increase in myopia prevalence in the United States (US) between 1971-72 to 1999-2004. The aim of this work is to predict the likely impact of this generational increase in myopia on the future prevalence of myopic retinopathy (MR).

Methods: In the absence of MR prevalence data at different refractive errors (RE) in US-based studies, 3 international population-based studies were used: the Blue Mountains Eye Study (BMES), the Beijing Eye Study (BES) and the Hisayama Study (HS). MR prevalence at a given RE varied greatly between these studies; however simple exponential regression of the MR odds ratios versus RE (y = ae^βx, where y is the odds ratio and x is RE) yielded a relatively consistent slope, -β, in semi-log plots across studies. Relative inter-generational MR prevalence was predicted by multiplying the average MR odds ratio at each RE (obtained from the average β) with the corresponding myopia prevalence data for both of the 1971-72 and 1999-2004 NHANES data sets and then summing across each set. Multiple assumptions were necessary in producing the estimate, including the following: myopia prevalence at age 12-54 years is assumed to be predictive of MR prevalence some 30 years later in those above 40 years of age; the BES study did not provide a denominator in odds-ratio estimates, so a dummy estimate was used; open-ended refractive error bins were assigned representative estimates.

Results: As noted above, the lines of best fit relating refractive error and the log of the odds ratios for each MR prevalence study were excellent fits and of surprisingly similar slopes (BMES; R^2 = 0.99, β = 0.61; BES; R^2 = 1.00, β = 0.67; HS; R^2 = 0.97, β = 0.61), supporting use of non-US MR prevalence odds for this analysis. There was no threshold apparent between low (physiological) myopia and high (pathological) myopia. The average increase in the odds of MR for each diopter increase in myopia is estimated to be 88%. The predicted increase in the overall prevalence of MR for the US is 3.0 times.

Conclusions: While the estimate remains subject to multiple assumptions, there is a disturbing projected threefold increase in MR prevalence expected by about 2030 compared to that at the turn of the century.

Commercial Relationships: Noel A. Brennan, Johnson & Johnson Vision Care (E)

Program Number: 3619 Poster Board Number: A0068
Presentation Time: 3:45 PM–5:30 PM
Canadian burden of choroidal neovascularization secondary to pathologic myopia: final results
Nancy Zaour1, Olaf Heisel2, Patrick Ma1. 1Novartis Pharmaceuticals Canada Inc, Dorval, QC, Canada; 2Syreon Corporation, Vancouver, BC, Canada; 1University of British Columbia, Vancouver, BC, Canada

Purpose: To identify the real world standard of care, treatment patterns, medical history, resource use and costs of patients with choroidal neovascularization (CNV) secondary to pathologic myopia (PM), also known as myopic CNV, in Canada.

Methods: The analysis includes the final data of 98 patients with myopic CNV who were recruited by Ophthalmologists and Retina Specialists from 16 centres across Canada to participate in this retrospective, multicenter study. Medical records covering at least one year and up to two years of follow up data from the CNV diagnosis were analyzed to gather all information related to myopic CNV.

Results: Patients had a mean age of 55.0 years (range: 22–82 years) at the time of their first lifetime CNV episode. The baseline characteristics of patients showed that 71.4% of participants were female, 75.5% were Caucasian, 57.1% had only subfoveal CNV in the affected eye and 28.6% had only juxtafoveal CNV. Thirteen percent (13.3%) of patients had both eyes affected with CNV. The approximate mean Snellen score at the time of CNV diagnosis was 20/125 in the affected eye and 20/80 in the fellow eye. Forty-nine percent (49%) of patients had visual acuity (VA) severity in the affected eye of normal/mild vision loss (VA 20/20 to > 20/80), 19% moderate vision loss (VA 20/80 to > 20/200), and 32% severe vision loss/nearly blind (VA ≤ 20/200). The mean duration of CNV episode was 0.78 years. Almost 90% of myopic CNV patients consulted a retinal specialist (on average 6.0 times per year), 11.2% of patients had to visit the ER and 2.0% were admitted to hospital due to CNV.

Conclusion: Most patients were treated with an anti-VEGF therapy and received on average 3.8 injections per year. The annual average myopic CNV-related cost per patient was $3,433 across all patients. The cost was $2,964 for patients with mild vision loss, $3,595 for patients with moderate vision loss and $4,060 for patients with severe vision loss.
Conclusions: Information on Myopic CNV is very limited in the literature. This is the first study worldwide investigating the burden of the disease. The baseline characteristics of Canadian patients presented here are aligned with other few data available in the public domain. In addition, the myopic CNV-related costs of care are increasing with the severity of vision loss and are substantial to the Canadian health care system.

Commercial Relationships: Nancy Zaour, Novartis Pharmaceuticals Canada Inc (E); Olaf Heisel, Novartis Pharmaceuticals Canada Inc (C); Patrick Ma, Novartis Pharmaceuticals Canada Inc (C)

Program Number: 3620 Poster Board Number: A0069
Presentation Time: 3:45 PM–5:30 PM

Optic Disc and Retinal Changes in Highly Myopic Young Adolescent Eyes
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Purpose: To determine the prevalence of myopia-related optic disc, macular and peripheral retinal changes in highly myopic eyes of young Asian adolescents

Methods: The current study was conducted in 2012 which included 718 randomly selected myopic (spherical equivalent [SE] worse than -6.00 D) male subjects aged between 19 and 25 years undergoing pre-employment screening for public service in Singapore. All participants underwent cycloplegic refraction, best corrected visual acuity (BCVA), axial length measurement and ophthalmoscopic examination of the peripheral retina was performed. Seven colour fundus photographs were taken including the optic disc-centred view rotated at 30 degrees to the right and left, macula-centred view, and the peripheral views. These photos were graded systematically using a standard template to determine the presence of disc and macular lesions.

Results: A total of 265 myopic (SE between -6.00 to -7.99 D), 204 high myopic (-8.00 to -9.99 D) and 141 very highly myopic (worse than -10.00 D) eyes were included for analysis. The mean age was 21.1 ± 1.2 years, all were male subjects, mean BCVA was 0.027 ± 0.10 logMAR and mean axial length was 26.6 ± 1.8 mm. The main optic disc findings were peripapillary atrophy (PPA) (97.3%) and disc tilt (27.5%). The most common myopia-related macular findings included posterior staphyloma (43.8%), chorioretinal atrophy (8.4%) and lacquer cracks (1.0%). There were no cases of myopic CNV and Fuchs’ spots. The most common peripheral retinal findings were white-without-pressure (57.2%), lattice degeneration (16.6%) and peripheral retinal tear/detachment (4.3%). Longer axial length was significantly associated with most lesions including optic disc tilt (odds ratio [OR] 1.31; 95% CI: 1.15, 1.51), PPA (OR 2.45; 95% CI: 1.44, 4.15), posterior staphyloma (OR 1.80; 95% CI: 1.56, 2.08), chorioretinal atrophy (OR 1.92; 95% CI: 1.53, 2.41), peripheral lattice degeneration (OR 1.30; 95% CI: 1.10, 1.52), and white-without-pressure (OR 1.21; 95% CI: 1.07, 1.38). Similar associations with SE were present. Associated with increasing axial length and SE. Disc tilt, PPA, posterior staphyloma and white-without-white pressure are the predominant early pathologic myopia signs in young adults.

