

■ Occurrence of Otitis Media and Hearing Loss Among First Nations Elementary School Children

■ Occurrence de l'otite moyenne et de la perte auditive chez les écoliers des Premières Nations

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Abstract

This study investigated the occurrence of otitis media and hearing loss among First Nations children for different age groups. The study also explored whether the presence of otitis media and hearing loss persisted throughout the school year. The 48 participants were children of Mi'kmaq heritage from a First Nations elementary school in Nova Scotia. Children underwent pneumatic otoscopy, tympanometry, and pure tone audiometry on two separate occasions 6 months apart. Three age groups (3-5 years, 6-8 years, and 9-11 years) were compared. Consistent with previous research, results revealed that First Nations children suffer from high occurrence of otitis media and hearing loss. Indeed, middle ear pathology and hearing loss were found in more than 20% of the children. Otitis media with effusion was the most common type of middle ear pathology observed. Although the occurrence of hearing loss tended to decline with increasing age, the 6 to 11 year-old children continued to show an abnormally high occurrence of middle ear pathology and hearing loss, a trend contradictory to that found in the general population. In each age group, occurrences of otitis media and hearing loss were similar for the two evaluations conducted 6 months apart, suggesting that otitis media remains high throughout the school year. Half of the children found to have middle ear pathology in the first evaluation presented with the same pathology 6 months later. The importance of regular hearing screenings and proper audiological and medical follow-up in First Nations children is highlighted.

Abrégé

La présente étude porte sur l'occurrence de l'otite moyenne et de la perte auditive chez les enfants des Premières Nations de divers groupes d'âge. Elle analyse aussi si la présence d'une otite moyenne et d'une perte auditive persiste tout au long de l'année scolaire. L'étude porte sur 48 enfants d'ascendance mi'kmaq d'une école des Premières Nations de la Nouvelle-Écosse. Les enfants ont subi une otoscopie pneumatique, une tympanométrie et une audiométrie tonale à deux occasions à six mois d'intervalle. Les chercheurs ont comparé les résultats de trois groupes d'âge (3 à 5 ans, 6 à 8 ans, 9 à 11 ans). À l'instar de recherches antérieures, les résultats ont révélé que les enfants des Premières Nations souffrent d'une occurrence élevée d'otite moyenne et de perte auditive. De fait, on a relevé une pathologie de l'oreille moyenne et une perte auditive chez plus de 20 % des enfants. L'otite moyenne avec effusion est la pathologie de l'oreille moyenne la plus courante. Bien que l'occurrence de la perte auditive tende à diminuer avec l'âge, les enfants de 6 à 11 ans continuent à présenter une occurrence anormalement élevée de pathologie de l'oreille moyenne et de perte auditive, une tendance contradictoire à celle de la population en général. Pour chaque groupe d'âge, les occurrences d'otite moyenne et de perte auditive étaient similaires pour les deux évaluations menées à six mois d'intervalle, ce qui laisse entendre que l'otite moyenne demeure élevée tout au long de l'année scolaire. La moitié des enfants atteints d'une pathologie de l'oreille moyenne lors de la première évaluation présentaient la même pathologie six mois plus tard. Cet article fait ressortir l'importance du dépistage auditif régulier et d'un suivi audiolinguistique et médical convenable pour les enfants des Premières Nations.

Key words: Otitis media, hearing loss, schoolchildren

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Hearing loss has been reported to be highly prevalent among Canadian Aboriginal children compared to other groups of people, with prevalence rates among the school-age population ranging between 4-30% (e.g., Ayukawa, Bruneau, Proulx, Macarthur, & Baxter, 1997; Ayukawa, Lejeune, & Proulx, 2000; Eriks-Brophy & Ayukawa, 2000; Julien, Baxter, Crago, Ilecki, & Therien, 1987; Ling, McCoy, & Levinson, 1969; Schilling, Buelow, & Duval, 2002; Woods, Moffatt, Young, O'Neil, Tate, & Gillespie, 1994). These studies were conducted in various regions across northern Canada and demonstrate that hearing impairment in school-aged Inuit children has been highly prevalent for over 3 decades. More specifically, Julien et al. (1987) reported hearing loss in Inuit children to be 23%, and more recently, in 2002, 30% of Inuit children were identified with hearing loss (Schilling et al., 2002). Comparatively, prevalence rates among the general population (nonspecific races) including 38,000 school-aged children found only 2.63% to have a hearing impairment (Lundeen, 1991). Evidently, Aboriginal children, in particular Inuit children, suffer from exceedingly high rates of hearing loss.

Few studies exist regarding hearing loss among Aboriginal children living in the southern regions of Canada, namely First Nations children. One study completed on an entire reservation in British Columbia reported abnormal hearing among 31.3% of the community (Cambon, Galbraith, & Kong, 1965). Another study in British Columbia found 19.2% of First Nations children to have a hearing impairment (Doyle & Morwood, 1976). More recently, a prevalence study completed on the eastern coast of Canada revealed hearing loss in 17.4% of First Nations elementary school children compared to 3.7% of non-Aboriginal age-matched children from a nearby community (Van Ek & Sockalingam, 2004). Although limited in number, these studies suggest that high rates of hearing impairment also exist among Aboriginal children beyond the arctic region.

