Visual Status of First Nations Children: The Sagamok First Nation Vision Care Project

BY CATHERINE A CHIARELLI, OD, FAAO* & A. PAUL CHRIS, OD **

ABSTRACT

Comprehensive eye examinations were provided to the students of the Sagamok First Nation Biidaaban Kinoomaagamik Elementary School in October 2012. Refractive findings indicated a high prevalence of with-the-rule astigmatism which decreased with age and a low prevalence of hyperopia in all age groups. The prevalence of myopia increased with age. Higher rates of amblyopia and strabismus than previously reported in studies of Canadian Aboriginal children were found. Vision correction was provided to all children, where required. A low rate of compliance with spectacle wear was found at follow-up, seven months later.

Introduction

It is a commonly held principle that health status and outcomes are tied to various socio-economic factors. These factors, referred to as social determinants of health, such as poverty, unemployment, housing, and level of education, play a significant role in understanding the health issues facing Aboriginal peoples in Canada.

First Nations children living on reserve often receive a lower level of health and medical care than non-Aboriginal children. They have fewer doctor visits, a 20% lower immunization rate and poorer nutritional status, which increases the risk for upper respiratory tract infections, ear infections, chronic health conditions and obesity.[1] First Nations children suffer higher rates of secondary hearing loss (up to 20%) and are at risk for associated reduced development of language skills, leading to learning and attention deficits.[1,2]

Access to eye care services also is lower for First Nations children. This often is attributed to the unavailability of eye care providers. However, it also is due to a lack of knowledge about the types of vision disorders in Aboriginal children and about the important role of vision in general development and learning.[2]

Prior studies reporting on the prevalence of vision problems in Canadian Aboriginal populations were conducted several decades ago in remote communities and may

Dr. Catherine Chiarelli from the Vision Institute of Canada examines a young student from the Sagamok First Nation elementary school.

* *Director of Clinical Services, Vision Institute of Canada*
** *Executive Director, Vision Institute of Canada*

not be representative of current Aboriginal peoples. The refractive status of Indians and Eskimos [i] of the Yukon and Northwest Territories[3], Sioux Lookout[4], Moose Factory Zone[5] and Belcher Island[6] has been studied. The prevalence of strabismus and strabismic amblyopia in random population samples in the Canadian North also has been reported.[7]

This study reports on results of the Sagamok First Nation Vision Care Project, a study examining the prevalence of refractive error and other eye/vision conditions in children attending the Sagamok First Nation Biidaaban Kinoomaagamik Elementary School and Day Care. Students were given a comprehensive eye examination, provided with corrective glasses as needed, and later revisited in follow up to determine the level of compliance with using the prescribed glasses. The results of the study are discussed and then compared against other vision studies involving both Aboriginal children and children from other ethnic groups across North America.

Methods

The Sagamok First Nation is one of 133 First Nation reserves in Ontario and is located on the north shore of Lake Huron between Sudbury and Sault Ste. Marie, Ontario. The nearest optometrists are in the town of Espanola, 40 kilometers to the east. Sagamok is one of 79 First Nation reserves in Ontario with an on-reserve elementary school. The Sagamok Biidaaban Kinoomaagamik Elementary School is also one of a small number of on-reserve elementary schools that have a native language (Ojibway) immersion program.

Subjects:

All 178 children attending Sagamok Biidaaban Kinoomaagamik Elementary School and Day Care were invited to participate in the study. Consent forms and information packages about the program were given to all the families and 163 consent forms were returned. Due to absences and limitations in clinic scheduling, a total of 146 (73 male, 73 female) children were examined. *(Table 1)*

Parents completed a health history questionnaire in advance of the examinations. (*Table 2*)

Sixty-one percent (61%) of the children who participated had never undergone a previous eye examination, and 84% of preschoolers had no previous eye examination. Ten percent (10%) of the children already wore glasses.