Commercial Relationships: Victor Koh, None; Ching-Yu Cheng, None; Colin S. Tan, None; Gerard Nah, None; Paul Zhao, None; Mellisa Tan, None; Adeline Yang, None; Kyoko Ohno-Matsui, None; Seang-Mei Saw, None

Support: SAF-JPP grant

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Presentation Time: 3:45 PM–5:30 PM

Prevalence, Incidence and Characteristics of Patients with Choroidal Neovascularization Secondary to Pathologic Myopia in a Representative Canadian Cohort
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Purpose: Choroidal neovascularization (CNV) is the most common vision-threatening complication associated with pathologic myopia (PM), also known as myopic CNV (mCNV). There is a lack of information on the epidemiology related to mCNV in the world and more so in Canada. This study aimed to determine the epidemiology and the demographic and treatment characteristics of Canadian mCNV patients.

Methods: Records from a longitudinal population-based database of more than 320,000 patients, collected from 75 physicians in Southwestern Ontario, Canada were analyzed between January 1, 2006 and December 31, 2011. Patient records were limited to subjects aged 18 years and older, and patients with at least one year of follow up. The clinical and demographics characteristics, comorbidity, medications, and resource use were reported in this study. A nested case-control study based on the final diagnosis of CNV secondary to PM was constructed within a PM cohort. In this study, 211 patients with mCNV were matched for demographic characteristics with 211 PM controls.

Results: The prevalence of CNV secondary to PM was estimated to be 0.084% in the general adult population with an annual incidence of 0.0061%. Amongst PM patients, 6.2% develop CNV. Ten percent (10%) of patients had both eyes affected with CNV. CNV was mostly subfoveal (87%) and was more common in women than men. At the time of CNV diagnosis, the mean Snellen score was 20/100 in the affected eye. The most common treatments were verteporfin and laser photoagulation. Approximately 23% of mCNV patients had hypertension. The burden of resource use, including emergency visits, general practitioners clinic visits, ophthalmology visits, and hospitalizations is more important in mCNV patients than in PM patients (p<0.01).

Conclusions: In a Canadian real-world setting, the prevalence and the annual incidence of myopic CNV was 0.084% and 0.0061%, respectively. This is the first Canadian study investigating the epidemiology of myopic CNV and the results will help us better understand this debilitating disease.

Commercial Relationships: Megan Pickering, Novartis Pharmaceuticals Canada Inc (E); Laura Luciani, Novartis Pharmaceuticals Canada Inc (F); Nancy Zaour, Novartis Pharmaceuticals Canada Inc (E); Robert Petrella, Novartis Pharmaceuticals Canada Inc (C)
Presentation Time: 3:45 PM–5:30 PM

Prevalence and Associated Factors of Myopia in Primary School Students in Chaoyang District of Beijing, China

Yueqiu Gong¹, Hao Zhang¹, Yan Y. Lv¹, Dan Wang¹, Ting Chen¹, Su H. Yang¹, Dan Y. Liu¹, Mei X. Kang¹, Xiang H. Guo².
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Purpose: To study the prevalence of myopia and its associated factors in primary school students in Beijing and formulate appropriate policies to prevent myopia.

Methods: A school-based prevalence survey on myopia was conducted in Chaoyang district, Beijing from September 2011 to October 2011. A total of 4249 students were included with 2201 boys and 2048 girls. Their age ranged from 5 to 14 years. The refractive status of each student was measured with an autorefractometer under cyclopia and checked with refinoscopy.

Results: Myopia was the most common type of refractive error. It was found in 36.71%±0.74% of the children. The prevalence of myopia in this sample was significantly higher for girls (38.57%±1.08%) than for boys (34.98%±1.02%). The prevalence of myopia increased with age increasing. Among children ≥11 years of age, the prevalence of myopia was greatest at 67.46%±1.82%.

Independent risk factors for myopia included female gender, increasing age, parents myopia history, incorrect reading posture, distance between eyes and books less than 20 cm, smaller font size of extracurricular reading books vs textbooks, learning time at home for 4 hours or above every day, continuous learning time more than one hour every time. Age and parents myopia history were the most important risk factors for myopia.

Conclusions: More efforts should be conducted on health education of vision and to make appropriate policies to prevent myopia from the childhood.

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Presentation Time: 3:45 PM–5:30 PM

Ocular biometric distribution and correlation with life style of the third and the fourth grade elementary school children

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Purpose: To evaluate ocular biometric distribution and correlation with life style of the third and the fourth grade elementary school children in Jeju island

Methods: 720 children in 6 elementary school were enrolled for cohort study. Questionnaire for life style, TV watching time, computer watching time, outdoor activity, parental myopia, and average homework (book reading) time was made. Age (month), and height, and body weight was measured. Ocular biometric factors about axial length, white-to-white, corneal curvature were measured using IOL master®. Emmetropic IOL power using Haigis formula was made.

Results: Outdoor activity, homework time, and computer time were all positively correlated. Low emmetropic power was significantly correlated with maternal myopia. Axial length was significantly correlated with paternal and maternal myopia. Keratometry alone did not show any significant correlation with parental myopia. Axial length was positively correlated with age (months) but keratometry did not. Mean axial length was 23.81 mm and mean keratometry was 43.08 D. Mean WTW was 12.20 mm, and average IOL power for emmetropia was 20.97 D.

Conclusions: We could find average biometric factors for the third and the fourth grade elementary school children in Jeju island, and could suggest that maternal genetic factor may work for myopia in Korean children. Life style data would be used for the myopia progression in next 2 years cohort study.

Commercial Relationships: Jinho Jeong, None

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Program Number: 3624 Poster Board Number: A0073

Reference centile curve as a predictor for high myopia in Chinese children

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Purpose: To report reference centile risk curves of cross-sectional data from the Guangzhou RESC study, and then evaluate the predictive power of the references using longitudinal data from the Guangzhou Twin Eye Study.