Narrowly defined, otitis media is the presence of inflammation in the middle ear cavity. The terminology, definitions and classification of middle ear disease has evolved over the past few decades. A multitude of terms have been used to describe the inflammatory condition of the middle ear, often resulting in confusion and misunderstanding among clinicians and researchers (Bluestone & Klein, 1995). To avoid ambiguity, the terms and classification used in this study are defined below.

Acute otitis media (AOM) is the presence of middle ear effusion with the rapid and short onset of signs and symptoms of inflammation of the middle ear cavity. One or more symptoms include acute onset of otalgia, otorrhea, fever, malaise, irritability, anorexia, vomiting or diarrhea. Local findings present with a full or bulging tympanic membrane with limited or absent movement to pneumatic otoscopy. Erythema may be present (Bluestone & Klein, 1995). After resolution of AOM symptoms middle ear effusion may persist for weeks to months following AOM, although this condition is indistinguishable from otitis

media with effusion (Rosenfeld & Bluestone, 2003).

Otitis media with effusion (OME) is the presence of inflammation of the middle ear cavity with relatively asymptomatic middle ear effusion. OME is distinct from AOM because it lacks the signs and symptoms of an acute ear infection (e.g., fever) (Bluestone, 1998). OME may occur spontaneously because of poor Eustachian tube function or as an inflammatory response following AOM. The middle ear effusion may be serous, mucoid or purulent. The most frequent otoscopic finding is opacification of the tympanic membrane, which makes assessment of the type of effusion not possible. Thus, the diagnosis of OME is limited to the observation that fluid of a non-specific nature is present in the middle ear space. Local findings reveal a convex or retracted tympanic membrane with impaired mobility on the pneumatic otoscopy. However, bulging or fullness of the tympanic membrane may be visualized. In addition, an air-fluid level or air bubbles may be observed. The duration of the presence of the middle ear effusion can be acute (less than 3 weeks), subacute (3 weeks to 3 months) or chronic (more than 3 months) (Bluestone, 1998; Bluestone & Klein, 1995).

Atelectasis of the tympanic membrane, which may or may not be associated with otitis media, is either collapse or retraction of the tympanic membrane. Collapse involves passivity, whereas retraction implies active pulling inward of the tympanic membrane, usually due to negative middle ear pressure. Atelectasis of the tympanic membrane is not considered a type of otitis media, but rather a related condition which may be present prior to, concurrent with or after an episode of OME (Bluestone & Klein, 1995).

Hearing loss secondary to otitis media can be affected not only by reduced air pressure in the middle ear space, but also by fluid retained in the middle ear cavity. The effusion compromises the traditional sound pathway of the middle ear by decreasing the tympano-ossicular mobility because of the supplemental mass, stiffness or friction of the middle ear mechanism which results in loss of hearing sensitivity (Bluestone & Klein, 1995; Rosenfeld et al., 2004).

Fluctuating conductive hearing loss is present in most children who have middle ear effusion as a result of OME or AOM. Due to their lack of symptoms, OME and persistent middle ear effusion following AOM and their concomitant hearing loss often go unrecognized by parents. The loss of hearing ranges from mild to moderate (15 to 40 dB), with an average hearing threshold of 27 dB HL (Rosenfeld & Bluestone, 2003). This variation in hearing loss is not influenced by the quality or viscosity of the fluid in the middle ear cavity (i.e., ears with serous fluid are not less impaired than those with more viscous fluid). Instead the volume of the effusion has been found to have an impact on hearing threshold. Ears that are only partially filled with fluid (as evident by the presence of an air-fluid level or bubbles on the pneumatic otoscopy) have less of a hearing impairment than those ears completely filled with fluid (Fria, Cantekin, & Eichler, 1985; Wiederhold, Zajtchuk, Vap, & Paggi, 1980).

Otitis media has been reported to be highly prevalent among Canadian Aboriginal children compared to other groups of people. More specifically, since the 1960s researchers have been finding overwhelming rates of chronic otitis media (COM) among this population (e.g., Baxter, 1999; Julien et al., 1987; Ling et al., 1969; Tremblay, 1990). COM is typically defined in these studies as a chronic infection of the middle ear cleft including perforation of the tympanic membrane, with and without otorrhea. This type of otitis media is uncommon in non-native children (Baxter, 1999) and is often a result of AOM, but may also occur when chronic or persistent OME is present (Bluestone, 1998).

Longitudinal data collected from the Eastern Canadian Arctic (Baffin Zone) has shown an evolving pattern of middle ear disease between 1968-1998. In particular, in the late 1960s and 1970s COM was the most common type of ear disease and AOM and OME were seldom seen. However, starting in the 1980s this pattern of ear disease began to change and AOM and OME were more frequently being diagnosed and no longer were discharging ears prevalent (Baxter, 1999; Baxter, Stubbing, Goodbody, & Terraza, 1992). On the contrary, a study (Ayukawa et al., 1997) in Nunavik, Quebec compared prevalence rates of otitis media between 1987 and 1997 and discovered that rates of OME decreased from 3.1% to 0%, whereas the prevalence of COM increased from 9.4% to 16.9%. These findings suggest that although a decreasing trend is occurring in some areas, the problem of COM continues to persist (Ayukawa et al., 1997; Baxter, 1999).

