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Sociodemographic characteristics and prevalence of otitis media among children under five years of age attending selected primary healthcare facilities in Calabar, Nigeria

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Abstract

Otitis media (OM) is the second most common disease of early childhood and an important cause of preventable hearing loss, poor intellectual performance and language development in children. This study investigated the microbial etiology, socio-demographic variables, and prevalence of otitis media among children- under 5 years of age- attending selected primary healthcare facilities in Calabar, Nigeria. Following administration of a structured questionnaire, ear swabs were collected from a total of 60 participants and processed using standard microbiological methods for isolation and identification of pathogens. Antibiotic susceptibility testing was carried out on bacterial isolates using Kirby-Bauer disc diffusion method. The prevalence of OM was 63.3%, with *Staphylococcus aureus* (76.3%) as the predominant pathogen, followed by *Pseudomonas aeruginosa* (15.8%), *Escherichia coli* (5.3%) and *Candida albicans* (2.6%). A higher prevalence of infection was found among male subjects (65.4%) than the females (61.8%). Subjects aged 2-3 years had the highest prevalence of infection (71.4%), followed by those aged <2 years old (69.1%), while those aged 4-5 years had the least (30%). The prevalence of the disease was significantly associated with the subjects' exposure to dusty environments (P=0.042), attendance of crèche/daycare facilities (P=0.047), and symptom of ear discharge (P=0.038). The high susceptibility of the bacterial isolates to meropenem, ceftriaxone and ciprofloxacin in this study may underscore the drugs' value as antibiotics of choice for prompt treatment of OM

in the population. Due diligence for care and protection of children from overcrowding, dust and poor hygienic conditions often associated with substandard daycare centers would likely reduce the burden of OM in the population.

Keywords: Otitis media, prevalence, socio-demographic variables, children under 5 years

Introduction

Otitis media (OM) is an inflammatory disease of the middle ear, with or without reference to microbial etiology. The disease is typically classified into acute otitis media (AOM), otitis media with effusion (OME), and chronic suppurative otitis media (CSOM) (Bluestone and Klein, 2007). Although OM can occur at any age, 80-90% of cases occur in children younger than 6 years (Waseem, 2020). Worldwide, AOM affects about 11% of people a year (Barber *et al.*, 2015), but half of the cases involve children less than five years of age (Taylor *et al.*, 2012). Children between the ages of 3 months and 3 years are known to be more vulnerable to OM because their Eustachian tube is immature and typically short, straight, wide and prone to infections (Taylor *et al.*, 2012). Additionally, underdeveloped or impaired immune system of infants may be involved in the development of AOM (Jamal *et al.*, 2022).

Whereas OME is a chronic condition characterized by the presence of non-infectious fluid in the middle ear, with symptoms of hearing loss that may lead to speech delay and poor educational development of children, it often

occurs following an episode of AOM (Van zon *et al.*, 2012; Minovi and Dazert, 2014). Similarly, CSOM usually occurs as a complication of AOM with perforation of the ear drum and presence of recurrent or persistent infectious discharge that often leads to hearing loss and speech impairment (Minovi and Dazert, 2014; Digna *et al.*, 2023).

Otitis media is frequently caused by bacteria, and sometimes viruses or fungi, following upper respiratory tract infections. It is thought that viral infections of the nasopharynx create an environment that promotes bacterial colonization, adhesion to cells and invasion of the middle ear (Massa *et al.*, 2015). Abnormalities in the physiologic function of the Eustachian mucosa, including ciliary dysfunction and edema, increase the risk of bacterial invasion of the middle ear and the resultant otitis media with effusion (Waseem, 2020).

Socio-demographic profiles of parents are often linked to environmental factors that may increase the risk of OM among children. In Nigeria, OM has been reported to be more prevalent among children exposed to overcrowding, poor sanitation and other deplorable living conditions often linked to parents with lower educational and socioeconomic status (Amusa *et al.*, 2005). This study investigated the socio-demographic variables, microbial etiology and prevalence of otitis media among children under 5 years of age in Calabar, Nigeria.

Materials and methods

This cross-sectional study was carried out between April and December 2022 in Calabar, a densely populated capital of Cross River state, Nigeria. The study participants were children within five years of age, who presented with fever and/or ear discharge at selected primary healthcare facilities in different segments of Calabar. A nonprobability (convenience) sampling technique was used. A total of 60 participants were enlisted into the study, following submission of a signed, thumb-printed or written informed consent by their parents or guardian. The parents or guardians were clearly informed of the purpose and potential benefits of the study, with firm guarantee to maintain the

participants' information with strict confidentiality for the research purpose only. Ethical clearance for the study was sought and obtained from the Ethical Committee of Cross River State Ministry of Health, Calabar, while permission for access of each facility was also obtained from the Facility's management.

Administration of questionnaire

A structured questionnaire entitled, "Socio-demographic variables of children with otitis media", was administered to a parent or guardian of each participant. The variables addressed were socio-demographic data including age, gender, parents' occupation and educational level, type of residence, family size, breastfeeding and other child's feeding methods, attendance of daycare centers or schools, environmental exposures, etc.