Methods: The cycloplegic refraction of 4218 children aged 5-15 years collected in the Refractive Error Study in Children (RESC) in urban Chinese children and 1963 children with annually follow-up data in the Guangzhou Twin Eye Study were analyzed. Age- and sex-specific percentile curves for refraction were constructed by quantile regression model using the RESC data. Linear mixed model was used to access the progression of refraction in longitudinal data of twins. The risk to develop high myopia was estimated by Cox proportional hazards model. To further explore the underlying predictive factors, the myopic relevant characteristics of the two groups were also described.

Results: Age and sex adjusted smoothed reference centile curves for the 97th, 90th, 75th, 50th, 25th, 10th and 3rd centiles were created based on the population-based data on 2175 boys and 2043 girls. Linear mixed model showed that progression of SE was at least -3 diopters greater in those with baseline refraction under 3rd, 5th and 10th centiles (p<0.01) compared to the other children. In Cox proportional hazard model, odds ratios for children below 3rd, 5th and 10th centiles to develop high myopia were 50.61, 47.82 and 45.51 respectively (for each p<0.01). In the comparison of myopia-relevant characteristics, parental myopia showed significant difference between the two groups using the reference centiles (for each p<0.05).

Conclusions: The reference centile curves provide information on the age- and sex-specific distribution of refraction, and can be used to identify the children on the more myopic extreme at their age group who may be at increased risk of developing high myopia by adulthood.

Commercial Relationships: Yanxian Chen, None; Jian Zhang, None; Wei Li, None; Ian G. Morgan, None; Mingguang He, None

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Commercial Relationships: Yanxian Chen, None; Jian Zhang, None; Wei Li, None; Ian G. Morgan, None; Mingguang He, None

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Purpose: To understand the impact of providing glasses on educational performance in rural China.

Methods: A list of primary schools was obtained for all 18 counties in two prefectures in Gansu and Shaanxi Provinces. One school from each township in these counties was selected at random, and within each school, one class was randomly chosen in each of the 4th and 5th grades. All children with uncorrected visual acuity (VA) <= 6/12 in either eye underwent cycloplegic refraction with subjective refinement by a trained refractionist. In September 2012, at the beginning of the school year, children were randomized by school to receive free glasses at school, to get a voucher to collect free glasses at a facility in their county, or to the control group where families were told when children needed glasses, which were given only at study closeout. A 90-minute mathematics test designed for the study was administered to all children at baseline and at the end of the school year in May 2013. Socioeconomic and demographic factors were measured for children and families.

Results: Among 19,975 children at 253 schools, 4849 (24.2%) failed vision screening, 4673 (96.4%) completed refraction, 3054 (63.5%) met criteria to receive glasses and 1003, 947 and 1104 respectively were randomized to Free Glasses, Vouchers and Control. The unadjusted change in test score among children in the Free Glasses group was 0.1 Standard Deviations (SD) higher than for Controls (P = 0.03). In regression models of final test score adjusting for baseline score and other potential predictors, statistically significant predictors of better score included membership in the Free Glasses group (0.11 SD, P = 0.03), older age (0.13 SD/year, P < 0.001), more myopic refractive error (0.05 SD/Diopter, P = 0.001) and residence in Shaanxi (a richer province than Gansu) (0.1 SD, P = 0.02). The effect of free glasses was greater than having family wealth in the younger group (0.967 ± 0.016 vs 0.986 ± 0.026, p<0.01), but there was no difference in the older adolescent group (0.997 ± 0.031 vs 1.004 ± 0.022, p>0.05). VC depth in the horizontal plane showed significant nasal-temporal asymmetry, (VC depth is greater on the temporal side) in emmetropes and myopes at both ages examined. However, the VC depth in the vertical plane showed a larger superior-inferior asymmetry (superior VC depth is greater) in children than in adolescents (e.g. at 0° of 50 deg, 1.23 vs 0.21, p<0.01). Myopic children had significantly deeper superior VCs than emmetropes (EM vs LM at 50 deg, 1.46 ± 0.26 vs 0.23 ± 0.29mm, p<0.001) that was not seen in the adolescent group (-0.48 ± 0.26 vs -0.68 ± 0.20mm, p>0.05).

Conclusions: Symmetry in eye shape associated with myopia in children was not apparent in adolescents. Further studies, including longitudinal tracking of eye shape in emmetropes and myopes are needed to confirm that this is a developmental change.

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Purpose: To study reasons for differences in myopia prevalence between middle-income Shaanxi (ranked #14 of 31 Chinese provinces on per capita income) and poor Gansu (ranked #30). These neighboring Chinese provinces both have populations > 90% ethnically Han.

Methods: Primary school children with uncorrected visual acuity (VA) <= 6/12 in either eye underwent cycloplegic automated refraction. Myopia was defined as spherical equivalent refractive error (SE) <= -0.5D in both eyes and uncorrected VA <= 6/12 in at least one eye. Socioeconomic, demographic and behavioral factors were assessed by questionnaire. School performance was assessed using a 90-minute mathematics test. Population density was calculated at the township level (each of 253 participating schools was located in a different township).

Results: Myopia prevalence among 9667 children in Shaanxi (mean age 10.4 (1.0) years, 53.6% male) was 23.1%, nearly twice that among 10,308 children (mean age 10.7 (1.2) years, 50.6% boys) in Gansu at 13.4% (P < 0.0001). Spectacle ownership was low among children with refractive error in both Shaanxi (464/2362 = 19.6%) and Gansu (250/1472 = 17.0%). In multiple regression modeling, predictors of myopia included older age (Relative risk [RR] = 1.08, P <0.001), female gender (RR = 1.25, P < 0.001), family wealth (RR = 1.13 for middle versus lowest tercile P = 0.04; RR = 1.24 for highest versus lowest tercile, P < 0.001), spectacle wear by parents (RR = 1.62, P < 0.001), math scores at the beginning of this study (RR = 1.21, P < 0.001) and residence in Shaanxi (RR = 1.18, P < 0.001), but not near work time, middle distance work time, outdoor activity, parents' highest education, or parents having out-migrated for work. Lower population density in Shaanxi (RR = 0.79, P = 0.03) and higher population density in Gansu (RR = 1.27, P = 0.04) were associated with myopia in separate province-specific models.

Conclusions: The predominant non-demographic predictors of myopia in this study were socioeconomic (family wealth), academic (math scores) and familial (parental spectacle wear), but these do not fully explain the very low prevalence of myopia in Gansu versus Shaanxi. The impact of population density on myopia is complex in this setting. It seems likely that there may be important determinants of myopia prevalence in China which are still not well understood.