There is more limited data on the prevalence and types of otitis media present in First Nations children outside of the Arctic Circle. Studies which report otitis media in First Nations children in the southern regions of Canada suggest that OME is the most common condition followed by some cases of perforated tympanic membranes, drainage of ears, and cholesteatoma (Cambon et al., 1965; Doyle & Morwood, 1976; Scaldwell & Frame, 1985). Cambon et al. (1965) reported the prevalence rate of middle ear disease among the First Nations population in British Columbia to be 13.7% (results were not given separately for children). Another study of western Canada found prevalence of middle ear disease in First Nations children to be 12.7% (Doyle & Morwood, 1976). Scaldwell and Frame (1985) investigated the prevalence rate of otitis media among 739 Cree and Ojibway school-aged children in six communities in Ontario and found that OME was present in 23% of the children. These studies were completed in western Canada and Ontario, and there is a dearth of knowledge on the types of otitis media diagnosed in the First Nations population on the eastern coast of Canada.

Parental report has also been used to provide insight in the prevalence of middle ear disease among First Nations children. The First Nations Regional Longitudinal Health Survey (2005) conducted a nation-wide survey on 270 First Nations communities across Canada (excluding Nunavut). According to parents, chronic ear infections are among the top three most common health conditions experienced by

the First Nations children (0-11 years) and youth (12-17 years). In particular, 9.2% of children and 5% of youth were reported to suffer from chronic ear infections or ear problems (likely otitis media). The First Nations Regional Longitudinal Health Survey (2004), which provided data for 13 Mi'kmaq communities around Nova Scotia, showed that parents reported ear problems to be the most common (18%) chronic health condition that their children (0-11 years) experienced. Similarly, the youth population (12-17 years) self-reported that ear problems ranked in the top two or three most common health problems, with 22% of females affected, and 24% of males experiencing ear problems. Interestingly, the First Nations Regional Longitudinal Health Survey (2005) also reported that only 1 in 4 (25%) of those children who suffer from ear infections were receiving treatment for them.

In the general population, typical prevalence patterns show episodes of otitis media to decline significantly after the first year of life, becoming relatively uncommon in children 7 years and older (Bluestone & Klein, 1995). In contrast, prevalence rates of COM among the Inuit school-age population have been found to range between 3.1-50% (e.g., Ayukawa et al., 1997; Baxter, 1999; Baxter & Ling, 1974; Julien et al., 1987; Ling et al., 1969; Woods et al., 1994). Similarly, high rates of otitis media and hearing loss have been found among school-age Mi'kmaq children of Nova Scotia, with reports of type B tympanograms (suggestive of effusion in the middle ear) ranging from 10 to 16% and hearing loss ranging from 16 to 20% (Van Ek & Sockalingam, 2004). These prevalence rates are exceptionally high especially considering that they represent children who are of school age.

In the general population, by the age of 3 years, children can be categorized into one of three groups: otitis media free, occasional otitis media or otitis prone (Bluestone & Klein, 1995). Clearly, Aboriginal children are often considered to be part of the later grouping. It has also been suggested that in Aboriginal children otitis media has the potential to establish itself and become chronic beyond the age of 3 (Ayukawa et al., 1997). On the contrary, persistent middle ear effusion in the general population is more common in children 2 years of age or younger (Pelton, Shurin, Donner, & Klein, 1977). In the general population middle ear disease is considered a disease of infancy and early childhood and its occurrence early in life is attributed to factors such as maturing anatomy, physiology, and immunology (Bluestone & Klein, 1995). It is not clear why the Aboriginal population seems to remain at risk for developing otitis media beyond early childhood (Baxter, 1999).

Although there are several studies demonstrating the high occurrence of otitis media and hearing loss in Canadian Inuit children, there are a limited number of studies on First Nations children in the southern regions of Canada. There is also limited research on the occurrence of middle ear pathology and hearing loss among First Nations children of different age groups. Moreover, there is a lack of studies examining whether the presence of otitis media

and hearing loss persists throughout the school year.

The objectives of the present study were to (1) examine the occurrence and type of middle ear pathology in Mi'kmaq elementary school children on two separate evaluations throughout the school year, (2) examine the occurrence of hearing loss among Mi'kmaq elementary students on two different occasions throughout the school year, and (3) examine the distribution of hearing loss and middle ear pathology across student ages.