Table 1: Age Range of the Children Examined

Age (years)	2-5	6-10	11-13
Number of Children	43	59	44

Table 2: Health History Profile

	Age 2-5	Age 6-10	Age 11-13	Total
Concern regarding Learning Difficulties	3 (7%)	16 (27%)	15 (34%)	34 (23%)
Allergies	11(26%)	8 (14%)	6 (14%)	25 (17%)
Asthma		1 (2%)	2 (5%)	3 (2%)
Premature Birth	1 (2%)	7 (12%)	2 (5%)	10 (7%)
Heart Problems	3 (7%)	1 (2%)		4 (3%)
Eczema	1 (2%)			1 (1%)
Developmental Delay	1 (2%)			1 (1%)
ADHD		1 (2%)	1 (2%)	2 (1%)
Thyroid Dysfunction		1 (2%)		1 (1%)
Hemangioma		1 (2%)		1 (1%)
Lazy Eye		2 (3%)	1 (2%)	3 (2%)

i) The terms Indian and Eskimo were the commonly used names at the time of this 1970's research. Today, the term "Indian" has mostly been replaced by First Nations people and "Eskimo" has been replaced by the name Inuit. The term Aboriginal refers to all First Nations, Métis and Inuit peoples.

Procedure:

A comprehensive eye examination was provided to all children. Monocular and binocular visual acuity was measured (unaided or with the child's current spectacles) at distance and at near. Age-appropriate visual acuity tests were used: Kay Pictures, Lea Symbols, HOTV tests for preschoolers and Snellen (Nidek SC-1700P LCD Acuity Chart) for older children. Unilateral and alternating cover tests were performed at distance and at near. Ocular motility was assessed with the Broad H test. Stereo acuity was assessed with the Titmus Stereo Fly test. Colour vision was assessed in boys with the HRR Pseudo-isochromatic Plates. Pupil reflexes were assessed. Pupillary dilation and cycloplegia was achieved through instillation of a cycloplegic spray (0.5% Cyclopentolate/Tropicamide) or eyedrops (1 drop 1% Cyclopentolate and 1 drop 1% Tropicamide). Refraction was determined by cycloplegic retinoscopy (after a minimum of 20-25 minutes). Ocular health was assessed through biomicroscopy, fundus biomicroscopy and binocular indirect ophthalmoscopy.

A full examination lane was set up in the community health center adjacent to the school. Examinations were completed during the school day, under the supervision of school and community health center staff. A written report of the findings was completed for each child. In most cases, parents were not present during the examination, but had the opportunity to attend an evening information session to ask any questions about the examination or results. Spectacles were dispensed at the same community health center, two weeks following the examinations. Corporate supporters of the Vision Institute of Canada provided the glasses at no cost.

Results

Refractive Error:

The refractive findings of all children are reported in *Table 3*.

Binocular Status:

The binocular status of all children is reported in *Table 4*.

Ocular Health Status:

The ocular health status of all children is reported in *Table 5*.

Follow-up:

A follow-up visit was made to Sagamok Biidaaban Kinoomaagamik Elementary School seven months later, to review the impact of vision

Table 3: Refractive Error

	Age 2-5 years	Age 6-10 years	Age 11-13 years	Total
Number of Children	43	59	44	146
Myopia (≥-1.00D in each principal meridian) in either eye	1 (2%)	4 (7%)	7 (16%)	12 (8%)
Hyperopia (≥ +2.00 in each principal meridian) in either eye	0	2 (3%)	0	2 (1%)
Astigmatism (≥1.00D) in either eye	20 (47%)	14 (24%)	7 (16%)	41 (28%)
WR (180°± 30° (150° to 30°)	20	13	6	
AR (90°± 30° (60° to 120°)	0	1	0	
Oblique (121° to 149°, 31° to 59°)	0	0	1	
Anisometropia (≥ 1.00D difference in refractive error in principal meridian between two eyes)	4 (9%)	5 (8%)	2 (5%)	11 (8%)
Emmetropia (both eyes) (any refractive error not classified as myopia, hyperopia or astigmatism)	22 (51%)	38 (64%)	30 (68%)	90 (62%)
Spectacles prescribed	8 (19%)	17 (29%)	17 (39%)	42 (29%)