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ARVO 2014 Annual Meeting Abstracts

Program Number: 3629 Poster Board Number: A0078
Presentation Time: 3:45 PM–5:30 PM

An Annual Rate of Myopic Progression Model for Asian children Padmaja Sankaridurg1, 2, Brien A. Holden1, 3, Leslie A. Donovan1, 2, Chi-ho To4, Wei Han Chua1, Li Li5, Xiang Chen5, 1Optometry, Brien Holden Vision Institute, Sydney, NSW, Australia; 2Vision Cooperative Research Centre, Sydney, NSW, Australia; 3School of Optometry and Vision Science, The University of New South Wales, Sydney, NSW, Australia; 4School of Optometry, Hong Kong Polytechnic University, Hong Kong, Hong Kong; 5Park Way Eye Centre@Mount Elizabeth, Singapore, Singapore; 6State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Centre, Guangzhou, China.

Purpose: High levels of myopia are associated with increased risk of cataract, glaucoma, retinal damage and permanent vision loss. Data from East Asian countries indicate an increasing prevalence of ≥ -6.00D myopia. We calculated the annual progression rate of myopia for a large group of Asian children aged 6 to 16 wearing single vision spectacles(SPL) or contact lenses(CL) to determine the influence of age and vision correction device. This model has value in identifying children at risk and as a baseline for evaluating the ability of myopia control procedures to reduce the rate of progression of myopia.

Methods: The Twins Early Development Study is a longitudinal cohort of 10,000 British twins enrolled at birth between 1994-96, who have been studied from a neurodevelopmental perspective using multivariate quantitative and molecular genetic techniques. A sample of 2,625 pairs (aged 16-18) was invited to participate (52% response rate) and consent requested to contact their optometrist for subjective refraction data (87% response rate). Myopia was defined as spherical equivalent (SE) ≤-0.75 D, high myopia if ≤-6.0 D and hyperopia as ≥+1.0 D. Multivariable regressions and mixed effect models were used to assess demographic features and associations during childhood (adjusted for age, sex, ethnicity, maternal education & family structure).

Results: SE data was obtained on 1992 subjects. Responders reflected the UK population (95% European, 55% female). Mean SE was -0.35 D (SD 1.80). In those aged 16-18, 32.2% (95% CI 30.0-34.9) were myopic, 1.6% (95% CI 1.0-2.4) were highly myopic and 8.4% (95% CI 7.0-9.9) were hyperopic. Significant odds ratios (OR) for myopia were identified for age (1.72), non-white ethnicity (3.06) and maternal education (1.13). In a mixed effect model of composite scores of cognitive ability (g) at 2,3,4,7,10,12,14, 16, the association with myopia was greatest in late adolescence (age 16: β=-0.287 p=0.03). Association between upper quartile cognitive ability and myopia tended to become significant with age: age 4 (OR 1.15 p=0.51), age 7 (OR 1.45 p=0.11), age 10 (OR 1.68 p=0.05) and age 16 (OR 2.11 p=0.003). Verbal cognition (VC) was consistently more associated with myopia than non-verbal cognition (NVC), with the greatest disparity and effect at younger ages (VC age 10 OR 1.26 [p=0.03] vs NVC OR 1.02 vs VC OR age 16 1.05). Bivariate twin modelling suggested shared genetic effects underlying SE and g.

Conclusions: Myopia prevalence in a UK-representative population of 16-18 year-olds is 32%. This suggests subsequent prevalence in adulthood may be higher than previous estimates, congruous with a cohort effect. A consistent and significant association of cognition for myopia was identified, with verbal cognition in early childhood and overall cognitive ability in adolescence most strongly associated with myopia risk.

Commercial Relationships: Katie M. Williams, None; Pirro G. Hysi, None; Robert Plomin, None; Christopher J. Hammond, None

Support: MRC Clinical Research Training Fellowship

Program Number: 3629 Poster Board Number: A0078
Presentation Time: 3:45 PM–5:30 PM

Prevalence of myopia in an adolescent British cohort and cognitive associations during childhood Katie M. Williams1, 2, Pirro G. Hysi1, Robert Plomin1, Christopher J. Hammond1, 3, 1Department of Ophthalmology, King’s College London, London, London, United Kingdom; 2Department of Twin Research and Genetic Epidemiology, King’s College London, London, United Kingdom; 3MRC Social, Genetic and Developmental Psychiatry Centre, King’s College London, London, United Kingdom.

Purpose: To report the prevalence of refractive error in an adolescent British cohort, and to examine the influence of cognition over childhood development on myopia risk.
Myopia is one of the first causes of visual impairment worldwide and high myopia, also called pathologic myopia, is associated with retinal complications. The aim of this study is to describe the prevalence of myopia and its complications in a multicentric cohort of individuals.

Methods: Data files from individuals with a clinical setting between January 2012 and November 2013 in four different centers were retrospectively reviewed. Demographic data included age and sex. Refractive error, best corrected visual acuity on both eyes and any history of retinal disease was also reported. Four different groups of individuals with Mild Myopia (-0.25 to -2.75D), Moderate Myopia (-3 to -5.75 D) and High Myopia (-6 to -7.75D and less than -8D) were created. For Mild and Moderate Myopias, patients were excluded in case of anisometropia higher than 1D. Furthermore, monophthalm patients or those with incomplete demographic data were excluded from the analysis. Prevalences of myopia related to the complete cohort and prevalence of retinal detachment (RD) and of peripheral laser photoacoagulation were analyzed in the different groups.

Results: Data files from 103 962 individuals were included in the analysis. From this cohort, data files from 37914 myopic patients (58.5% of women), mean age 33.8 years (SD=13) were analyzed. Among them, 26532 individuals had a Mild Myopia (28.35%) with a mean age of 32.2 years. The prevalence of RD and of photoacoagulation was of 0.056% and 0.23% respectively. 7995 individuals had a Moderate Myopia (8.54%) with a mean age 32.5 years. The prevalence of RD and of photoacoagulation was of 0.06% and 0.26% respectively. 1509 individuals had a High Myopia Higher than -7.75D with a mean age of 33.8 years. The prevalence of RD and of photoacoagulation was of 0.08% and 0.13% respectively. 7995 individuals had a Moderate Myopia (8.54%) with a mean age 32.5 years. The prevalence of RD and of photoacoagulation was of 0.06% and 0.26% respectively. 1509 individuals had a High Myopia Higher than -7.75D with a mean age of 33.8 years. The prevalence of RD and of photoacoagulation was of 0.08% and 0.13% respectively. High Myopia represented 3.62% of this cohort.

Conclusions: This large cohort provides new insights on the prevalence of myopia and on its complications in the young European population. The prevalence of RD was doubled between mild myopia and the group with myopia less than -8 D. Prospective analyses should be performed to confirm these data.