Method

Participants

The participants were 48 children (29 boys and 19 girls) of Mi'kmaq heritage from a First Nations elementary school in Nova Scotia. They represented 80% of all students from that First Nations elementary school. Out of these 48 children, 47 took part in the first evaluation and 41 took part in the second evaluation. Participation in each evaluation was based on those students in school attendance on each particular evaluation day. The participants included children enrolled in the school's headstart program, grade primary level, as well as all subsequent grades represented at the school (i.e., grades 1 to 6). The mean age of all the participants at the time of the initial assessment was 6.73 years (SD = 2.32 years), with a range of 3 to 11 years. Parental consent was obtained from all students involved prior to the commencement of the study.

Procedure

Two separate otolaryngological and audiological evaluations were conducted during the school year (October and April). On both evaluation dates, pneumatic otoscopy was performed by the same otolaryngologist and the audiological evaluations were completed by the same audiologist with the assistance of graduate students. All evaluations were performed in one of three consultation rooms located in the medical center of the Mi'kmaq First Nations community.

The otolaryngological examination included a pneumatic otoscopy evaluation. The U.S. Department of Health and Human Services strongly recommends the use of pneumatic otoscopy in clinical practice as the primary diagnostic method for diagnosing otitis media (Rosenfeld et al., 2004). The pneumatic otoscopy allows visual inspection of the ear canal and tympanic membrane, using a light source and magnifying lens. As well, the pneumatic otoscopy is used to create a seal in the ear canal and then slight positive and negative pressure is applied in order to observe the tympanic membrane and evaluate its mobility (Bluestone & Klein, 1995).

An otolaryngologist assessed each child's ears with the pneumatic otoscopy. Diagnoses were classified according to the following criteria: (1) normal tympanic membrane, (2) retracted tympanic membrane/negative pressure, (3) otitis media with effusion, (4) acute otitis media, (5) tympanostomy tube (normal), (6) tympanostomy tube (with otorrhea), (7) dry tympanic membrane perforation,

(8) tympanic membrane perforation with otorrhea, and (9) granulation or cholesteatoma.

Tympanometry was performed with a Microtym 2 Middle Ear Analyzer (Welch Allyn) to evaluate immittance characteristics of the middle ear system. The U.S. Department of Health and Human Services suggests the use of tympanometry as an optional diagnostic tool to confirm the diagnosis of middle ear effusion (Rosenfeld et al., 2004). Only type B tympanogram (Jerger, 1970) was considered to be abnormal and indicative of OME (Babonis, Weir, & Kelly, 1991; Dempster & Mackenzie, 1991). Type B tympanogram has been found to have a positive predictive value (83.6%) for middle ear effusion (Babonis et al., 1991).

Although both pneumatic otoscopy and tympanometry essentially measure the same thing, that is, tympanic membrane mobility, they have been recognized to compliment each other because the strengths of one measure can offset the weaknesses of the other test. Tympanometry provides a quantitative measure of the tympanic membrane activity, whereas pneumatic otoscopy gives a qualitative diagnosis (Stool et al., 1994). A diagnosis of middle ear pathology was determined based on clinical findings with the pneumatic otoscopy. Middle ear dysfunction revealed through tympanometry was used to supplement the pneumatic otoscopy findings.

Pure tone air-conduction threshold audiometry was conducted on all participants using a AD226 Diagnostic Audiometer (Interacoustics) and a TDH-50P supra-aural headphones (Telephonics). The ambient noise in the testing rooms were measured with a sound level meter revealing an average ambient noise level that did not exceed 35 dBA (with a range of 30 to 40 dBA). Hearing sensitivity was classified as normal if the average of hearing thresholds obtained at 500, 1000, 2000, and 4000 Hz was 25 dB HL or better. The decision to use a 25-dB HL cut-off, rather than a 15-dB HL cut-off as per ANSI (1996) classification for slight hearing loss, was based on the fact that testing did not occur in a sound treated room which could have interfered with the measurement of thresholds at soft intensities. If average hearing thresholds exceeded 25 dB HL then the loss was classified as mild (26-30 dB HL), moderate (31-50 dB HL), moderately severe (51-70 dB HL), or severe (71-90 dB HL). The parents/guardians of those students diagnosed with otitis media and/or a hearing loss were contacted by telephone and referred for further medical follow-up and/or audiological testing.

Results

Pneumatic otoscopy was performed on 47 students in the October evaluation and 41 students (5 students absent, 2 students no longer attended that school) in the April evaluation. The percentage of children diagnosed with middle ear pathology in at least one ear was 25.5% ($n = 12$ children) in the October evaluation and 24.4% ($n = 10$ children) in the April evaluation. In the October evaluation, 7 of the 12 children affected presented with

a unilateral middle ear pathology, while in the April evaluation 5 of the 10 children affected presented with a unilateral middle ear pathology.

As seen in Figure 1, the most common type of middle ear pathology observed (both ears combined) on both evaluation dates was OME. There were no occurrences of AOM, tympanic membrane perforations, granulation or cholesteatoma in either screening. Half (50%) of those students found to have a middle ear pathology in the October evaluation presented with the same pathology (i.e., OME, retracted tympanic membrane, or tympanostomy tube with otorrhea) in the April evaluation.

