REFRACTIVE ERROR STUDY IN CHILDREN IN AFRICA (RESCA): ASTIGMATISM RESULTS FROM DURBAN, SOUTH AFRICA

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INTRODUCTION

A series of population-based surveys of refractive error and visual impairment in school-age children have been recently conducted – all using the same protocol.[1] Beginning in 1998, these RESC (Refractive Error Study in Children) surveys have been carried out in several populations with very different ethnic origins and cultural settings: a rural district in eastern Nepal,[2] a rural county outside of Beijing, China,[3] an urban area of Santiago, Chile,[4] a rural district near Hyderabad in southern India,[5] and an urban area of New Delhi in northern India.[6] This article reports on the implementation and findings from a sixth such survey, which was conducted in Durban, South Africa. Particular emphasis will be placed on the astigmatism data of the study.

The South African study was motivated by the paucity of any type of refractive error data to guide the efficient mobilization of refractive and eye-care services, in South Africa or elsewhere on the African continent.

METHOD

Sample Selection

According to the 1996 census (the first democratic census for SA), South Africa has a population of 40,583,573.[7] It is estimated that this population has increased to approximately 42 million from the more recent unpublished statistics. The Durban metropolitan area, on the east coast of Kwazulu Natal was selected for the study. This province had a population of 8,417,021: over 82% African/Black, 6.6% White, 9.4% Indian/Asian; 1.4% Coloured (mixed race). The 1996 census population of the Durban area was 2,751,193.[7]

Areas bordering the area within the South Region (Umlazi, Lamontville, and Chatsworth areas), the Inner West Region (Dassenhoek and Mpola areas), and the Outer West Region (Mpumalanga and Ntshongweni areas) were selected. The Durban South and Inner West Regions are urban with both developed and underdeveloped previously disadvantaged areas. The Outer West Region is semi rural to rural.

The clusters were defined geographically using “enumerator areas” (EAs) where each EA is a geographically-defined area consisting of 100 to 250 dwelling units. The precise boundaries of these EA’s and household locations were defined using geographic GPS (Global Positioning System) coordinates. The study sample thus comprised 26 randomly selected clusters. An estimated 5749 children between the ages of 5 and 15 years were expected from these clusters.

Field Operations

A pilot study was conducted in 2001. Fieldwork for the main study was conducted between January and August 2002. A handheld GIS (global information system) device was thus used to map the boundaries of the selected areas. After mapping, enumeration involved a house visit by the fieldworkers. If a parent refused participation, that house was visited a further two times

Clinical examination:

The clinical examination comprised visual acuity measurements, vertometer readings, extra-ocular muscle evaluation, drop instillation, cycloplegic retinoscopy, cycloplegic autorefraction and cycloplegic subjective refraction. Cycloplegia was induced with 3 drops of 1% cyclopentolate with the second drop being instilled 5 mintues after the first and the third drop following 20mintues thereafter. Pupils were considered fully dilated when they reached a diameter of 6mm or greater and cycloplegia was complete when the light reflex was absent. Thereafter cycloplegic retinoscopy was performed with a streak retinoscope and this was followed by cycloplegic autorefraction using a handheld autorefractor. Subjective refraction was performed on those children who presented with visual acuity ≤ 20/40 in either eye.

Data Management and Analysis

Data cleaning programs were employed to detect any discrepancies prior to analysis. Statistical analysis was performed using Stata Statistical Software, Release 8.0. Eyes with dilation < 6 mm and presence of light reflex were excluded from the refractive error analyses. Children were considered myopic if one or both eyes were myopic where myopia was defined as spherical equivalent refractive error of at least –0.50DS. Children were considered hyperopic if one or both eyes were hyperopic where hyperopia was defined as spherical equivalent refractive error of at least +2.00DS, as long as neither eye was myopic. Emmetropic children were those where neither eye was myopic or hyperopic

Quality Assurance

Five of the 35 clusters were designated as quality assurance (QA) clusters. These were randomly selected. QA examinations were conducted on 10% of children with normal or near normal visual acuity and those who presented with visual acuity ≤ 20/40 in or both eyes.