Table 4: Binocular Status

	Age 2-5 years	Age 6-10 years	Age 11-13 years	Total
Number of children	**43**	**59**	**44**	**146**
Amblyopia (BCVA 20/30 or worse)	2 (5%)	6 (10%)	1 (2%)	9 (6%)
Anisometropic	2	4	0	6 (4%)
Anisometropic/Strabismic			1	1 (0.7%)
Isometropic (bilateral)		2		2 (1.4)
Strabismus (any manifest misalignment of the eyes - constant or intermittent)	1 (2%)	1 (2%)	4 (9%)	6 (4%)
Esotropia			1	
Exotropia	1	1	3	
Phoria (latent misalignment of the eyes)	0	1 (2%)	2 (5%)	3 (2%)
Esophoria (≥ 10 pd)				
Exophoria (≥ 10 pd)		1	1	
Hyperphoria (≥ 10 pd)			1	

Table 5: Ocular Health Status

	Age 2-5 years	Age 6-10 years	Age 11-13 years	Total
Number of children	**43**	**59**	**44**	**146**
Ocular Health Anomaly:	**1 (2%)**	**6 (10%)**	**5 (11%)**	**12 (8%)**
Ptosis	1			
Trichiasis		1		
Lid papilloma (squamous cell)		1		
Eyelid nevus		1		
Corneal scar			1	
Pterygium			1	
Allergic conjunctivitis		1		
Glaucoma suspect		2	1	
Chorioretinal scar			1	
Peripheral retinal tear			1	
Colour Vision Deficiency (boys)	2 (9%)	1 (3%)	1 (4%)	4 (5%)

correction on these children. Only one-third of the children for whom glasses were prescribed and dispensed reported using the glasses on a regular basis. These children reported that glasses allowed them to see better in the classroom and at home. Greatest compliance (100%) was amongst Senior Kindergarten children. Amongst the children not wearing their glasses, common reasons included poor fit, forgot glasses at home, able to see fine without glasses.

Discussion

The results indicate that the refractive, binocular and ocular health status of our population of First Nation children differs from that reported in other studies involving Aboriginal children and children from other ethnic groups across North America.

Refractive Findings:

With-the-rule (WTR) astigmatism was the most prevalent refractive error in this population of children. The prevalence was highest in preschoolers (47%) and decreased with age (24% in 6-10 year-olds, 16% in 11-13 year-olds). A low prevalence of hyperopia (1%) was found across all ages. The prevalence of myopia was found to increase with age (1% in 2-5 year-olds, 7% in 6-10 year-olds, 16% in 11-13 year-olds). These findings are compared to those of prior studies reporting on the refractive status of Canadian Aboriginal children.

The Indian children of the Sioux Lookout Zone of Northwestern Ontario demonstrated a higher prevalence of astigmatism, which also was observed to decrease with age (43% in 0-9 year-olds; 33% in 10-19 year-olds).[4] The Indian and Eskimo children of the Yukon and Northwest Territories demonstrated differing prevalence of astigmatism:

The children at the elementary school were delightful and cooperative patients and were excited to have their eyes examined.

38.4% in Eskimos and 74.5% in Indians across all age ranges. The axis of astigmatism was not specified. A genetic or environmental factor influencing the development of astigmatism in Indians was suggested, to explain this finding.[3] The Belcher Island Eskimo children demonstrated a low prevalence of (mostly WTR) astigmatism (8-9%).[6]

A low prevalence of hyperopia (1%) was reported in the Sioux Lookout Zone Indian children,[4] similar to our findings. In contrast to our findings, however, prior studies have reported myopia to be the most prevalent refractive error in Canadian Aboriginal children. The Sioux Lookout Zone study found myopia in 37% of the Indian children (0-19 years old).[4] The Yukon/Northwest Territories study found myopia in 20% of the Indian and Eskimo children at age 10 years.[3] Recently, Sharma et al. also presented data indicating a higher incidence of myopia in First Nations and Métis children (median age 6.48 years) compared to non-Aboriginal children (median age 6.69 years).[8] The Belcher Island Eskimo children, however, demonstrated a lower prevalence of myopia (7%) across all ages.[6]

The refractive status of America's Native Indians has been studied extensively.