Collection and processing of specimens

Ear swabs were collected by the consulting Medical Officers in the clinic using a sterile swab stick. Prior to collecting the samples, a sterile pipette was used to aspirate any ear drainage to avoid stirring the discharge. The specimens were placed into an Amies transport medium and transported to the microbiology laboratory for processing within an hour of collection.

Ear swabs were inoculated onto bacteriological media including chocolate agar, blood agar, cysteine lactose electrolyte deficient agar (CLED) and Sabouraud dextrose agar. The inoculated plates were incubated at 37°C in a 5-10% carbon dioxide enriched atmosphere and examined for growth of bacteria after 24-48 hours' incubation. The isolates were identified by conventional bacteriological and biochemical procedures.

Antimicrobial susceptibility testing of bacterial isolates

Antimicrobial susceptibility test was carried out on each bacterial isolate using the disk diffusion method on nutrient agar plates. Three to five pure colonies of each bacterium were picked and transferred to a tube containing 5ml sterile peptone water. The preparations were mixed thoroughly to make a homogenous suspension.

The bacterial suspension was incubated at 37 °C until its turbidity matched the opacity of 0.5 McFarland Standard (equivalent to bacterial concentration of 1.5×10^8 colony forming unit/ml). A sterile swab was dipped in the suspension and used to inoculate nutrient agar plates by spreading it uniformly on the agar surface and allowed to dry for about 15-30 minutes. Commercially available antibiotic susceptibility test discs were placed on the inoculated plates using sterile forceps, with adequate spacing (at least 24 mm) between discs to avoid overlapping zones of inhibition. The antibiotics used included Meropenem (10µg), Erythromycin (15µg), azithromycin (30µg), Ciprofloxacin (5µg), Gentamicin (10µg), Ceftriaxone (30µg), and Ceftazidime (30µg). The plates were allowed to dry at room temperature for 30 minutes, then incubated overnight at 37°C, and examined for zones of inhibition. Susceptibility patterns were interpreted by comparison of the zones of inhibition according to Clinical and Laboratory Standards Institute guidelines (CLSI, 2018).

Data analysis

The data obtained in this study were analyzed using IBM SPSS Statistics 20 computer software (SPSS for Windows 20.0; SPSS Inc, Chicago, Illinois). Proportions were presented in frequencies and percentages. Pearson's chi-square analysis was used to test the statistical significance of bacterial etiology, demographic variables and clinical symptoms on the prevalence of otitis media. P-values were set at 0.05 level of significance.

Results

Prevalence of otitis media among the study participants

The prevalence of OM among the study participants was 63.3% (Table 1). The highest prevalence by the age of the participants was found in those aged 2-3yrs (71.4%), followed by those <2yrs old (69.1%), and those aged 4-5yrs (30%). Association between age and the

prevalence of OM was not statistically significant ($P=0.457$). The prevalence of infection was found to be slightly higher in males (65.4%) than the females (61.8%). There was no significant association between gender and occurrence of otitis media in the study population ($P=0.891$).

Microbial etiology of otitis media in the study population

Only 38 (63.3%) of the 60 ear swabs analyzed in this study yielded growth of pathogens, consisting of 3 genera of bacteria- *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, and a fungus- *Candida albicans* (Table 2). The predominant etiologic agent of OM was *Staphylococcus aureus* (76.3%), followed by *Pseudomonas aeruginosa* (15.8%), *Escherichia coli* (5.3%) and *Candida albicans* (2.6%). Whereas bacterial pathogens accounted for 98.3% of the infections, fungal pathogens contributed only 1.7%. Occurrence of OM in the population was significantly associated with bacterial pathogens ($P=0.001$).

Antibiotic susceptibility patterns of bacterial isolates

As shown in Table 3, *Staphylococcus aureus* isolates were highly susceptible to Meropenem (82.7%), Erythromycin (79.3%) and Ciprofloxacin (79.3%), but showed modest sensitivity to Ceftriaxone (68.9%) and Ceftazidime (65.5%). The isolates were more resistant to gentamicin (65.5%). followed by Ceftriaxone (31%) and then Ceftazidime (24.1%). *Pseudomonas aeruginosa* isolates were highly susceptible to Ceftriaxone (83.3%) and Meropenem (66.6%). The isolates showed high resistance to erythromycin (83.3%) and gentamicin (66.7%). Isolates of *Escherichia coli* were completely susceptible to Meropenem (100%) and Ceftriaxone (100%), but conversely showed total resistance to erythromycin (100%). The isolates were moderately resistant to Ciprofloxacin (50%) and Gentamicin (50%).