Commercial Relationships: Padmaja Sankaridurg, Brien Holden Vision Institute (E); Brian A. Holden, Brien Holden Vision Institute (E); Leslie A. Donovan, Brien Holden Vision Institute (E); Chi-ho To, None; Wei Han Chua, None; Li Li, None; Xiang Chen, None

Support: Australian Federal Govt CRC grant

Clinical Trial: ChiCTR-TRC-09000476
**Purpose:** To estimate the sex- and age-specific prevalence of myopia in a population-based sample of adult Chinese Americans in the city of Monterey Park, California.

**Methods:** 4582 study participants underwent a non-cycloplegic automated refraction or a standardized subjective refraction if presenting visual acuity was worse than 20/20. The gender- and age-specific prevalence of spherical equivalent myopia in phakic eyes was calculated. Comparisons of prevalence rates between CHES and other eye studies in persons of Chinese ancestry as well as Latinos in Los Angeles were performed using chi square tests. Prevalence of anisometropia was calculated.

**Results:** Refractive error data was present in 4212 of 4582 participating Chinese Americans. The overall prevalence of myopia (≤-1.0 D) calculated based on worse eye was 34.1% (95% CI, 32.7%-35.6%), and high myopia (≤-5.0 D) was 9.4% (95% CI, 8.5%-10.3%). The overall prevalence of myopia calculated based on better eye was 25.8% (95% CI, 24.5%-27.1%), and high myopia was 6.1% (95% CI, 5.4%-6.8%). The overall prevalence of myopia calculated based on the right eye was 30.0% (95% CI, 28.6%-31.4%), and high myopia was 7.9% (95% CI, 7.1%-8.7%). The prevalence of myopia and high myopia was lower in older men and women compared to younger participants. There was no statistically significant difference in the prevalence of myopia and high myopia between men and women after adjusting for age (p=0.12 and 0.54 for myopia and high myopia respectively). Of 1437 participants who had myopia in the worse eye, 78.2% of them wore glasses. Anisometropia was present in 21.4% (95% CI, 20.1%-22.6%) of the participants who had refractive error data on both eyes. There was no age-associated trend in the prevalence of anisometropia in men and women; also there was not statistically significant difference between men and women after adjusting for age (p=0.77).

**Conclusions:** These data provide the first population based estimates of myopia in Chinese Americans. The age-adjusted prevalence of myopia and high myopia in Chinese Americans is higher than the age-adjusted prevalence of Chinese from studies outside of the US including the Handan Eye Study, the Liwan Eye Study and the Tanjong Pagar Eye Study. In addition, the age-adjusted prevalence of myopia and high myopia is significantly higher than the age-adjusted prevalence in Latinos.

**Commercial Relationships:** Shuang Wu, None; Chunyi Hsu, None; Mina Torres, None; Roberta McKeen-Cowdin, None; Stanley P. Azen, None; Rohit Varma, None

**Support:** NIH Grant EY-017337 and Research to Prevent Blindness, NY

**Program Number:** 3632 Poster Board Number: A0081

**Presentation Time:** 3:45 PM–5:30 PM

Is myopia more common in Asians? A systematic review and meta-analysis

Seang-Mei Saw1, 2; Chen Wei Pan1, 2; Mohamed Dirani1; Ching-Yu Cheng2; Tien Y. Wong2.

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**Purpose:** To perform a meta-analysis to estimate the prevalence of myopia in Asia.

**Methods:** We searched PubMed, Embase and Web of Science from their inception till September 2013 for population-based surveys reporting the prevalence of myopia in adults or children in Asia. We pooled the prevalence estimates for myopia using a random effects model.

**Results:** We identified 49 eligible population-based studies including 210,512 individuals aged 0 to 96 years reporting the prevalence of myopia from 16 Asian countries or regions. The pooled prevalence estimate of myopia was highest at 47.3% (95% confidence interval [CI], 19.3, 75.2) in Asians aged 20 to 29 years. There was a U-shaped relationship between year of birth and myopia prevalence. The cohort effect especially marked in urban Asian communities such as Singapore and South Korea. The prevalence of myopia of 36.3% (95% CI 27.6, 45.0) was higher in adults aged more than 70 years compared with middle-aged adults, which revealed nuclear catactetmyopia shifts.

**Conclusions:** There are large variations in the prevalence of myopia in Asia. Overall, the prevalence of myopia in middle-aged to elderly adults is similar in Asians compared with Western populations. However, myopia is more prevalent in younger generations living in urbanized Asian communities compared with their counterparts in Western communities, suggesting that the epidemic of myopia in Asia may be a recent generational phenomenon.

**Commercial Relationships:** Seang-Mei Saw, None; Chen Wei Pan, None; Mohamed Dirani, None; Ching-Yu Cheng, None; Tien Y. Wong, None

**Support:** NMRC/CIRG/1349/2012

**Program Number:** 3633 Poster Board Number: A0082

**Presentation Time:** 3:45 PM–5:30 PM

The Prevalence of Uncorrected Refractive Error and Unmet Refractive Need in Chinese Americans: The Chinese American Eye Study (CHES)

Charlotte E. Joslin1, 2; Chunyi Hsu1, Shuang Wu1, Xuejuan Jiang1, Mina Torres1, Rohit Varma1.

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**Purpose:** To estimate the sex- and age-specific prevalence of uncorrected refractive error and unmet refractive need in adult Chinese Americans.

**Methods:** 4582 of 5785 (participation rate, 79.2%) self-identified Chinese Americans aged ≥ 50 years, ascertainment through a population-based, door-to-door census of 15 census tracts in Monterey Park, CA, completed an in-home questionnaire and comprehensive eye exam. Binocular and monocular distance acuity with presenting correction was measured using standard Early Treatment Diabetic Retinopathy Study (ETDRS) protocols, and automated followed by subjective refraction was performed using standard protocols (Humphrey Autorefractor; Carl Zeiss Meditec, Dublin, CA). Uncorrected refractive error was defined as a ≥ 2 line improvement with refraction in the better seeing eye. Unmet refractive need was defined as <20/40 in the better seeing eye and achieving > or =20/40 after refraction (definition 1) or having <20/40 in the better seeing eye and achieving a > or =20/40 improvement with refraction (definition 2). Methods were identical to the Los Angeles Latino Eye Study (LALES).

**Results:** Overall prevalence of uncorrected refractive error was 17.9 (95% CI 16.8-19.0). No significant age-specific trend existed (p=0.28), nor did a male-female difference after controlling for age (p=0.10). The prevalence of unmet refractive need increased significantly with age in a dose-response fashion with both definitions (p < 0.0001), increasing from 7.6 (5.8-9.4; definition 1) and 7.9 (6.0-9.8; definition 2) among participants 50–59 years, to 18.7 (12.6-24.8; definition 1) and 20.5 (14.0-27.1; definition 2) among subjects ≥ 80 years. No significant male-female difference in unmet refractive need existed after controlling for age (p=0.10, definition 1; p=0.12, definition 2).

