Original Article

Assessment of Prevalence of Otitis Media with Effusion and Correlation Between Otoscopic Findings with Jerger's Diagnostic Tympanograms Among Pupils in Calabar Municipality

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Received: 14-May-2024;
Revision: 09-Jul-2024;
Accepted: 26-Aug-2024;
Published: 30-Sep-2024

ABSTRACT

Background: OME is an accumulation of serous or mucoid fluid in the middle ear cavity with an intact tympanic membrane and without any sign of acute infection. **Aims:** This study aimed to determine the prevalence of otitis media with effusion among preschool and school-age children aged 1-10 years in private and public schools in Calabar municipality and the correlations between otoscopic findings and Jerger's diagnostic criteria among study participants. **Methods:** This school-based descriptive cross-sectional study used a multistage sampling technique to recruit participants. The Institutional Ethical Committee approved the study. Consent and assent were obtained from parents/guardians of children aged < 6 years and >7 years, respectively. A structured questionnaire was used to obtain sociodemographic characteristics, symptoms, and possible risk factors for otitis media with effusion. In addition, ear, nose, and throat (ENT) examinations and tympanometry were performed for each participant. Jerger's type B and C tympanograms were the diagnostic criteria for otitis media with effusion. The data were analyzed using IBM SPSS version 25, and the threshold for statistical significance was set at $P < 0.05$. **Results:** The overall prevalence of OME was 13.8%, with P values ≤ 0.001, $P = 0.597$, and $P = 0.007$ for daycare (45.85%), public schools (14.7%), and females, respectively. Jerger type B tympanograms had a strong positive correlation with middle ear fluid ($r = 0.777$) on otoscopy, Jerger type C tympanograms with dull TM ($r = 0.687$), and retracted TM ($r = 0.774$). **Conclusion:** Otitis media with effusion was more prevalent among preschool children aged 1-2 years in public schools and among female children in Calabar municipalit. The otoscopic results of otitis media with effusion were consistent with Jerger's diagnostic criteria in our study.

Keywords: *Otitis media with effusion, preschool, prevalence, schoolchildren*

Introduction

Otitis media with effusion (OME) is an accumulation of serous or mucoid fluid in the middle ear cavity with an intact tympanic membrane and without any sign of acute infection.[1,2] Approximately 85% of OME cases occur in children, but OME is a rare disorder in adults.[3] OMEs exhibit geographical and racial variations and are more common among Canadian, Australian Aboriginals, and Native American children than among Africans.[3,4] In general, an incidence of 8–50% was reported and decreased with increasing age, reaching 40% at age 2 and 1.4% at age 11.[2]

In sub-Saharan Africa, Nigeria, in particular, studies on OME have recorded variable results because of differences in the study population, methodology, and diagnostic criteria.[5] Nwosu *et al*.,[6] in Port Harcourt, Nigeria, reported a high prevalence of 25.2% among

Access this article online

Quick Response Code:

Website: www.njcponline.com

DOI: 10.4103/njcp.njcp_332_24

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How to cite this article: Onwughalu BC, Adekanye AG, Mgbe RB, Anisi CO, Umana AN, Somefun OA. Assessment of prevalence of otitis media with effusion and correlation between otoscopic findings with Jerger's diagnostic tympanograms among pupils in Calabar Municipality. Niger J Clin Pract 2024;27:1112-9.

226 children aged 1–6 years in daycare and nursery schools. In contrast, a study by Okolugbo *et al*.[5] in schoolchildren aged 5–7 years in Benin City, Nigeria, reported a lower prevalence of 15.9%. Libwea *et al*.,[7] in Yaoundé, Cameroon, reported a prevalence of 8.8% in a study of 2–3-year-old children selected randomly from households within 40 clusters in the community.