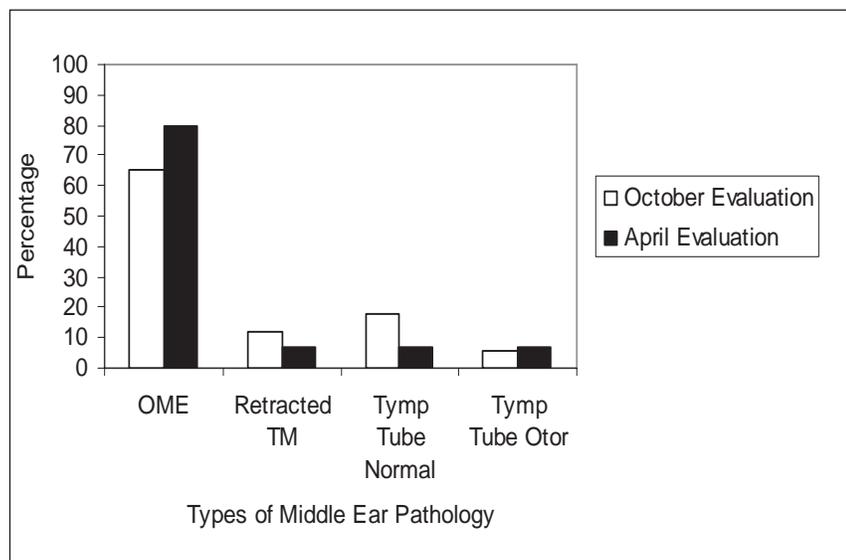


Figure 1. Types of middle ear pathology observed in ears with middle ear problems in the October and April evaluations. (OME: otitis media with effusion; TM: tympanic membrane; Tymp Tube Normal: tympanostomy tube in normal conditions; and Tymp Tube Otor: tympanostomy tube in place with otorrhea).

Figure 2 shows the percentage of children with middle ear pathology across three age ranges: 3 to 5 years, 6 to 8 years, and 9 to 11 years. At both evaluations, all age groups tended to have a similar percentage of children with middle ear pathology, except for the 3-5 year-old children who tended to show a slightly higher occurrence in the October evaluation.

Pure tone audiometry was performed on 45 of the 47 students who participated in the October assessment (two students could not be tested due to noncompliance). Of those students tested, 20% ($n = 9$) were found to have a hearing loss in at least one ear. A unilateral hearing loss was identified in five of the students affected and a bilateral hearing loss was found in four of the students affected.

In the April assessment, pure tone audiometry was completed on 40 of the 41 students (one student was noncompliant). Results revealed that 25% ($n = 10$) of students had a hearing loss. Of these students, five were found to have a unilateral hearing loss and 5 had a bilateral hearing loss.

Figure 3 shows the percentage of hearing loss in both evaluation sessions for the three age groups. Children between 3 to 5 years of age had the highest percentage of hearing loss (50% in the October evaluation and 37% in the April evaluation), whereas the 9 to 11 year-old children had the smallest percentage of hearing loss (6% in the October evaluation and 15% in the April evaluation).

The degree of hearing loss was determined by averaging the thresholds across all frequencies (500, 1000, 2000, 4000 Hz). As seen in Table 1, the degree of hearing loss identified in both evaluation sessions ranged from mild to moderately severe. In both evaluation sessions, the majority of children with hearing loss (77% and 70% for the October and April evaluations, respectively) were found to have a mild hearing impairment.

Discussion

The purpose of the present study was to compare the occurrence of types of middle ear pathology and hearing loss on two separate occasions during the school year and for different age groups of First Nations students. Each evaluation included pneumatic otoscopy performed by an otolaryngologist, as well as tympanometry and pure tone audiometry conducted by an audiologist and graduate students.

The percentage of children found to have a middle ear pathology in at least one ear was 25.5% and 24.4% for the October and April evaluations, respectively. These results are consistent with prevalence rates of middle ear disease in Aboriginal school-aged children reported in the Arctic, as well as in other First Nations communities of Canada. For example, on First Nations reservations throughout Ontario, Scaldwell and Frame (1985) found that 23% of all children sampled had a middle ear pathology. The most common type of middle ear pathology observed in both evaluation sessions in the present study was OME, which has also been found to be the most frequent ear pathology in First Nations children living in British Columbia and Ontario (e.g., Doyle & Morwood, 1976). This finding is not surprising considering that OME is easily overlooked in an asymptomatic child (Rosenfeld & Bluestone, 2003).

The occurrence of hearing loss was 20% in the October evaluation and 25% in the April evaluation. These rates are exceptionally high in comparison to the prevalence of hearing loss in non-Aboriginal students in a nearby community (3.7%) (Van Ek & Sockalingam, 2004) and in school-age children in the general population (2.63%) (Lundeen, 1991). These findings are consistent, however, with those found in Aboriginal children across northern and southern regions of Canada (e.g., Ayukawa et al., 1997; Doyle & Morwood, 1976).