RESULTS

Study Population

6351 households were identified during the enumeration. Interviews were conducted in 6041 living units. 5599 eligible children were enumerated. 49.3% of the overall study population was male. 4890 (87.3%) of the enumerated children were examined.

Refractive error

The prevalence of uncorrected, presenting, and best-corrected visual acuity of ≤ 20/40 in the better eye was 1.4%, 1.2%, and 0.32%. Refractive error was the cause in 63.6% of the 191 eyes with reduced vision, amblyopia in 7.3%, retinal disorders in 9.9%, corneal opacity in 3.7%, other causes in 3.1%, with unexplained causes in the remaining 12.0%. Myopia (≤ -0.50 D) in one or both eyes was present in 2.9% of children when measured with retinoscopy and in 4.0% with autorefraction. Beginning with an upward trend at age 14, myopia prevalence with autorefraction reached 9.6% at age 15. Hyperopia (≥ +2.00

D) in at least one eye was present in 1.8% of children when measured with retinoscopy and in 2.6% with autorefraction, with no significant predictors of hyperopia risk.

Astigmatism

Astigmatism of at least 0.75 D was found in 6.7% of right eyes and 6.8% of left eyes, measured with retinoscopy; and in 9.3% and 9.6%, respectively, with autorefraction. The higher prevalence with autorefraction pertained to both mild and severe forms of astigmatism. Astigmatism in *either* eye (persons) was present in 9.2% of children with retinoscopy, and in 14.6% with autorefraction.

The prevalence of astigmatism in the low category (<0.75D), whether determined by retinoscopy or autorefraction was much greater than that of the medium to high degrees of astigmatism, with astigmatism of <0.75D, 90.75 %(autorefraction) and 93.3% (retinoscopy) in the right eye and 93.2% and 90.4% in the left eye. Astigmatism >0.75D and <2.00D was 5.9 %(retinoscopy) and 8.2 %(autorefraction) OD and 6.1 %(retinoscopy) and 8.6 %(autorefraction) OS. Astigmatism ≥ 2.00 D was 0.8 %(retinoscopy) and 1.1 %(autorefraction) OD and 0.7 %(retinoscopy) and 1.00 %(autorefraction) OS.

The prevalence of astigmatism between the two eyes (autorefraction) was comparable with high astigmatism (> 3D) 1.07% (OD) and 1.11 %(OS) and low astigmatism (0 to 1.00D) 60.25 %(OD) and 59.3 %(OS). The prevalence of spherical refractive error in the sample was 28.3(OD) and 29.02(OS)

Of the children presenting with astigmatism 20% had with the rule astigmatism (OD) and 14% OS. Against the rule astigmatism was 29 %(OD) and 37 %(OS). Oblique astigmatism represented 51 %(OD) and 49% (OS).

In multiple logistic regression modelling, astigmatism was associated with older age with both retinoscopy (OR, 1.10; 95%CI, 1.05-1.15) and autorefraction (OR, 1.03; 95% CI, 1.00-1.06), but not with female gender (P = 0.133 and P = 0.536). For astigmatism greater than 2.00 D, neither age nor gender was significant.

Figure 1a: With-the-rule, Against-the-rule and Oblique astigmatism (D)

