

Prevalence of Middle Ear Effusion (MEE) and other Middle Ear Problems among Apparently Healthy Children in Some Selected Primary Schools in Kano Metropolis, Nigeria

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Abstract

Middle ear effusion (MEE) is the commonest ear problem affecting children less than 6 years and is a threat to deafness which is common in our environment. Tympanometry is used to determine MEE and other problems of the middle ear. This study was aimed at determining the prevalence of middle ear effusion and other middle ear problems among apparently healthy school children in some selected schools in Kano Metropolis. The study was in four primary schools located in Kano metropolis where socio-demographic characteristics of the participants (whose parents consented) were recorded, and pneumatic tympanometry was conducted. The participants were 150 school children (78 males and 72 females) aged 4-12 years and were selected using stratified sampling technique, with mean age of 9.8 ± 2.2 years. Results showed that Cronbach's alpha was $> 85\%$ for both intra and inter-observer error estimate. In all the measured parameters, significant sexual dimorphism was only found in the right ear cavity volume (Rt ECV) with males having higher values ($p < 0.05$). Majority of the pupils (82%) had normal (type A) tympanogram, 6% had flat (type B) which signifies middle ear effusion, 5.4% had type C tympanogram which signifies negative middle ear pressure and clinically eustachian tube dysfunction, 5.6% had type As (osteosclerosis of the middle ear), and 1% has Ad type (ossicular discontinuity). Age, height & weight correlated significantly with one or more of the measured ear parameters of the left or right in both sexes. The prevalence of MEE among school-aged children in Kano metropolis is alarming and is a threat to deafness. Therefore, clinicians should be more suspicious and include routine ear examination for children in their practice to detect uncomplicated MEE.

Keywords: Prevalence, Middle ear effusion, Children, Kano, Tympanometry,

INTRODUCTION

Middle ear effusion (MEE) is the commonest ear problem affecting children who are below the age of 6 years worldwide (Ashoor, 1994), particularly in the developing countries like Nigeria (Amusa, Ijadunola and Onayade, 2005, Ibekwe and Nwaorgu, 2011, Chukwuonye *et al.*, 2013), and it poses a significant threat to loss of hearing which is common in our environment. Tympanometry is one of the tests used to assess the functions and movements

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of the tympanic membrane as well as the assessment of presence or absence of middle ear effusion (Bauer and Jenkins, 2010). However, the use and practice of tympanometry is skewed even among the developed countries (Lous *et al.*, 2012, Shuaibu *et al.*, 2016). This has largely contributed to the higher prevalence of hearing disorders, mainly from the middle ear effusion (MEE). Many clinicians pay little or no attention to ear examination and as a result rarely detect presence of MEE in its early stage. Failure to detect MEE early may lead to complications including hearing impairment (Cai and McPherson, 2017). Anatomically, the middle ear is the portion of the human ear between outer and inner ear demarcated by eardrum (Tympanic membrane) and the oval window, respectively. The middle ear functions to transmit vibration by the means of three small bones called the ossicles from outer to the inner ear and it is lined by specialized type of sheet of cells called the mesothelial epithelium (Luers and Hüttenbrink, 2016). These cells secrete clear (serous) fluids that increase the efficiency of the middle ear function. The serous fluid is continuously secreted and drained by the Eustachian tube and when this drainage is impeded it accumulates resulting in middle ear effusion (Llewellyn *et al.*, 2014). In MEE, there is inflammation of all the structures in the middle ear including the eustachian tube, which gets blocked thereby creating a negative middle ear pressure. Consequently, the middle ear serous secretions accumulate in the middle ear cavity.

In majority of cases, MEE is asymptomatic, however, some children may present with various degrees of hearing loss, delayed speech development, or child may become withdrawn (Leung and Wong, 2017). Middle ear effusion is diagnosed clinically by pneumatic otoscopy which is diagnostic in around 78% of cases with 95% specificity. MEE is diagnosed when there is no air pressure change in the external ear signifying negative pressure in the middle ear and limited movement of tympanic membrane, this signifies Type B tympanogram (Atkinson, Wallis and Coatesworth, 2015).