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Conclusions: Data suggest a high burden of uncorrected refractive error and unmet refractive need in this cohort representative of Chinese Americans in the U.S. Overall prevalence of uncorrected refractive error and unmet refractive need is similar to LALES. These results identify a large burden of visual impairment in Chinese Americans that reduces quality of life and that can be improved with a relatively modest intervention of refraction and visual correction.

Commercial Relationships: Charlotte E. Joslin, None; Chunyi Hsu, None; Shaung Wu, None; Xuejuan Jiang, None; Mina Torres, None; Rohit Varma, None

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Program Number: 3634 Poster Board Number: A0083
Presentation Time: 3:45 PM–5:30 PM

Choroidal thickness profiles in myopic eyes of young adults in the Correction of Myopia Evaluation Trial cohort

Elise N. Harb1, Leslie Hyman1, Jane E. Gwiazda1, Wendy Marsh-Tottle1, Qinghua Zhang2, Wei Hou2, Thomas T. Norton1, Keri Dirkes3, Linda M. Zangwill4. 1New England College of Optometry, Boston, MA; 2Preventive Medicine, Stony Brook University, Stony Brook, NY; 3School of Optometry, University of Alabama at Birmingham, Birmingham, AL; 4Hamilton Glaucoma Center, Dept. of Ophthalmology, University of California at San Diego, San Diego, CA; 5Department of Vision Sciences, University of Alabama at Birmingham, Birmingham, AL.

Purpose: To examine the relationship of choroidal thickness (ChT) with axial length (AL) and myopia in young adult eyes in the large, ethnically diverse COMET cohort.

Methods: COMET, initially a myopia treatment trial, enrolled 469 myopic children and had 14 years of follow-up. At their last visit (mean age of 24.3±1.4 years), in addition to measures of myopia by cycloplegic autorefraction and AL by A-scan ultrasonography, participants underwent OCT imaging of the choroid (RTVue) in both eyes. Using digital calipers, two independent readers manually measured ChT in the right eye (left eye if poor right eye quality (n=37)) at seven locations; fovea and 750, 1500, 2250μm nasal (N) and temporal (T) to the fovea. The average of the two ChT measures was used, after adjudication for any discrepant measurements.

Results: ChT measurements were available from 294/346 (85%) imaged COMET participants (44.9% male), with mean myopia of -5.3±2.0D and mean AL of 25.5±0.9mm. Overall, ChT varied by location (p<0.0001) and was thickest at the fovea (273.8±70.9μm) and thinnest in the nasal periphery (N2250, 191.5±69.3μm). Univariate analysis, based on a median split (4.94D of myopia / 25.49mm AL), showed thinning of ChT in longer or more myopic eyes at all locations (p≤0.02), but was most notable in the nasal locations (~35μm thinner in longer or more myopic eyes, p<0.01). Compared to African-Americans, Asians had significantly thinner ChT (~35-66μm thinner) in all locations except T1500 and T2250 (p≤0.02). At N1500 and N2250, Caucasians and Hispanics also had thinner ChT compared to African-Americans (p≤0.05). There was no significant difference in ChT by gender at any location. After adjusting for ethnicity and age (using AL or myopia as a covariate) thinner ChT remained associated with more myopia or longer AL at all locations (p≤0.03) and ChT was associated with ethnicity in some, but not all locations.

Conclusions: Choroids were thinner in eyes with more myopia or longer AL in the ethnically diverse COMET cohort. In some locations, ethnicity was associated with choroidal thickness, with Asians having the thinnest choroids. Longitudinal human studies are needed to determine how the choroid changes during the axial elongation associated with myopia.

Commercial Relationships: Elise N. Harb, None; Leslie Hyman, None; Jane E. Gwiazda, None; Wendy Marsh-Tottle, None; Qinghua Zhang, None; Wei Hou, None; Thomas T. Norton, None; Keri Dirkes, None; Linda M. Zangwill, Carl Zeiss Meditec, Inc. (F), Heidelberg Engineering GmbH (F), Nidek, Inc. (F), Optovue, Inc. (F), Topcon Medical Systems, Inc. (F)

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Clinical Trial: NCT00000113

Program Number: 3635 Poster Board Number: A0084
Presentation Time: 3:45 PM–5:30 PM

Vision Impairment in Highly Myopic Eyes: the ZOC-BHVI High Myopia Study

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Purpose: To assess vision impairment in highly myopic eyes and its relationship with various ocular parameters and the presence of retinal pathology.

Methods: Nine hundred and seventeen participants aged 7 to 70 years with myopia ≥6.00D (both eyes), mean age 22.1 ± 12.5 years, were recruited from the Zhongshan Ophthalmic Centre clinics. Exclusion criteria were systemic or ocular conditions including syndromic myopia, previous ocular surgery or myopia treatment. Ocular parameters measured in both eyes comprised refraction, best corrected visual acuity (BCVA), axial length (AL) corneal curvature, anterior chamber depth (ACD) intraocular pressure (IOP). Retinal findings were recorded as A. normal; B. abnormal (including retinal break, macular oedema, posterior staphyloma, retinal detachment). Percent of the total population was used to calculate prevalence of retinal pathology for each ocular measure. Vision was classified as: Normal (≥ 1.0); Mild Vision Impairment (<1.0 to <0.3); Moderate Vision Impairment (0.3 to ≤0.1); Severe Vision Impairment (<0.1 to ≤0.05) and Blindness (<0.05). The eyes were divided into a better vision (BV) group, BCVA ≥ 0.5 (6/6) (mean 0.911±/0.16) and a worse vision (WV) group, < 0.5 BCVA, (mean 0.29±/0.11). Linear mixed model and logistic regression robust estimation of variance were used to evaluate for significant influences (p<0.05).

Results: Data from 1686 eyes (843 participants, 442 female) were analysed. The spherical equivalent (SE) was -9.30 ± 2.90 D (range: -6.00 to -29.80 D) and axial length, 27.2 ± 1.4 mm (range 23.8 to 31.8 mm). Thirty four percent of subjects had 1 myopic parent, 19% had two. 37.1% of the eyes had mild vision impairment; 4.5% had moderate vision impairment; 0.6% were blind. Myopic retinal pathology was seen in 13% (224) of eyes. On average the BCVA ≤ 0.5 group had -5.57D more myopia (p = < 0.01), 0.28 mm thicker ocular lenses (p<0.01), 1.6 mm greater axial lengths (p < 0.01); -0.19 mm shallower AC depths; more likely to have retinal pathology 35% vs 11% and 7.7 years older.

Conclusions: Vision impairment was associated primarily with the severity of high myopia and the presence of retinal pathology, and to a lesser extent, increased ocular lens thickness and shallower anterior chamber depth. Vision impairment was not as strongly influenced by...
axial elongation. In 65% of cases, vision impairment occurred in the absence of obvious retinal pathology.