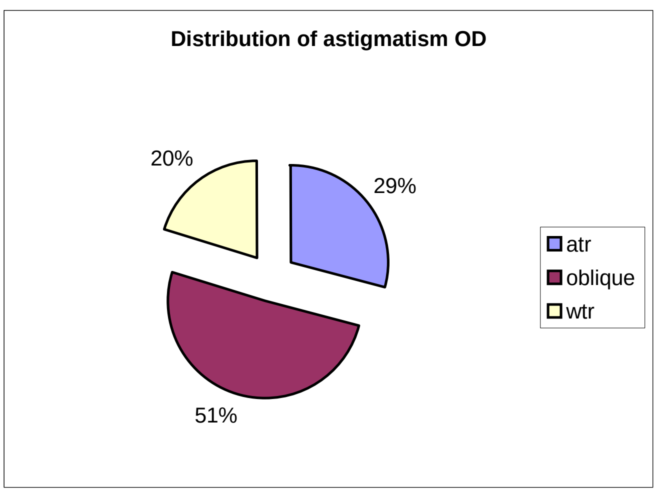
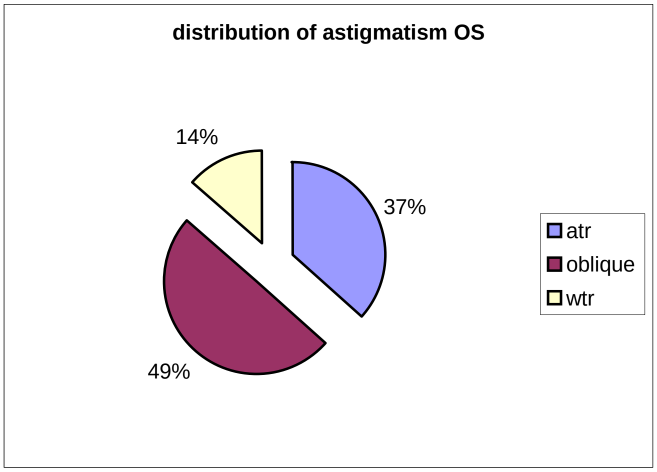


Figure 1b: With-the-rule, Against-the-rule and Oblique astigmatism. (OS)



DISCUSSION AND CONCLUSION

In quality assurance test-retest evaluations, reproducibility of cycloplegic retinoscopy and cycloplegic auto-refraction was found to be good. Repeat measurements were within 0.6 D 95% of the time for retinoscopy and within 0.5 D for auto-refraction, with statistically insignificant mean differences. Agreement between the two methods was not as good, however, with differences of nearly 1.0 D lying within the 95% agreement interval. For intercounty comparisons and planning it would be appropriate to utilize the autorefraction data.

This survey provides reliable evidence that the prevalence of any significant vision impairment is low in school-age children in South Africa: only 2.74% of study subjects had uncorrected visual acuity of $\leq$ 20/40 in any eye, with no significant differences between males and females. This prevalence of astigmatism was lower than that found in the RESC surveys conducted in Chile (27%) and comparable to China, and urban India, where the corresponding prevalences were 10%, and 10.2%, respectively. The astigmatism prevalence, while relatively low, should not be taken to suggest that the correction of astigmatism is an insignificant contributor to visual disability in South Africa. The severe backlog of refractive services and the lack of trained personnel to conduct complex refractions (as opposed to spherical refraction) in the public sector enhances the important of astigmatism as a public health challenge.

REFERENCES

1. Negrel AD, Maul E, Pokharel GP, *et al*. Refractive error study in children: sampling and measurement methods for a multi-country survey. *Am J Ophthalmol.* 2000; 129:421-426.
2. Pokharel GP, Negrel AD, Munoz SR, Ellwein LB. Refractive error study in children: results from Mechi Zone, Nepal. *Am J Ophthalmol.* 2000; 129:436-444.
3. Zhao J, Pan X, Sui R, *et al*. Refractive error study in children: results from Shunyi District, China. *Am J Ophthalmol.* 2000; 129:427-435.
4. Maul E, Barroso S, Muñoz SR, *et al*. Refractive error study in children: results from La Florida, Chile. *Am J Ophthalmol.* 2000;129:445-454.

5. Dandona R, Dandona L, Srinivas M, *et al*. Refractive error study in children in a rural population in India. *Invest Ophthalmol Vis Sci*. 2002; 43:615-622.
6. Murthy GVS, Gupta SK, Ellwein L, *et al.* Refractive error in children in an urban population in New Delhi. *Invest Ophthalmol Vis Sci.* 2002; 43:623-631.
7. Statistics South Africa. The People of South Africa: Population Census 1996, Census in Brief. [Report No. 03-01-11 (1996)]. Pretoria: Statistics South Africa; 1998. (http://www.statssa.gov.za)

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