A high prevalence of WTR astigmatism (42-78%) has been reported in Tohono O'odham and Navajo American Indian children. [9 10 11 12 13 14] This is much higher than reported in our First Nations population. A higher degree of Native American Indian ancestry has been identified as a risk factor for WTR astigmatism.[15] Maples et al. reported the prevalence of astigmatism to decrease with age (as in our population), leveling off after age 10 years. This is thought to be related to a flattening of the vertical corneal meridian.[13] Other studies, however, have shown no relation between age and astigmatism in this population.[9 11 12] Increasing myopia between 6 and 18 years of age also is reported in Navajo Indian children.[13]

Comparisons also can be made with the Baltimore Pediatric Eye Disease Study (BPEDS), Multi-Ethnic Pediatric Eye Disease Study (MEPEDS) and Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study, which have established normative refractive data for children of different ethnicities. [16, 17, 18, 19] While these studies used slightly different age groupings and limits to define hyperopia, myopia and astigmatism, their results serve a useful comparison to our population.

Higher rates of astigmatism were reported in Hispanic children (13% in 2-6 year olds; 37% in 5-17 year olds) and Asian children (33% of 5-17 year olds). Lower rates of astigmatism were reported in African American and Caucasian children (10-13% of 2-6 year olds; 20-26% of 5-17 year olds). WTR astigmatism orientation was more common in all children.[16 17 18 19] Our population demonstrated a higher prevalence of astigmatism in the preschool age group than has been reported in these other ethnicities. The rate decreases with age, and is similar to that of Caucasian and African American children in the older age groups. This is in contrast to Hispanic children, who have a higher prevalence of astigmatism (greater than our First Nations children) in the older age groups.

Caucasian and Hispanic children demonstrate a higher prevalence of hyperopia (25-33% in 2-6 year olds; 12-19% in 5-17 year olds) than do African American children (15-24% in 2-6 year olds; 6% in 5-17 year olds) and Asian children (6% in 5-17 year olds).[16 17 18 19] Our finding of a very low prevalence of hyperopia may partially reflect the level at which the criterion for hyperopia was set (greater than or equal to two diopters in each principal meridian).

Caucasian children demonstrate a low prevalence of myopia (less than 2% in 2-6 year olds, 4% in 5-17 year olds). African American children also demonstrate a low prevalence of myopia (approximately 6%) that is consistent at all ages. Older Hispanic and Asian children demonstrate a higher prevalence of myopia (13-18% in 5-17 year olds).[16 17 18 19] The rate of myopia in the older subgroups of our First Nations children approaches these higher levels.

BPEDS reported a rate of anisometropia of 8-10% (equal in Caucasian and African American children),[16] which is equal to the rate found in our population.

Binocular Status:

The overall prevalence of amblyopia in our population of First Nations children was 6% (4% anisometropic, 1.4% mixed strabismic/anisometropic and 0.7% isometropic/bilateral). This is greater than the 1% prevalence rate previously reported in Canadian Aboriginal children.[4, 7]

Our finding indicates a much lower prevalence of amblyopia than has been reported in astigmatic Tohono O'odham American Indian children. In children under 10 years of age, 43-58% of those with hyperopic astigmatism and 67-74% of those with mixed/myopic astigmatism demonstrated best-corrected acuity of 20/40 or worse.[20]

MEPEDS reported an interocular acuity difference in approximately 3% of Caucasian and African American children and in 6.7% of Hispanic children (2-6 years old). A bilateral decrease in acuity was found in less than 1% of Caucasian children and in 1.5% of African American and Hispanic Children.[21] The amblyopia found in our population would appear to be most consistent with that of Hispanic children.

The overall prevalence of strabismus was 4% in the children we examined. This is consistent with that reported in the children of Sioux Lookout Zone.[4] Exotropia (3%) was more common than esotropia (0.7%) in our population. Wyatt and Boyd also reported a greater prevalence of exotropia than esotropia in older children, however they found a lower overall prevalence of strabismus (2-2.5%) in northern Canadian Eskimo and Indian children.[7]

MEPEDS and BPEDS reported strabismus rates of less than 2% each for esotropia and exotropia, in children 2-6 years of age. This was similar amongst ethnic groups, including Caucasian, African American and Hispanic children.[22] The results for the younger children we examined are consistent with this finding.