The management of OME is multidisciplinary and involves otorhinolaryngologists, speech and language therapists, audiologists, and pediatricians.[7] The guidelines for the diagnosis and management of OME are based on those issued by three organizations: The American Academy of Otolaryngology-Head and Neck Surgery Foundation (AAO-HNSF), the University of Michigan Health System (UMHS), and the National Institute for Health and Care Excellence (NICE).[8-10] The target patients for the guidelines are 2-month-old to 12-year-old children. The AAO-HNSF recommendations for the diagnosis of OME include documentation of the presence of OME using pneumatic otoscopy. In cases of diagnostic uncertainty in pneumatic otoscopy, tympanometry is used for confirmation. The guidelines also recommend screening children between 12 and 18 months of age who are at high risk for developing OME.

UMHS recommends combining otoscopy, pneumatic otoscopy, and tympanometry when necessary.[9]

The NICE recommends that the concern of parents, caregivers, or professionals about the clinical features suggestive of OME should precipitate an initial assessment and that all children with Down syndrome or cleft palate should be assessed regularly for OME.[10]

AAO-HNSF and NICE recommend watchful waiting for three months from the onset of OME or three months from the date of diagnosis for children who are not at risk for speech, language, or learning problems. AAO-HNSF and NICE recommend tympanostomy tube insertion in children with bilateral or unilateral OME for more than three months with documented hearing difficulty, speech/language, learning difficulties, or reduced quality of life. Adenoidectomy is recommended by the AAO-HNSF and NICE only when necessary.

In exceptional circumstances, AAO-HNSF recommends antibiotics, systemic steroids, intranasal steroids, antihistamines, and decongestants, whereas NICE does not recommend medical therapy.

This descriptive cross-sectional study primarily aimed to determine the prevalence of otitis media with effusion among preschool and primary school children aged 1-10 years in private and public schools in Calabar municipality.

Materials and Methods

Study design

This school-based descriptive cross-sectional study used a multistage sampling technique to recruit children aged 1–10 years from the government and privately owned daycare, nurseries (preschools), and primary schools in Calabar municipality. This study was conducted from June 2020 to July 2021.

Participant selection

The inclusion criteria were children aged 1–10 years attending daycare, nursery, or primary school whose parents/guardians consented to the study, children aged 7–10 years who also consented to the study, and children in the above age bracket who had spent three months or more in the school. The school registers containing the names of all daycare, nursery, or primary school pupils formed the sampling frame from which the subjects whose names fell on an even number on the school registers were consecutively selected until a proportionate sample size was attained.

The exclusion criteria were tympanic membrane perforation, previous ear surgery, congenital ear deformity, a history of adenoidectomy/adenotonsillectomy, and difficulty restraining/not cooperating.

Sample size determination

The sample size included 320 preschool and schoolchildren, as determined using the Cochran formula for a single proportion ($N = Z^2pq/d^2$).

Z = Standard deviation set at 1.96 (at 95% confident interval), P = Prevalence from a previous similar study (25.2%, i.e.,% p = 0.25),[6] q = 1-p = 1-0.25 = 0.75, d = degree of precision set at 0.05

$N = (1.96)^2 \times 0.25 \times 0.75//(0.05)^2 = 288$

By assuming a nonresponse rate of 10% (i.e., r = 0.01), the estimated minimum sample size is adjusted for nonresponses as follows:

$N_a = N/1 - r = 288/1 - 0.1 = 288/0.9 = 320$

Therefore, 320 preschool and school children were recruited for the study.

Sampling technique

A multistage, proportionate, stratified sampling technique was used to determine the selected number of pupils from each of the three categories of schools (i.e., daycare, nursery schools, and primary schools). Hence, the selected number of pupils from each of the three school categories is calculated as follows:

The number selected from a category is expressed as

(Total number of Schools in the category)/(Total Number of Registered Schools) X Estimated

Sample size

Numbers to be selected from daycare = 18/237 × 320 = 24.30 ≈ 24

The numbers to be selected from Nursery Sch. =104/237 × 320 = 140.42 ≈ 141

Numbers to be selected from Primary Sch. =115/237 × 320 = 155.27 ≈ 155

Therefore, 24 d care pupils, 141 nursery pupils, and 155 primary pupils were recruited for the study.