Since MEE in most cases asymptomatic, many clinicians have low index of suspicion and rarely check for its presence and as a result, majority of cases are only detected when complications arise. Data on the prevalence of MEE among children in northwestern Nigeria is lacking and, understanding the prevalence of this condition will raise the suspicion of clinicians and hence look for salient signs of the conditions for early management that is central to the prevention of its complications. The aim of this study therefore was to evaluate the prevalence of middle ear effusion among apparently healthy school children in selected primary schools in Kano metropolis, Nigeria.

MATERIALS AND METHOD

Study design

This was a descriptive cross-sectional, prospective study

Study population

Subjects consisted of 150 primary school pupils (78 boys and 72 girls) aged 4-14 years. The pupils, whose parents consented, were recruited using simple random sampling, in four primary schools located within Kano metropolis, Kano state, northern Nigeria.

Materials

Designed proforma, Questionnaire (for socio-demographic data), Cerumol, Olive oil, Chairs, Otoscope, Tympanometer, Head light, metallic probe, cotton wool, antiseptics (methylated spirit) and computer.

Method

Subjects were recruited between January and April 2019. The Ethics Review Committee of the Kano state ministry of health approved all study procedures. Specially designed proforma forms were used to record the socio-demographic data. The procedure was fully explained to the subjects, and they were requested to sit comfortably still on the chair and not to swallow during the tympanometry. Efforts were made to minimize any discomfort that could arise from the procedure. A detailed ear and nasal examination with a head light was then performed, and subjects with ear debris and wax were treated with cerumenolytic agents (cerumol and olive oil) to soften the ear wax prior to removal in those subjects with ear wax and subsequently cleared using wax hook to enable the tympanometer to take the reading from tympanic membrane. Otoscopy with different sizes of speculums was done to visualize the integrity of the external ear and the tympanic membrane ears prior to tympanometry. The pinna was gently pulled, and straightened, and the probe of the tympanometer (TYMP 4000, 226Hz) was then inserted into the external ear canal pointing in the direction of the tympanic membrane to avoid the risk of occluding the probe aperture. The tympanometer then delivered a tone, the information of which was displayed in a graph form as tympanogram, and the peak pressure was recorded, which was categorized based on Jerger's classification (types A, As, Ad, B & C). Type A (normal), Type As (otosclerosis), Ad (ossicular discontinuity), Type B (middle ear effusion) and Type C (Eustachian tube dysfunction). The same procedure was performed in both ears under antiseptics measures of cleaning the tip of the probe before and after use in each ear and in each subject.