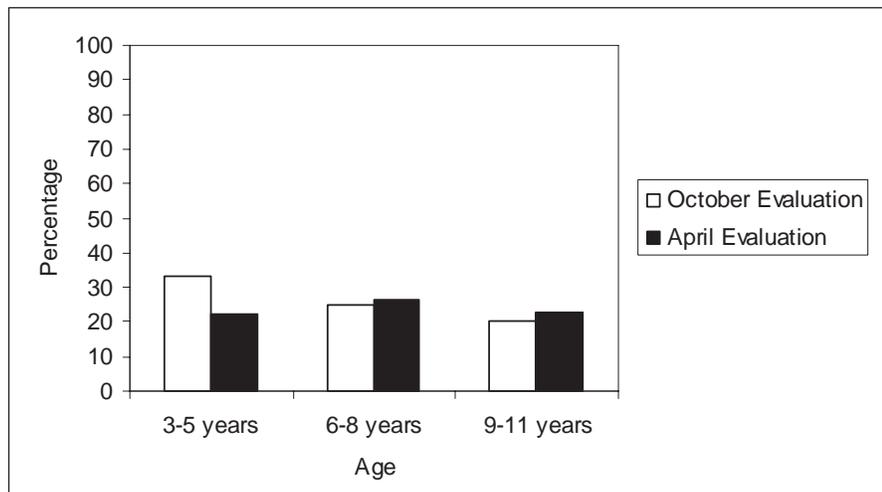


Figure 2. Percentage of children, within each age group, with middle ear pathology in at least one ear in the October and April evaluations. Total number of children in the 3-5 years, 6-8 years, and 9-11 years groups were 12, 20, and 15, respectively, for the October evaluation, and 9, 19, and 13 for the April evaluation.

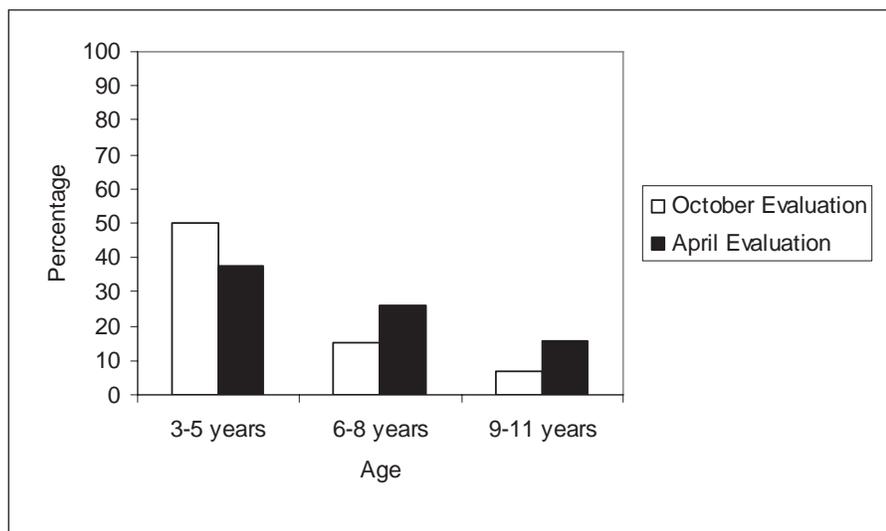


Figure 3. Percentage of children, within each age group, with hearing loss in at least one ear in the October and April evaluations. Total number of children in the 3-5 years, 6-8 years, and 9-11 years groups were 10, 20, and 15, respectively, for the October evaluation and 8, 19, and 13 for the April evaluation.

In general, in both evaluation sessions, middle ear pathology was found to be equally high among the three age groups, except for a somewhat higher occurrence in the 3 to 5 year-old children in the October evaluation only. Although the occurrence of hearing loss at each evaluation session tended to decrease with increasing age, it continued to remain relatively high in the 6 to 11 year-old students. These findings contradict those found in the general population, where rates of otitis media decline significantly after the first year of life, becoming relatively uncommon in

children 7 years and older (Bluestone & Klein, 1995). It does, however, support the contention that Aboriginal children are more prone to persistent or recurrent middle ear effusion (Bluestone & Klein, 1995), and that in Aboriginal children otitis media has the potential to establish itself and become chronic beyond the age of 3 (Ayukawa et al., 1997).

The present study also found the occurrence of middle ear pathology to be equally high during both the October evaluation (25%) and the April evaluation (24%). The occurrence of hearing loss was also found to be equally high during the October evaluation (20%) and the April evaluation (25%). Moreover, 50% of the students found to have middle ear pathology in October continued to exhibit the same pathology in April. These results suggest that middle ear disease and hearing loss among the Mi'kmaq elementary school children in eastern Canada remain relatively high throughout the school year. The persistence of middle ear pathology over a 6-month period found in the present study, coupled with the First Nations Regional Longitudinal Health Study (2005) report that only one in four children with middle ear problems were receiving treatment, highlight the need for adequate medical and audiological follow-up. In this study, the parents of children who were identified with middle ear problems in October were contacted by telephone and referred for medical consultation and/or audiological assessment; however, half of these children still presented with the same middle ear pathology in April. The present study did not investigate whether parents complied with the recommendation and/or the efficacy of medical or audiological intervention. Future studies should examine compliance with medical and audiological recommendations and efficacy of treatment of middle ear pathology in First Nations children.