Ethical considerations

Ethical approval was obtained from University of Calabar Teaching Hospital HREC (UCTH/HREC/33/678).

The researchers presented an introductory letter from the Ministry of Education, Calabar, Cross River State, to the head teachers of the selected schools to obtain permission to proceed with the research.

Advocate visits to the selected schools to explain the essence of the study to head teachers, teachers, parents/guardians, and older participants before the commencement of the study.

Sample collection

Before the commencement of the study, a pilot study of this study population was conducted using a 50-point questionnaire. The pilot study aimed to validate the structural questionnaire used for this study, and the results obtained were not included in the data. The pupils met the minimum criteria for the study, as mentioned above, and their parents/guardians provided informed consent and assent from the older subjects. The parents/guardians and older subjects either signed or thumb-printed the structured and pretested questionnaire distributed through the head teacher of the selected schools a day before the scheduled examination to obtain sociodemographic data and clinical details.

Clinical examination

The parents/guardians of children aged 1–4 years had appointments with the researchers at the examination of their children to enhance their cooperation.

The researchers completed a structured questionnaire given to the subjects and ensured that the information provided in the questionnaire was adequate. A detailed explanation of the physical and ENT examinations was provided to the parents/guardians of the younger children (1–4 years) and older children (5–10 years).

A general physical examination was performed in a well-lit, quiet school clinic/room. The older child was comfortably seated on a chair; the younger child (1 to 4 years old) sat on the lap of the parent/guardian with the leg between the parent/guardian's legs and the arm around the child's body; the other hand held the child's head firmly against the parent/guardian's chest, and the investigator masked and gloved, then sat in front of the participant. The children were distracted by nursery rhymes on the phones shown to them to cooperate.

The ear was examined with the aid of a headlight, followed by otoscopy using a fiberoptic video otoscope. The pinna of children aged 1–4 years was pulled downward, outward, upward, and backward in children aged 5–10 years. An otoscope with an appropriately sized speculum was inserted carefully into the external auditory canal to assess the patency of the external auditory canal and integrity of the tympanic membrane, followed by taking photographs of the TM with a fiberoptic video otoscope for proper evaluation.

Turning fork tests (Rinne's and Weber's tests) and facial nerve examinations were performed on participants aged 5–10 years. The examination findings were documented using a questionnaire.

Children whose external auditory canals showed obstructive debris/wax on otoscopy were referred to the ENT clinic (UCTH, Calabar) for aural syringing. Pupils with hard or impacted wax were softened by advising parents/guardians to instill olive oil or cerumol eardrops into the ear for several days before aural syringing. Tympanometry was delayed for approximately two days in children who had aural syringing to allow any inflammation to subside.

Tympanometry

The researchers used the Amplivox Otowave 202 hand-held calibrated tympanometer (Amplivox Limited, United Kingdom), which has a 226 Hz tone frequency and probe tips of various shapes and sizes, as it fits the children's ear canal to carry out tympanometry on each participant.

The tympanometry procedure and purpose were described to the older children (5–10 years) and the parents/guardians of the younger children (1–4 years) by the researchers. Children (5–10 years old) sat in a comfortable position to avoid unnecessary movement and were asked not to speak or swallow after the probe was fixed to their ears. The researchers informed the participants that the soft tip of the probe used to seal the ear could cause a pressure sensation in the ear for a few seconds.[11] The older participants were asked to signal

in case of any discomfort to the researcher by raising their hands or saying stop.[11]

Younger children aged 1–4 years were held by their parents/guardians and seated sideways on the adult's lap, with the hands secured by one hand and the head against the chest with the other. Some children aged 1–4 years, especially those who appeared to enjoy the tympanometer probe in their ears, stayed quietly for tympanometry, while others were given a doll to cooperate. However, most of these participants underwent tympanometry during their naptime at noon. Children who did not cooperate were excluded from this study.