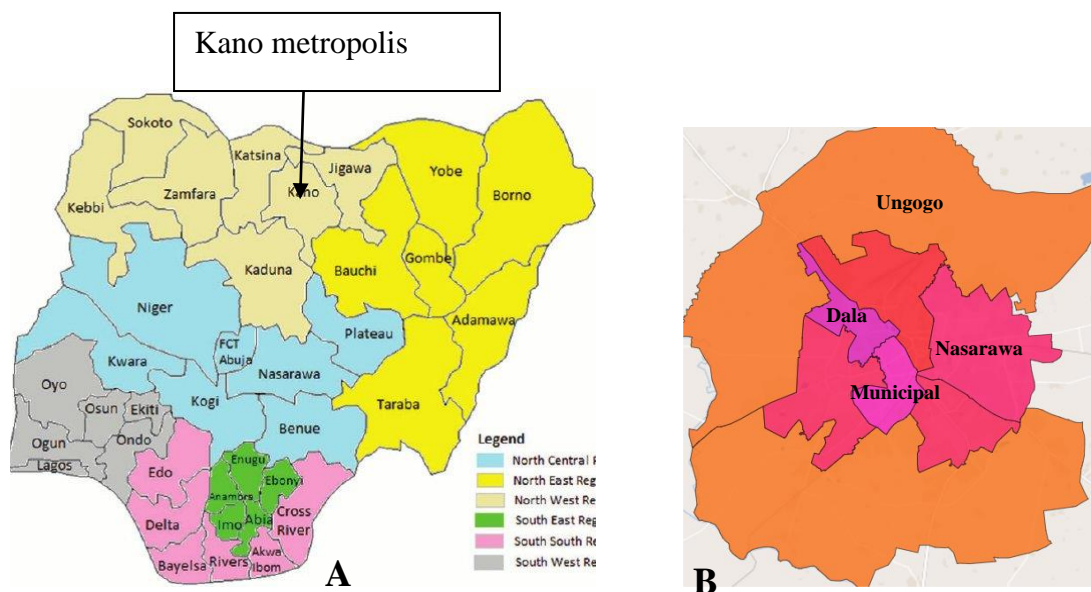


Plate 1: A = Map of Nigeria, B = 4 study local governments in Kano Metro

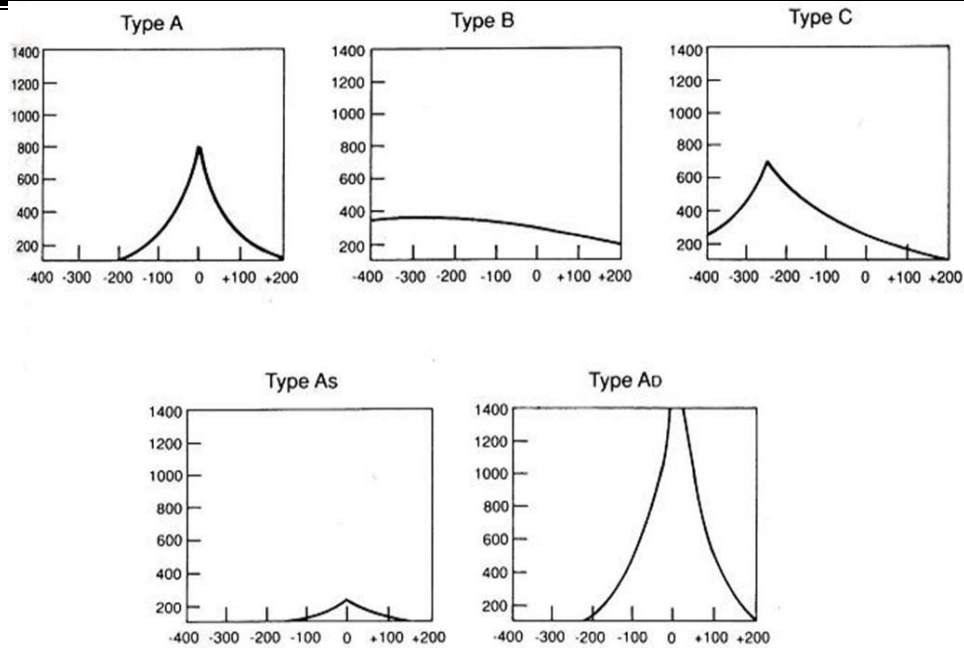


Figure 1: Types of tympanometry. A = Normal, B = Flat, C = Negative, As = Hypo mobile, Ad = Hyper mobile

Repeated measurements were recorded and were used to determine the intra and inter-observer errors using Pearson’s correlation coefficient. Descriptive statistics of the measured variables in the study were presented as mean, standard deviation & standard error. Sexual dimorphism was determined using independent sample t-test. Prevalence of MEE and other middle ear problems was determined using frequency distribution. Subjects with type B (flat tympanogram) were diagnosed with middle ear effusion. All the analyses were done using SPSS IBM version 20.

RESULTS

The intra-observer and inter-observer error estimation results were all greater than 0.85 as shown in Table 1. The mean, standard deviation, standard error of mean of age, height, weight, and other ear parameters of the subjects are presented in Table 2. There was no significant mean difference between males and females in all the measured variables from the independent sample t-test ($P > 0.05$), except for the right ear cavity volume (Rt ECV) which was higher in males than in females ($P < 0.05$).

Table 1: Intra-observer and inter-observer error estimate

Variables	Cronbach’s Alpha	Cronbach’s Alpha
Height	1.00	0.95
Weight	0.94	0.94
MEP	0.97	0.86
SC	0.99	0.99
ECV	1.00	0.90

Table 2: Independent Sample t-test & Descriptive statistics of Age and other measured variables of the subjects.