Ocular Health:

The overall prevalence of ocular health anomalies was low in our population. Most anomalies were benign and did not require treatment. Three children were identified as glaucoma suspects due to large optic nerve cupping, and were scheduled for appropriate follow-up and monitoring with local optometrists. One child was referred to an ophthalmologist on an urgent basis, for treatment of a peripheral retinal tear.

Previous studies of Canadian Aboriginal peoples have reported on ocular health anomalies in adults, but not children. Prevalence range from 10-21% is reported. The most common conditions reported were pinguecula, pterygium, cataract, blepharitis, retinal disease, corneal scarring. [4 6]

Today's First Nations people are identified as being at high risk for diabetes and other chronic health diseases. Ocular manifestations of such diseases were not observed in the children we examined.

Follow-Up:

Most of the children were non-compliant with wearing glasses as prescribed. We predict that compliance could be improved through greater parent involvement at the time of the examination and/or spectacle dispensing. A greater understanding by parents as to the nature of their child's vision problem and the importance of vision correction likely would improve

motivation to follow-through with the recommended treatment.

Compliance also could be improved by assigning a school staff member to monitor the children's compliance with spectacle wear. This person could assist with developing strategies such as keeping the glasses at school so that they are always available for use in the classroom, verifying spectacle wear on a daily basis (in a manner similar to taking attendance), establishing rewards for consistent spectacle wear and/or consequences for lapses in compliance. The high rate of spectacle compliance observed with the Senior Kindergarten class can be attributed to the class teacher who was actively involved in encouraging the children to wear their glasses.

Conclusions

This clinical study of First Nations school children showed a high prevalence of WTR astigmatism that decreased across the three age groups studied. The prevalence of myopia increased with age. A low prevalence of hyperopia was seen at all age levels. Overall, 29% of the children required spectacle correction. We found higher rates of amblyopia and strabismus than have been reported in previous studies of Canadian Aboriginal children. The prevalence of amblyopia in our population also was higher than that reported in Caucasian and African American preschoolers. Poor compliance with spectacle wear and follow-up visits was observed.

These results highlight the importance of comprehensive eye examinations for First Nations children. Education programs directed towards Aboriginal peoples regarding vision problems and eye care are needed. Community supports to improve compliance with treatment regimens must be developed.

One strength of our study is that it involves a community vs. clinic-based population. Over 80% of children in the Sagamok Biidaaban Kinoomaagamik Elementary School were examined, including many who had no presenting concerns or complaints. The use of cycloplegic retinoscopy is another strength, since this allowed stable, objective assessment of refraction in all children. A further strength of this study was to involve the nearest optometrists in order to improve follow-up care and to establish ongoing relationships with the community health team.

The limitations of our study include its small sample size and the fact that it was not a longitudinal study. As a result, the significance of a decrease in prevalence of astigmatism with age is difficult to determine.

Acknowledgements

We would like to thank Drs. Josee Labrecque, Teri Fisher, and Charles Booth from Espanola, Ontario for their help in providing eye exams to the children of the Sagamok elementary school, and Ms. Crystal Gagne (from the office of Dr. Labrecque) for assisting with the spectacle dispensing services to the children. We would also like to thank Centennial Optical for donating the eyeglass frames, Essilor Canada for providing the lenses and lab work, and Innova Medical for providing the eye exam instruments and equipment. Special thanks also to Mr. Tony Jocko, Federal Health Policy Analyst for the Union of Ontario Indians and Mr. Eric Martin, Health Program Manager, Sagamok First Nation.