A clean probe tip of suitable size and shape was mounted on the probe, inserted into the ear canal in rotatory movement,[11] and adjusted until a light indicator appeared on the tympanometer. The probe transmitted a soft tone while the air pressure in the external ear canal changed, and the results were automatically displayed on the tympanometer in graphic form and printed using an infrared printer.

After tympanometry, the probe tip was removed and placed in an antiseptic (Savlon) solution for washing and sterilization. Sufficient probe tips were used daily. There was approximately 5 min of tympanometry[11] in children aged 5–10 years and 10 min in younger children aged 1–4 years.

Jerger type B or C tympanograms were used as the diagnostic criterion for OME. The type B tympanogram constituted a flat graph showing no change in compliance with pressure changes, and type C had maximum compliance with negative pressure above 100 mm of water.[12]

Data analysis

The data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 25, and the results are presented as tables and bar charts. Statistical significance was set at $P < 0.05$.

Results

A total of 320 children participated in this study. The sociodemographic characteristics of the participants are presented in Table 1. The frequencies of the otoscopic features of fluid in the middle ear and dull and retracted TMs among the study participants are shown in Table 2. Jerger's type B and C affectation of both ears was more common in preschool children than in school children, and type AS tympanograms were very common among school children [Table 3]. OME was predominant bilaterally in children aged 1–2 years (45%), with a statistically significant difference of <0.001. The male-to-female ratio (M: F =1:3) of OME was significantly different ($P < 0.007$) [Table 4].

Table 1: Sociodemographic characteristics of the study participants (*n*=320)

Variable	Frequency	Percentage
Gender		
Male	140	43.8
Female	180	56.3
Age group (years)		
1-2 (Daycare)	24	7.5
3-6 (Nursery)	141	44.1
7-10 (Primary)	155	48.4
Tribe		
Efik	114	35.6
Ibibio	37	11.6
Igbo	57	17.8
Hausa	12	3.8
Yoruba	11	3.4
Ekoi	89	27.8
Religion		
Christianity	305	95.3
Islam	15	4.7

Table 5 shows the prevalence of OME among daycare, nursery, and primary school children, with statistical significance ($P < 0.001$).

Table 6 shows that OME is more prevalent among public schoolchildren than among private schoolchildren, although the difference was not statistically significant.

The left ear was more affected (10.9%) than the right ear (8.8%). The incidence of bilateral affectation was 5.9% [Figure 1].

As shown in Table 7, there was a strong positive significant correlation between the diagnostic criteria for Jerger type B tympanograms and the otoscopic findings of middle ear fluid (r = 0.777), a weak positive correlation with the findings of bubbles (r = 0.442) and dull TM (r = 0.483), a weak negative significant correlation with normal TM (r = -0.390), and a weak nonsignificant negative correlation with the finding of retracted TM (r = -0.510). There was a strong positive correlation between the Jerger type C tympanograms and dull TM (r = 0.687) and retracted TM (r = 0.774) but a strong negative correlation with the finding of normal TM (r = 0.494) and a weak negative correlation with the finding of middle ear fluid (r = -0.039) and bubbles (r = -0.019).