	Gender	Group Statistics				
		N	Mean	SD	SE Mean	P value
Age (yrs)	M	78	9.64	2.579	.292	0.560
	F	72	9.89	2.609	.307	
Ht m	M	78	1.2681	.16676	.01888	0.407
	F	72	1.2907	.16581	.01954	
Wt (kg)	M	78	25.22	7.784	.881	0.471
	F	72	26.14	7.808	.920	
Lt MEP	M	78	-9.22	53.818	6.133	0.625
	F	72	-13.13	42.318	4.987	
Rt MEP	M	78	-1.97	46.800	5.299	0.552
	F	72	-6.58	47.839	5.638	
Lt SC	M	78	.577	.3618	.0410	0.883
	F	72	.565	.5896	.0695	
Rt SC	M	78	.623	.4348	.0492	0.186
	F	72	.536	.3593	.0423	
Lt ECV	M	78	.858	.2641	.0299	0.506
	F	72	.831	.2311	.0272	
Rt ECV	M	78	1.037	.3204	.0363	0.027
	F	72	.936	.2190	.0258	

Table 3 shows the frequency distribution of the types of tympanometry in the study subjects and the total amount of tympanometry of both left and right ears, and in both male and female subjects was 300. The total amount of left and right ears' tympanometry in both males and females that were normal (type A) was 246 (82%), the remaining 54 (18%) were abnormal. As type A signifies normal middle ear condition, the number of subjects with type A was larger in males especially tympanometry of the right ear (Rt tymp). Similarly, Rt tymp was larger than the Lt tymp in females, and on average, subjects were more with right normal tympanometry in both sexes. The incidence of flat (type B) tympanogram (which signifies middle ear effusion) was found to be 18 (6%), while that of type C tympanogram, which signifies negative middle ear pressure and clinically eustachian tube dysfunction, was found to be 16 (5.4%). Type Ad signifies increased mobility of middle ear system which is usually found in ossicular discontinuity or hyper flaccid tympanic membrane and was 3 (1%), while type As signifies reduced mobility of middle ear system usually found in tympanosclerosis or otosclerosis and was found to be 17 (5.6%).

Table 3: Frequency of the Types of tympanometry in both females and males

Types of tymp	Male		Female		TOTAL
	Lt tymp	Rt tymp	Lt tymp	Rt tymp	
A	53 (17.7%)	60 (20%)	63 (21%)	70 (23.3%)	246 (82%)
Ad	2 (0.7%)	0%	0%	1 (0.3%)	3 (1%)
As	7 (2.3%)	6 (2%)	4 (1.3%)	0%	17 (5.6%)
B	4 (1.3%)	3 (1%)	6 (2%)	5 (1.7%)	18 (6%)
C	6 (2%)	3 (1%)	5 (1.7%)	2 (0.7%)	16 (5.4%)
TOTAL	72	72	78	78	300 (100%)

Table 4 indicates statistically significant ($P < 0.01$) but weak ($r < 0.5$) negative correlations between Age, height, and weight of the female subjects with only right middle ear pressure (Rt MEP) among all the ear parameters measured.

Table 4: Correlation between Age, height, weight, and Ear parameters for the female subjects

		Correlations					
		Lt MEP	Rt MEP	Lt SC	Rt SC	Lt ECV	Rt ECV
Age (yrs)	Pearson Correlation	.022	-.365**	-.078	-.005	-.088	.010
	Sig. (1-tailed)	.426	.001	.258	.484	.232	.468
	N	72	72	72	72	72	72
Ht m	Pearson Correlation	.074	-.404**	-.119	.059	.010	.042
	Sig. (1-tailed)	.269	.000	.159	.310	.465	.363
	N	72	72	72	72	72	72
Wt (kg)	Pearson Correlation	.121	-.350**	.045	.158	-.144	.000
	Sig. (1-tailed)	.156	.001	.352	.093	.114	.499
	N	72	72	72	72	72	72

** . Correlation is significant at the 0.01 level (1-tailed).

* . Correlation is significant at the 0.05 level (1-tailed).

Table 5 indicates statistically significant ($P < 0.01$) but weak ($r < 0.5$) negative correlations between Age, and right middle ear pressure (Rt MEP) of the male subjects. Similarly, it (age) correlates positively with the left and right static compliance of the middle ear measures (Lt SC & Rt SC) with statistical significance ($P < 0.05$). Again, age correlates positively with left middle ear cavity volume (Lt ECV) with statistical significance ($P < 0.01$).

Height of the males also correlated but positively with right static compliance (Rt SC) with statistical significance ($P < 0.05$), while weight correlated with left middle ear cavity volume (Lt ECV) with statistical significance ($P < 0.05$). However, all these correlations were all weak because all the Pearson correlations' r were less than 0.5.