Commercial Relationships: Brien A. Holden, None; Mingguang He, None; Monica Jong, None; Wayne Li, None; Serge Resnikoff, None; Ian G. Morgan, None; Earl L. Smith, None

Support: Australian Government Cooperative Research Centres Grant Scheme and Vision CRC

Program Number: 3636 Poster Board Number: A0085
Presentation Time: 3:45 PM–5:30 PM

The rate of myopia progression in children who become highly myopic

Monica Jong1; Mingguang He2, Brien A. Holden1,3; Wayne Li2; Padmaja Sankaridurg1, Xiang Chen2, Thomas Navadiluth1, Earl L. Smith1, Ian G. Morgan3, Jian Ge1. 1Research, Brien Holden Vision Institute, Sydney, NSW, Australia; 2Research, Brien Holden Vision Institute, Guangzhou, China; 3College of Optometry, University of Houston, Houston, TX; 4ARC Centre of Excellence in Vision Science and Visual Sciences Group, Research School of Biology, College of Medicine, Australian National University, Canberra, ACT, Australia.

Purpose: A retrospective study investigating whether those that become highly myopic have faster rates of myopia progression from ages 7 to 15 years.

Methods: One hundred and twelve eyes, 59 children, aged 7 to 15 & spherical refractive error (SE) ≥ -6.00 D recruited to the ZOC-BHVI High Myopia Study were studied. Three years of their historical myopic changes were compared to that of 260 eyes of 156 children with SE from -0.50 to -3.75 D (2 yr prospective study). All wore standard spectacles. The low myopia group (LMG) underwent cycloplegic refraction & 93% of the high myopia group (HMG) did so at the 3 year visit. Refractive history of the HMG & parental myopia information from both groups were collected. Myopic increase per year per eye was analysed with respect to age at the start of the year. Equations were derived for rates of refractive error progression. Linear mixed models with subject intercepts as random effects were used to test for significant (p<0.05) associations with age, parental myopia, gender, baseline sphere.

Results: Fig. 1 shows myopic progression vs age for HMG & LMG. Mean ages at baseline: 10.4 ± 1.7 yrs (LMG) &11.6 ± 2.6 yrs (beginning of historical record for HMG). Mean SE at baseline: LMG = -2.00 ± 0.80D (-0.37 to -3.80D); HMG = -5.00 ± 1.90D (-1.00 to -12.00D). Mean annual progression in SE for LMG: -1.14 ± 0.43D (age 7); -0.76 ± 0.36D (age 10), -0.67 ± 0.20D (age 13) and -0.66 ± 0.16D (age 15). Mean annual progression in SE for HMG: -1.65 ± 1.05D (age 7), -1.02 ± 0.58D (age 10), -1.12 ± 0.69D (age 13) and -0.75 ± 0.47D (age 15). A significantly greater rate of progression was seen in the HMG vs LMG (p <0.01). Higher levels of myopia were associated with earlier onset & greater baseline amounts (both P<0.01). Parental myopia & gender were not associated with rates of change for either group. At 8 & 10 to 13 years, rate of myopia progression was significantly greater (p <0.05) for HMG. At 14 & 15 years, rates of change in myopia were found to be not different.

Conclusions: Children with high myopia with greater risk of and eventual vision impairment have consistently greater rates of myopic progression across the ages studied, developed myopia earlier and with initially higher levels. Parental myopia was not found to be a risk factor for higher rates of progression. These findings may help identify those at risk of developing high myopia and who would especially benefit from myopia control.
Correction for myopia is an exceptionally cost-effective approach to documented. Incorporating therapeutic optical designs into the vision Optometry, University of Waterloo, Waterloo, ON, Canada to reproduce any abstract, contact the ARVO Office at ARVO Office at ARVO Office at pubs@arvo.org.

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Refractive data of the same eye were also determined using auorefractor (Topcon RM8900) and subjective refraction performed by an experienced optometrist. The refractive errors of the subjects ranged from -0.75D to -8.75D. Exclusion criteria included amblyopia and any ocular pathology.

**Results:** Fifty-one subjects (51 eyes) underwent AR, SR and SSR refractive assessment, respectively. The age ranged from 17 to 25 years (20.8±1.7 years). The average diopters examined by AR, SR and SSR were -3.22 ± 1.97D, -3.07 ±1.95D and -3.64 ± 2.05D, respectively. There was no statistically significant difference between SSR and AR (p>0.05). The mean absolute difference was 0.72 ± 0.59 diopters. About 80.4% of the subjects had an error smaller than 1.0D between SSR and AR. However, according to the analytical results, there was significantly difference between SSR and AR (p<0.05) with mean absolute difference of 0.79 ± 0.67 diopters. Over 30% of subjects had a refractive error larger than 1.0 D between SSR and SR. Further analysis displayed that two measures, AR and SR, were also statistically significantly different from each other (p<0.05).

**Conclusions:** This study demonstrated good agreement of SSR with the traditional methods of auto-refraction and subjective refraction in subjects. The results show that SSR has good potential as an effective, simple and portable tool to rapidly estimate refractors errors by non-professionals in a vision-screening program. However, it is necessary to improve further the accuracy of this novel prototype device in estimating refractive errors.

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**Prevalence of astigmatism in school-aged children: a multi-country refractive error study in children**

Lili Wang1, Mingguang He1, Leon Ellwein2.  
1State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Guangzhou, China; 2National Eye Institute, National Institute of Health, Bethesda, MD.

**Purpose:** To evaluate the prevalence and characteristics of astigmatism in Chinese, Hispanic, Indian, Malay, Nepali and African children from eight sites of the multi-country Refractive Error Study in Children (RESC).

**Methods:** Among 46,260 children enumerated, cycloplegic (1% cyclopentolate) auto-refraction and a reliable visual acuity measurement were performed on 37,650 children of population-based, random cluster samples aged 5-15 in the RESC study.