Discussion

Our study showed that otitis media with effusion is a common childhood disease among preschool-aged children and schoolchildren. This finding is consistent with reports in the literature worldwide.[3,6]

The overall prevalence of OME in daycare, nursery, and primary schools in Calabar municipality was 13.8%. This prevalence was lower than the 15.9% reported by Okolugbo *et al*.[5] in their study among primary school children aged 5 to 7 years in Benin Citycity, Nigeria, but higher than the 8% reported by Ogisi[13] in Benin City (1988). Additionally, the percentage of participants with type B tympanograms in this study (6.9%) was greater than the 6.7%, 5.2%, and 6.6% reported by Okolugbo,[5] Ogisi,[13] and Okeowo,[14] respectively. The difference in prevalence may be attributed to differences in the diagnostic criteria and study population. Nwosu *et al*.,[6] in Port Harcourt, Nigeria, reported a 25.2% prevalence. This may be because their study population included only preschool-aged individuals who are known to be more prone to OME. Additionally, Port Harcourt is an oil-producing and industrialized area with high environmental pollution, rainfall, and humidity, which might increase its susceptibility to OME. Amusa *et al*. reported a prevalence of less than 1% despite a study on an age group similar to our study. This may be because they used only otoscopy findings of dull TM for the diagnosis of OME.[15] Therefore, our study supports the combination of otoscopy and tympanometry as a better diagnostic tool for OME.

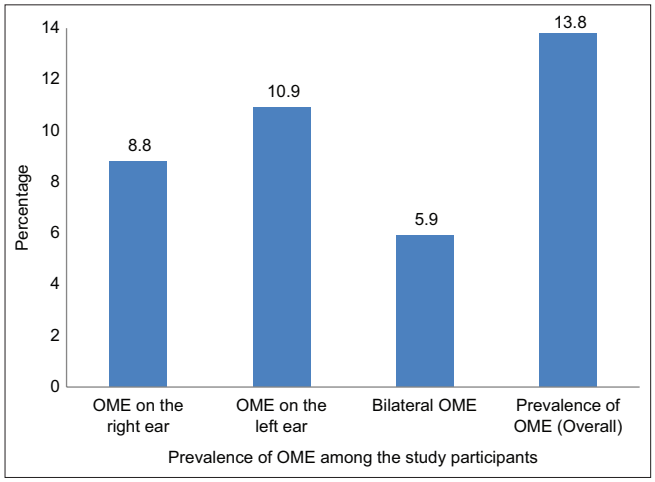

Figure 1: Overall prevalence of OME among the study participants

A wide variation in the prevalence of OME across studies has been reported due to differences in the age groups of study participants, study methodology, and levels of exposure to environment-related risk factors.[16,17] The index study prevalence was in contrast to that of Nwosu *et al*.[18] and Maris *et al*.,[19] who reported 55.9% and 66.7%, respectively, in children with adenoid hypertrophy and Down's syndrome. These pathological conditions are known to be prone to OME. Children with these diseases were excluded from our study population.

The index study prevalence of OME was slightly greater in public schools than in private schools, but this difference was not statistically significant. However, these results contrast with those of a study by Takwoingi *et al*.[20] in Yola, northern Nigeria.

Table 2: Otoscopic findings among study participants (*n*=320)

Variable	Daycare (Frequency/percentage)		Nursery (Frequency/percentage)		Primary (Frequency/percentage)	
	RT ear	LT ear	RT ear	LT ear	RT ear	LT ear
Middle ear fluid	4 (16.7)	4 (16.7)	3 (2.1)	2 (1.4)	1 (0.6)	2 (1.3)
Bubble behind TM	1 (4.2)	3 (12.5)	1 (0.7)	2 (1.4)	_	2 (1.3)
Retracted TM	4 (16.7)	5 (20.8)	6 (4.3)	8 (5.7)	3 (2.0)	4 (2.6)
Dull TM	10 (41.6)	7 (29.2)	9 (6.4)	5 (3.5)	6 (3.9)	6 (3.8)
Normal TM	5 (20.8)	5 (20.8)	122 (86.5)	124 (88.0)	145 (93.5)	141 (91.0)
Total	24 (100)	24 (100)	141 (100)	141 (100)	155 (100)	155 (100)

Digital video otoscopic findings of fluid and bubbles behind the TM and retracted and dull Tm were used to make a clinical diagnosis of OME