The majority of the children with hearing loss exhibited a mild degree of hearing loss, and half of them were found to have a unilateral hearing loss. This trend is consistent with the notion that hearing loss associated with otitis media is typically relatively mild (Bluestone & Klein, 1995). It is important to note that the hearing evaluations conducted in the present study were based on a 25-dB threshold cut-off and consequently would have missed those children with a

Table 1

Distribution of the degree of hearing loss among children found to exhibit a hearing problem in October in April

Degree of hearing loss	Evaluation Session	
	October	April
Mild (26-30 dB HL)	7 (77%)	7 (70%)
Moderate (31-50 dB HL)	2 (22%)	2 (20%)
Moderately severe (51-70 dB HL)	-	1 (10%)
Severe (71-90 dB HL)	-	-

slight degree of hearing loss. This is especially noteworthy considering that even a 15-dB hearing loss, or unilateral hearing loss, can pose educational and learning problems for children (Dobie & Berlin, 1979; Flexer, 1999; Northern & Downs, 1991). Moreover, conductive hearing loss often fluctuates and may go unrecognized by parents due to the often asymptomatic nature of otitis media (Rosenfeld & Bluestone, 2003). Therefore, in the classroom, on any given day, children may unknowingly suffer from hearing loss which adversely affects their ability to hear and attend to the teacher (Berg, 1987). In addition, the effects of unrecognized hearing loss within the classroom are often associated with problems or causes other than hearing impairment. For example, when a child is off-task or struggles to keep up with the rapid pace of class discussion, the cause of that child's behaviour may be attributed to noncompliance, attention problems or learning difficulties rather than hearing problems (Crandell, Smaldino, & Flexer, 1995).

The fluctuating hearing loss associated with otitis media suggests that on any given day in the classroom, First Nations children may not be receiving the necessary instruction provided by the teacher. Moreover, OME, the most common middle ear pathology found in the present study, is often asymptomatic and therefore these children may experience a loss of hearing that goes unnoticed. In view of the high rates of conductive hearing loss in the Aboriginal elementary school population, modifications to the classroom environment (for example, installation of soundfield amplification systems) should be considered to accommodate their incomplete and inconsistent hearing.

Overall, the present study demonstrates that, similar to the Inuit population and First Nations children from western and central Canada, Mi'kmaq elementary school children of Nova Scotia suffer from considerably high rates of otitis media and hearing loss. Past research has recognized this pattern since the 1960s and the present findings suggest that middle ear pathology and hearing loss continue to be an ongoing problem for Aboriginal children. The reasons for the inflated prevalence rates among the First Nations population are unknown, but future research should continue to investigate otitis media

and conduct hearing screenings to develop longitudinal data on Aboriginal children. A more comprehensive body of research will contribute to a better understanding of the etiology of these high rates in this particular population.

Clinicians should be mindful of the high occurrence of middle ear pathology and hearing loss among First Nations children and, when possible, conduct regularly hearing and tympanometry screenings on this population. Considering that these children suffer from persisting and recurring otitis media, these screenings will enable clinicians to monitor the hearing and middle ear status, provide the necessary referrals, and help identify those children who may be at educational risk due to hearing problems. In addition, it is important for clinicians to provide education on the occurrence of otitis media and hearing loss to First Nations communities in order to raise awareness and implement remediation strategies.