References

1. Macaulay AC. Commentary: Improving aboriginal health. How can health care professionals contribute? *Canadian Family Physician*. 2009;55:334–336.
2. Atkinson DL. Aboriginal preschool vision screening in BC - closing the health gap. *Canadian Journal of Optometry*. 2010;72(4):17–24.
3. Morgan R, Munro M. Refractive problems in Northern natives. *Can J Ophthalmol*. 1973;8(2):226–8.
4. Boniuk V. Refractive problems in native peoples (the Sioux Lookout Project). *Can J Ophthalmol*. 1973;8(2):229–33.
5. Woodruff M, Samek M. A study of the prevalence of spherical equivalent refractive states and anisometropia in Amerind populations in Ontario. *Can J Public Health*. 1977;68(5):414–24.
6. Woodruff M, Samek M. The refractive status of Belcher Island Eskimos. *Can J Public Health*. 1976;67(4):314–20.
7. Wyatt H, Boyd T. Strabismus and strabismic amblyopia in Northern Canada. *Can J Ophthalmol*. 1973;8(2):244–51.
8. Sharma N, Post J, Pahwa P, Erraguntla V. Follow-up eye care a major concern in *Canadian Aboriginal pediatric population.*; 2011.
9. Harvey EM, Dobson V, Miller JM. Prevalence of High Astigmatism, Eyeglass Wear, and Poor Visual Acuity Among Native American Grade School Children. *Optometry and vision science : official publication of the American Academy of Optometry*. 2006;83(4):206–212.
10. Miller JM, Dobson V, Harvey EM, Sherrill DL. Astigmatism and Amblyopia among Native American Children (AANAC): design and methods. *Ophthalmic Epidemiology*. 2000;7(3):187–208.

11. Harvey EM, Dobson V, Miller JM, et al. Prevalence of corneal astigmatism in Tohono O'odham Native American children 6 months to 8 years of age. *Investigative ophthalmology & visual science*. 2011;52(7):4350–5.

12. Harvey EM, Dobson V, Clifford-Donaldson CE, Green TK, Messer DH, Miller JM. Prevalence of astigmatism in Native American infants and children. *Optometry and vision science: official publication of the American Academy of Optometry*. 2010;87(6):400–5.

13. Maples W, Atchley J, Hughes J. Refractive profile of navajo children. Journal of *Behavioral Optometry*. 1996;7(3):59–64.

14. Miller JM, Dobson V, Harvey EM, Sherrill DL. Comparison of preschool vision screening methods in a population with a high prevalence of astigmatism. *Investigative ophthalmology & visual science*. 2001;42(5):917–24.

15. Goss D. Meridional Analysis of With the Rule Astigmatism in Oklahoma Indians. *Optometry and vision science: official publication of the American Academy of Optometry*. 1989;66(5):281–87.

16. Giordano L, Friedman DS, Repka MX, et al. Prevalence of refractive error among preschool children in an urban population: the Baltimore Pediatric Eye Disease Study. *Ophthalmology*. 2009;116(4):739–46, 746.e1–4.

17. Kleinstein RN, Jones LA, Hullett S, et al. Refractive Error and Ethnicity in Children. *Archives of ophthalmology*. 2003;56(8):1141–1147.

18. Fozailoff A, Tarczy-Hornoch K, Cotter S, et al. Prevalence of astigmatism in 6- to 72-month-old African American and Hispanic children: the Multi-ethnic Pediatric Eye Disease Study. *Ophthalmology*. 2011;118(2):284–93.

19. Multi-Ethnic Pediatric Eye Disease Study Group. Prevalence of myopia and hyperopia in 6- to 72-month-old african american and Hispanic children: the multi-ethnic pediatric eye disease study. *Ophthalmology*. 2010;117(1):140–147.

20. Harvey EM, Dobson V, Miller JM, Clifford-Donaldson CE. Amblyopia in Astigmatic Children: Patterns of Deficits. *Vision research*. 2007;47(3):315–326.

21. Tarczy-Hornoch K, Varma R, Cotter S a, et al. Risk factors for decreased visual acuity in preschool children: the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology*. 2011;118(11):2262–73.

22. Cotter S a, Varma R, Tarczy-Hornoch K, et al. Risk factors associated with childhood strabismus: the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology*. 2011;118(11):2251–61.

La version française de cet article suivra dans le mochain numéro de la RCO.

Children and Their Vision – What Parents and Teachers Need to Know

The Vision Institute of Canada, in partnership with the National Collaborating Centre for Aboriginal Health, has created a 16 page booklet titled: "Children and Their Vision – What parents and teachers need to know." This culturally relevant booklet will be made available to Aboriginal (First Nations and Inuit) schools, community health centres and other Aboriginal health care organizations. This is an excerpt on "*A child's visual milestones*" from that booklet. The complete booklet can be viewed and downloaded from the Vision Institute at: http://www.visioninstitute.optometry.net