Table 3: Types of tympanograms among the study participants (*n*=320)

Tympanograms	Daycare		Nursery		Primary	
	RT ear	LT ear	RT ear	LT ear	RT ear	LT ear
Type	Frequency percentage		Frequency percentage		Frequency percentage	
A	13 (54.2)	14 (58.4)	112 (79.5)	107 (76.0)	120 (77.4)	118 (76.1)
As	1 (4.2)	1 (4.2)	18 (12.8)	15 (10.6)	19 (12.3)	21 (13.5)
Ad	1 (4.2)	-	3 (2.1)	5 (3.5)	5 (3.2)	4 (2.6)
B	4 (16.6)	4 (16.6)	4 (2.8)	5 (3.5)	2 (1.3)	3 (2.0)
C	5 (20.8)	5 (20.8)	4 (2.8)	9 (6.4)	9 (5.8)	9 (5.8)
Total	24 (100)	24 (100)	141 (100)	141 (100)	155 (100)	155 (100)

B and C tympanograms affected both ears more in preschool children than in schoolchildren, and the frequency of type AS tympanograms was very high among schoolchildren

Table 4: Age and sex distribution of OME among the study population (*n*=320)

Variable	OME on Right ear			OME on Left ear			OME on Both ears		
	Present, *n*=29	Absent, *n*=291	*P* (Test stat)	Present, *n*=36	Absent, *n*=284	*P* (Test stat)	Present, *n*=44	Absent, *n*=276	*P* (Chi square)
Age/years									
1-2	2 (8.3)	22 (91.7)	FET; 21.64	3 (12.5)	21 (87.5)	6.381	11 (45.8%)	13 (54.2%)	23.114
3-6	2 (1.4)	139 (98.6)	(<0.001*)	9 (6.4)	132 (93.6)	(0.028*)	18 (12.8%)	123 (87.2%)	(<0.001*)
7-10	25 (16.1)	130 (83.9)		24 (15.5)	131 (84.5)		15 (9.79%)	140 (90.3%)	
Sex									
Male	9 (6.4)	131 (93.6)	χ^2; 2.095	7 (5.0)	133 (95.0)	χ^2; 9.737	11 (7.9%)	129 (92.1%)	0.007*
Female	20 (11.1)	160 (88.9)	(0.148)	29 (16.1)	151 (83.9)	(0.002*)	33 (18.3%)	147 (81.7%)	

*Statistically significant; FET=Fisher's Exact Testexact, One-sided OME in the right ear only or left ear only was significantly greater in the upper age group. However, bilateral OME was significantly greater in the younger age group ($P < 0.001$), and this difference was statistically significant in females

Table 5: The prevalence of OME among daycare, nursery, and primary school children

Class category	OME			Chi-square	*P*
	Present 44 (13.8%)	Absent 276 (86.2%)	Total 320 (100.0%)		
Daycare	11 (45.8%)	13 (54.2%)	24 (100%)	23.114	<0.001*
Nursery	18 (12.8%)	123 (87.2%)	141 (100%)		
Primary	15 (9.7%)	140 (90.3%)	155 (100%)		

*Statistically significant

Table 6: Comparison of the prevalence of OME among children in private and public schools (*n*=320)

Variable	School type			Chi-Square Test	*P*
	Public *n*=170	Private *n*=150	Total *n*=320		
OME (Right ear)					
Present	14 (8.2%)	14 (9.3%)	28 (8.8%)	0.120	0.729
Absent	156 (91.8%)	136 (90.7%)	292 (91.3%)		
OME (Left ear)					
Present	19 (11.2%)	16 (10.7%)	35 (10.9%)	0.021	0.884
Absent	151 (88.8%)	134 (89.3%)	285 (89.1%)		
OME (Total)					
Present	25 (14.7%)	19 (12.7%)	44 (13.8%)	0.279	0.597
Absent	145 (85.3%)	131 (87.3%)	276 (86.3%)		