**Results:** The prevalence of astigmatism (defined as <=-0.75 DC in the right eye) was 13.3% (95% confidence interval [CI]: 12.5%-14.0%) of all children with significant variation across ethnic groups after adjusted for confounders (p<0.001): 17.2% of Chinese, 8.22% of Indian, 12.2% of Malay, 3.32% of Nepali, 27.0% of Hispanic and 8.81% of African. The Guangzhou Chinese children (26.3%) had higher astigmatism prevalence than did the Shunyi Chinese children (9.53%). The Indian children in Delhi (9.24%) had higher prevalence than in India (5.78%). The prevalence of astigmatism decreased from 18.4% of 5-6 years old group into 11.65% of 10-12 years old group and then increased to 14.1% of 13-15 years. Higher astigmatism prevalence was associated with younger age (odds ratio [OR] =0.98, p=0.001), Female genders (OR=1.11, p=0.003), absolute spherical equivalent (OR=1.67, p<0.001). Astigmatism was predominantly oblique (cylinder between 16° to 75° or 106° to 165°; 44.8%, 95%CI: 44.0%-45.6%) and with-the-rule (WTR, cylinder between 0° to 15° or 166° to 180°; 40.2%, 95%CI: 39.1-41.3). Children with astigmatism had significantly more visual impairment (uncorrected visual acuity<=6/12) than did the children with non-astigmatism (OR=4.60, 95%CI: 4.10-5.16).

**Conclusions:** Astigmatism had a strong correlation with age, gender, spherical equivalent, ethnicity and site. Astigmatism was more common in Spanish and Chinese children. Children with astigmatism are more likely to have visual impairment.
Two factors that might be responsible for this protective effect are exposure to bright visible light or exposure to ultraviolet (UV) light when outdoors. Personal dosimetry may be a useful technique for measuring these two exposures.

Methods: Eighteen young adult subjects (24.9±1.9 years) wore two electronic personal dosimeters side by side on the upper arm for one week (7.1±0.4 days) during July-October 2013. One was sensitive to visible light (Daysimeter, Lighting Research Center, Rensselaer Polytechnic Institute) and the other to UV (National Institute of Water and Atmospheric Research, New Zealand). Each reading was accompanied by a date and time stamp. The Daysimeter recorded average lux exposure each minute. The UV dosimeter recorded UV exposure every 5 seconds. Subjects were instructed to go about their normal daily activities. Subjects also completed a custom activity frequency survey at the end of the week. The UV dosimeters were calibrated against a Kipp & Zonen UV-SBT radiometer to emphasize exposure to UVB. Being outdoors was defined as any reading >1000 lux on the Daysimeter or any positive reading on the UV dosimeter.

Results: The Daysimeter estimate of time spent outdoors was the highest at 790 minutes per week (range = 207-1593) followed by the survey estimate of 538 minutes per week (range = 140-1680). The UV dosimeter provided the lowest estimate at 272 minutes per week (range = 92-768). Time outdoors by each method was significantly different from the other two (repeated measures ANOVA p<0.026 with Bonferroni correction). Each method was significantly correlated with the other two (r = 0.58 to 0.76, p<0.012). Time indoors from the survey was uncorrelated with time outdoors by any method (p<0.69).

Conclusions: Each method provides a significantly different estimate of time outdoors. The highest estimate using visible light is likely to be the most accurate. Surveys may be subject to poor recall of brief and non-specific outdoor activities. UV exposure may not always occur when outdoors due to car windows, low solar angle, cloud cover, or shade. Given that visible and UV light exposures differ, double monitoring of each type of exposure may be useful in studies of time outdoors and refractive error.

Commercial Relationships: Donald O. Mutti, None; Shane P. Mulvihill, None
Support: UL1RR025755 from the National Center for Research Resources; NIH Grant T35 EY007151

Program Number: 3642 Poster Board Number: A0091
Presentation Time: 3:45 PM–5:30 PM
Possible cause of monozygotic twins discordant in refraction: nearwork, outdoor activity and stochastic variation
Xiaohe Ding¹, Ian G. Morgan¹, Mingguang He¹. ¹Zhongshan Ophthalmic Center, Guangzhou, China; ²ARC Centre of Excellence in Vision Science and Research School of Biology, Canberra, ACT, Australia.

Purpose: To evaluate the role of nearwork and outdoor activity variance in the monozygotic(MZ) twins with discordance on refraction.

Methods: A longitudinal twin study was launched in 2009, Guangzhou City, China. Standard questionnaire was administered by in-person interview to obtain daily activities, including time spent on near work and outdoor activities. Refraction was measured by auto-refraction under cycloplegia. Cross-sectional analyses on associations of refractive discordance with environmental factors were conducted among monozygotic (MZ) twins, who share identical genetic background.

Results: A total of 490 MZ twin pairs were eligible, the refraction was -1.50±1.45 Dioptr (Mean±SD), nearwork time was 4.24±1.45 hours, and outdoor activity time was 1.36±0.86 hours. In the mixed model, we found that nearwork activities conferred increased risk to myopic spherical equivalent (SE) whereas the outdoor activity has a marginal protective effect to myopic SE. The variance on nearwork activities within MZ explained about 2.0% of total phenotypic discordance and outdoor activity explained about 0.5%.

Conclusions: Given the very marked genetic similarity of MZ twins, and the small effects of known risk factors on discordance, we suggest that the discordance between MZ twins largely results from uncollected environmental factors or stochastic variations at the genomic or epigenetic levels.

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Two patterns of ciliary muscle growth in myopia
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Purpose: To test the hypothesis that more than one ciliary muscle growth pattern is present in human myopia and to determine if each pattern is different from emmetropic ciliary muscle growth.

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Methods: Children with emmetropia (N = 55, 9.3 ± 1.2 years), myopia (N = 84, 9.2 ± 1.1 years), and hyperopia (N = 46, 8.4 ± 1.4 years) from a longitudinal study were included in analyses. Cycloplegic autorefraction was used to determine spherical equivalent refractive error. Cycloplegic images of the ciliary muscle were obtained with the Visante Anterior Segment OCT and processed with a semi-automatic algorithm to obtain thickness measurements. The thickness of the ciliary muscle at 2 mm posterior to the scleral spur (CMT2) was used to create multilevel growth models of ciliary muscle development for each refractive error group. A cluster analysis, Ward's method, was used to group the growth curves of myopes into two groups (Myopia 1 and Myopia 2).

Results: The CMT2 growth curve for one myopia group identified by the cluster analysis (Myopia 2) had significantly larger intercept when compared to all other groups (all p ≤ .0001) and a significantly steeper slope when compared to all other groups: emmetropia (β = -12.5, p = 0.03), myopia 1 (β = -16.7, p = 0.002), and hyperopia (β = -23.8, p ≤ 0.0001).

Conclusions: There appear to be at least two different ciliary muscle growth patterns present among children who develop myopia: one that is more similar to the patterns observed in emmetropia or hyperopia and another pattern that is characterized by a larger muscle that increases in thickness at a greater rate than what was observed in all other children. Our future studies will determine if differences in ciliary muscle thickness indicate that human myopia has more than one underlying cause.

Ciliary muscle growth curves by refractive error group. Myopia 1 and Myopia 2 were identified through cluster analysis as two distinct growth curve patterns. Myopia 2 has a significantly greater slope (all p < 0.03) and intercept (all p ≤ .0001) when compared to all other groups.


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