Table 5: Correlation between Age, height, weight, and Ear parameters of male subjects

		Correlations					
		Lt MEP	Rt MEP	Lt SC	Rt SC	Lt ECV	Rt ECV
Age (yrs)	Pearson Correlation	-.138	-.322**	.288*	.254*	.338**	.064
	Sig. (2-tailed)	.231	.004	.011	.025	.002	.581
	N	78	78	78	78	78	78
Ht m	Pearson Correlation	.001	-.222	.190	.253*	.220	.044
	Sig. (2-tailed)	.993	.051	.096	.026	.053	.701
	N	78	78	78	78	78	78
Wt (kg)	Pearson Correlation	-.206	-.204	.107	.106	.241*	.027
	Sig. (2-tailed)	.072	.074	.349	.358	.033	.815
	N	78	78	78	78	78	78

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

The prevalence of middle ear effusion as shown by flat tympanogram (type B) in the present study was found to be lower (1.3% -2%) than reported by other authors. For example, 18.75% in India (R and A, 2009), 8.7% in Istanbul (Gultekin E, Develioğlu ON, Yener M, Ozdemir I, 2009), and 15.5% in Upper Egypt (Saad K, Abdelmoghny A, Abdel-Raheem YF, Gad EF, 2020). The higher values obtained by those authors could be explained by the difference in the geographical location. This is particularly true when similar study was conducted in Nigeria (Kirfi AM, Fufore MB, Quadri OR and OG, 2020) and the prevalence was still found to be lower (3.5%) than found elsewhere although slightly higher than obtained in the present study. It has been established that type B tympanogram is much more common in lower age children (ZIELHUIS *et al.*, 1990, Saim *et al.*, 1997).

The middle ear pressure was higher in the right as compared to the left ears, whereas right ear canal volume (ECV) was higher than that of the left, with significant differences ($P < 0.05$). However, the right and left ears had the same static compliance in both sexes. These results agreed with the findings of Kei *et al.*, 2003 (Kei *et al.*, 2003) who equally found statistically significant difference between right and left middle ear pressures and ear canal volumes. This means that the effects of genes on either side of the ears during ear ontogeny may likely be different especially for the canal volume and pressure but not for the static compliance. To buttress this, no significant difference was found between right and left static compliance in the present study and that of others (Tos, Poulsen and Borch, 1978).

The middle ear pressure (MEP), the ear canal volume (ECV) and static compliance (SC) for male subjects were higher than that found in female subjects in this study. These sexually dimorphic results were same to the results found by Omar, 2000. The similarity between this and that of Omar indicates that there is an element of influence of Y-chromosome on the ear morphological development.

The middle ear pressure, ear canal volume and static compliance of the studied subjects in the present study, irrespective of sex and sides, were similar to those of the Caucasians (Jonge, 1986, Palmu *et al.*, 2001, Kei *et al.*, 2003). This indicates that age, sex, and side to some extent (as seen above) rather than race play an important role in the overall tympanometry. In male subjects, age correlated negatively with right middle ear pressure, positively with left & right static compliance as well as left ear cavity volume with statistical significance ($p < 0.001$). However, this correlation is surprising since several body forms change with age including the ear (Hall and Weaver, 1979, Sogebi, 2015, Sogebi *et al.*, 2017). The fact that height correlated positively with right static compliance and weight with left ear cavity volume with statistical significance in the male subjects in the current study may not be unconnected to the effect of growth hormone on the ear development similar to the effects of the hormone on the height and weight. In female subjects, age, height and weight correlated negatively with right middle ear pressure with statistical significance ($p < 0.001$) in this study, which is in keeping with the other studies (Bylander and Tjernström, 1983, Hall, 1979, Shirejini *et al.*, 2018). It can therefore clearly be conclusive that age, sex, and side are correlates of tympanometry but as seen in this study and others (Shahnaz and Davies, 2006).

CONCLUSION

The prevalence of undiagnosed middle ear effusion among school-aged children in Kano metropolis was found to be 6%, which is a source of concern considering the health implication of the condition. Other middle ear problems such as osteosclerosis of the middle ear ossicles and negative middle ear pressure were all source of concern based on their prevalence in this study.

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