OME was significantly more common in younger children in our study than in relatively older children, with the highest occurrence in the 1- to 2-year-old age group, followed by the 3- to 6-year-old age group, and the lowest occurrence in the 7- to 10-year-old age group. This result is in agreement with the findings of a study by Nwosu *et al*.,[21] in which a high prevalence of OME was recorded in the age group of 1–2 years (33.7%), followed by the age group of 3–6 years (19.4%). Similarly, Amusa *et al*.[15] reported the highest prevalence of OME among individuals aged 1–4 years. The high prevalence of OME in young children might be attributable to the orientation of their Eustachian tube, which is more horizontal, shorter, and wider with reduced cartilage density than in older children.[21] Studies carried out in other countries likewise revealed a decline in the prevalence of OME with the increasing age of the child.[17,22,23] However, a study in Malaysia found no significant relationship between OME and the age of the study participants.[24]

Our study revealed a statistically significant female preponderance among children with OME. This was in contrast to the study by Amusa *et al*.,[15] who reported a greater proportion of OME in males, although the difference was not statistically significant. However, previous studies in the literature have documented no significant difference in the prevalence of OME in relation to the sex of the child.[5,21,23]

We used a fiberoptic video otoscope to examine our participants' ears, enabling us to clearly observe the various features of OME, such as middle ear fluid and bubbles behind the TM; there was a strong positive correlation between fluid in the middle ear, dull, and retracted TM and Jerger's Type B and Type C, respectively.

Table 7: Correlations between otoscopic findings and diagnostic criteria among study participants (*n*=320)

Otoscopic findings	Diagnostic criteria	
	B	C
Middle ear fluid		
R	0.777	-0.039
P	0.000*	0.486
n	320	320
Bubbles		
R	0.442	-0.019
P	0.000*	0.730
n	320	320
Dull		
R	0.483	0.687
P	0.000*	0.000*
n	320	320
Retracted		
R	-0.037	0.774
P	0.510	0.000*
n	320	320
Normal		
R	-0.390	-0.494
P	0.000*	0.000*
n	320	320

*Statistically significant; *r*=Correlation coefficient

The use of fiberoptic video otoscopy is useful in the diagnosis of OME, especially in poor resource areas where patients could not afford the cost of tympanometry.

Additionally, in this study, we reported a high prevalence of Jerger's type As, which is a diagnostic indicator of tympanosclerosis. Therefore, affected participants need to be closely followed up to prevent early progression to tympanosclerosis and hearing loss.

The limitation of our study was that we did not document treatment options for participants with OME. In addition, we did not follow-up with the participants to determine their quality of life.

Recommendation: We recommend regular advocacy teaching on radio and television on the symptoms of otitis media with effusion. Additionally, parents and guardians should have a periodic awareness educational program on the symptoms of otitis media, especially at parent and teacher association meetings, for the early identification and treatment of children with this disease. The government should establish a policy to screen healthy children as well as high-risk children for OME to prevent complications that may arise from OME. Furthermore, we recommend further studies on the correlation between otoscopic findings and Jerger's diagnostic criteria and myringotomies for OME. In addition, the quality of life of children with OME should be studied in future research.

Conclusion

Otitis media with effusion is more common in preschool-aged children than in school-aged children, especially among public school-aged children in Calabar municipality. Furthermore, it is more common among children between the ages of 1 and 2 years and among females. Additionally, the otoscopic results of patients with otitis media with effusion were consistent with Jerger's diagnostic criteria in our study.

Acknowledgments

I acknowledge Mr. JA Oyelakin, an audiologist in my department, for his guidance in the acquisition of our handheld tympanometer; the appropriate sizes and shapes of the probe tips; his assistance, guidance, and training during the pilot study; and his guidance during the study. Our gratitude goes to all the heads and teachers of the schools where I conducted my research for their assistance and cooperation.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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