References

- American National Standards Institute (ANSI). (1996). *American National Standard specification for audiometers. ANSI S3.6-1996*. New York: Author.
- Ayukawa, H., Bruneau, S., Proulx, J., Macarthur, J., & Baxter, J. (1997). *Otitis media and hearing loss in 12-16 year old Inuit of Inukjuak, Quebec, Canada*. Unpublished manuscript.
- Ayukawa, H., Lejeune, P., & Proulx, J. (2000). *Hearing screening outcomes in Inuit children in Nunavik, Quebec, Canada*. Unpublished manuscript.
- Babonis, T., Weir, M., & Kelly, P. (1991). Impedance tympanometry and acoustic reflectometry at myringotomy. *Pediatrics*, 87(4), 475-480.
- Baxter, J. (1999). Otitis media in Inuit children in eastern Canada arctic – an overview – 1968 to date. *International Journal of Pediatric Otorhinolaryngology*, 49(1), S165-S168.
- Baxter, J., & Ling, D. (1974). Ear disease and hearing loss among the Eskimo population of the Baffin Zone. *Canadian Journal of Otolaryngology*, 3(2), 110-122.
- Baxter, J., Stubbing, P., Goodbody, L., & Terraza, O. (1992). The light at the end of the tunnel associated with the high prevalence of chronic otitis media among Inuit elementary school children in the eastern Canadian arctic is now visible. *Arctic Medical Research*, 51, 29-31.
- Berg, F. (1987). *Facilitating classroom listening*. Boston, MA: College Hill Press.
- Bluestone, C. (1998). Epidemiology and pathogenesis of chronic suppurative otitis media: Implications for prevention and treatment. *International Journal of Pediatric Otorhinolaryngology*, 42, 207-223.
- Bluestone, C., & Klein, J. (1995). *Otitis media in infants and children* (2nd ed.). Toronto, ON: W.B. Saunders Company.
- Cambon, K., Galbraith, J., & Kong, G. (1965). Middle-ear disease in Indians of the Mount Currie reservation, British Columbia. *Canadian Medical Association Journal*, 93, 1301-1305.
- Crandell, C., Smaldino, J., & Flexer, C. (1995). *Sound field FM amplification: Theory and practice*. San Diego, CA: Singular Publishing Group.
- Dempster, J., & Mackenzie, K. (1991). Tympanometry in the detection of hearing impairments associated with otitis media with effusion. *Clinical Otolaryngology*, 16, 157-159.
- Dobie, R., & Berlin, C. (1979). Influence of otitis media on hearing and development. *Annals of Otolaryngology, Rhinology, and Laryngology*, 88, 48-53.
- Doyle, P., & Morwood, D. (1976). Middle ear disease in native Indian children in British Columbia – incidence of disease and an evaluation of screening methods. *Journal of Otolaryngology*, 5(2), 103-115.
- Eriks-Brophy, A., & Ayukawa, H. (2000). The benefits of sound field amplification in classrooms of Inuit students of Nunavik: A pilot project. *Language, Speech, and Hearing Services in Schools*, 31, 324-335.
- First Nations Centre. (2004). *First Nations and Inuit Regional Health Surveys 1996/1997*. Ottawa, ON.
- First Nations Centre. (2005). *First Nations and Inuit Regional Health Surveys 2002/2003*. Ottawa, ON.
- Flexer, C. (1999). *Facilitating hearing and listening in young children* (2nd ed.). Clifton Park, NY: Delmar Learning.
- Fria, T., Cantekin, E., & Eichler, J. (1985). Hearing acuity of children with otitis media with effusion. *Archives of Otolaryngology – Head and Neck Surgery*, 111, 10-16.
- Jerger, J. (1970). Clinical experience with impedance audiometry. *Archives of Otolaryngology – Head and Neck Surgery*, 92, 311-324.
- Julien, G., Baxter, J., Crago, M., Ilecki, H., & Therien, F. (1987). Chronic otitis media and hearing deficit among native children of Kuujuaaraapik (northern Quebec): A pilot project. *Canadian Journal of Public Health*, 78, 57-61.

Ling, D., McCoy, H., & Levinson, E. (1969). The incidence of middle ear disease and its educational implications among Baffin Island Eskimo children. *Canadian Journal of Public Health*, 60, 385-390.

Lundeen, C. (1991). Prevalence of hearing impairment among school children. *Language, Speech, and Hearing Services in Schools*, 22, 269-271.

Northern, J., & Downs, M. (1991). *Hearing in children* (4th ed.). Baltimore, MD: Williams & Wilkins.

Pelton, S., Shurin, P., Donner, A., & Klein, J. (1977). Persistence of middle ear effusion after otitis media. *The New England Journal of Medicine*, 300, 1121-1123.

Rosenfeld, R., & Bluestone, C. (2003). *Evidence-based otitis media* (2nd ed.). Hamilton, ON: BC Decker Inc.

Rosenfeld, R., Culpepper, L., Doyle, K., Grundfast, K., Hoberman, A., & Kenna, M., et al. (2004). Clinical practice guideline: Otitis media with effusion. *Otolaryngology – Head and Neck Surgery*, 130(5), S95-S118.

Scaldwell, W., & Frame, J. (1985). Prevalence of otitis media in Cree and Ojibway school-children in six Ontario communities. *Journal of American Indian Education*, 25(1), 1-5.

Schilling, H., Buelow, B., & Duval, L. (2002). *Prevalence of hearing loss in an Inuit school age population*. Unpublished manuscript.

Stool, S., Berg, A., Berman, S., Carney, C., Cooley, J., & Culpepper, L. (1994). *Otitis media with effusion in young children*. Rockville, Maryland: U.S. Department of Health and Human Services.

Tremblay, C. (1990). Prevalence of hearing loss in northern Quebec: A medical and statistical challenge. *Circumpolar Health*, 90, 653-654.

Van Ek, H., & Sockalingam, R. (2004). *Prevalence of hearing loss and middle ear dysfunction in Mi'kmaq elementary school age children in Pictou Landing, Nova Scotia*. Unpublished manuscript, Halifax, Nova Scotia.

Wiederhold, M., Zajtchuk, J., Vap, J., & Paggi, R. (1980). Hearing loss in relation to physical properties of middle ear effusion. *Annals of Otolaryngology and Laryngology*, 89, 185-189.

Woods, W., Moffatt, M., Young, T., O'Neil, J., Tate, R., & Gillespie, I. (1994). Hearing loss and otitis media in Keewatin children, NWT. *Arctic Medical Research*, 53(2), 693-696.

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