Table 1: Prevalence of OM among the participants

Variables	No. tested	No. infected	Prevalence (%)	P-value
Age (years)				
<2	29	20	68.9	0.457
2-3	21	15	71.4	
4-5	10	3	30.0	
Gender				
Male	26	17	65.4	0.891
Female	34	21	61.8	
Total	60	38	63.3	

Table 2: Microbial etiology of OM among the participants

Pathogens	No. isolated (%)	P-value
<i>Staphylococcus aureus</i>	29 (76.3)	0.001
<i>Pseudomonas aeruginosa</i>	6 (15.8)	
<i>Escherichia coli</i>	2 (5.3)	
<i>Candida albicans</i>	1 (2.6)	

Table 3: Antibiotic susceptibility patterns of bacterial isolates to commonly used antibiotics

Pathogen	Status	Number of isolates (%)						
		*CRO	AZI	CAZ	MEM	ERY	CIP	GEN
<i>S. aureus</i> (n=29)	Sensitive	20(68.9)	23(79.3)	19(65.5)	24(82.8)	5(17.2)	23(79.4)	4(13.8)
	Resistant	9(31.1)	6(20.7)	10(34.5)	5(17.2)	24(82.8)	6(34.6)	25(86.2)
<i>P. aeruginosa</i> (n=6)	Sensitive	5(83.3)	2(33.3)	3(50)	4(66.7)	0(0)	3(50)	2(33.3)
	Resistant	1(16.7)	4(66.7)	3(50)	2(33.3)	6(100)	3(50)	4(66.7)
<i>E. coli</i> (n=2)	Sensitive	2(100)	1(50)	1(50)	2(100)	0(0)	2(100)	1(50)
	Resistant	0(0)	1(50)	1(50)	0(0)	2(100)	0(0)	1(50)

* CRO- Ceftriaxone, AZI=Azithromycin, CAZ - Ceftazidime, MEM - Meropenem, ERY=Erythromycin, CIP=Ciprofloxacin and GEN=Gentamicin

Prevalence of OM based on clinical symptoms and demographic characteristics of the participants

The prevalence of OM based on socio-demographic characteristics of the participants is shown in Table 4. The highest prevalence of OM by educational status of the parents was found among subjects whose parents had no formal education (88%), followed by those who attained only primary education (67%), with the disease prevalence gradually decreasing with

increasing level of education. However, the educational status of parents had no significant association with the prevalence of OM among the study subjects (P=0.762).

In relation to living conditions of the participants, the highest prevalence of OM was found among subjects who live in single room apartments (72%), compared to those that occupy larger apartments. There was no significant association

between the type of residential apartments and the prevalence of OM among the participants (P=0.743). Similarly, the highest prevalence of OM was found among those with large family size numbering up to ten (100%), while the lowest was seen in those having 1-3 number of house occupants (31%). There was no significant association between the number of house occupants and the occurrence of otitis media among the study participants (P=0.455).

A high prevalence of OM was found among participants who attended daycare centers (78%), compared with those who were not enrolled in such facilities (42%). Similarly, the prevalence of infection was higher among children who had exposure to environmental dust or smoke (84%) compared to others without such exposures (39%). The prevalence of OM among the participants was significantly associated with

attendance at daycare centers (P=0.047), and exposure to dusty environment (P=0.042).

Subjects who were weaned with bottle feeders had a higher prevalence of OM (80%) than those who used oral suckers (62%), but, no correlation was found between the disease occurrence and the weaning formulary of the subjects (P=0.721).

Even though a higher prevalence of OM was found among subjects who had exposure to tobacco smoke (87%), compared to others without such exposure (55%), there was no significant association between the incidence of OM and exposure to tobacco smoke (P=0.09)

Based on clinical symptoms, subjects who had fever symptoms were found with a higher prevalence of OM (69%) compared to those with no symptom of fever (54%).

Table 4: Prevalence of OM based on clinical symptoms and demographic variables of the study participants

Variables	No. of subjects	No. (%) infected	P-value
Demographics			
Parents' educational status			
• No formal education	8	7 (87.5)	0.762
• Primary	24	16 (66.7)	
• Secondary	18	10 (55.5)	
• Tertiary	10	5 (50.0)	
Residential apartments			
• Single room	18	13 (72.2)	0.743
• Self-contained room	28	19 (67.8)	
• 1-bedroom flat	10	4 (40.0)	
• 2 or more bedrooms flat	4	2 (50.0)	
Family size			
•	13	4 (30.8)	0.455
• 4-6	40	26 (65.0)	
• 7-9	10	7 (70.0)	
•	1	1 (100)	
Attendance of crèche or daycare facility			
• Yes	36	28 (77.8)	*0.047
• No	24	10 (41.7)	
Exposure to dust or smoke			
• Yes	32	27 (84.4)	*0.042
• No	28	11 (39.3)	

Child's weaning method			
• Bottle feeder	55	34 (61.8)	0.721
• Use of sucker	5	4 (80.0)	
Exposure to tobacco smoke			
• Yes	15	13 (86.7)	0.095
• No	45	25 (55.6)	
Clinical symptoms			
Fever			
• Yes	36	25 (69.4)	0.467
• No	24	13 (54.2)	
Ear discharge			
• Yes	45	34 (75.6)	*0.038
• No	15	4 (26.7)	

***Significant at P 0.05**

Association between symptoms of fever and occurrence of otitis media was not statistically significant (P=0.467). However, the prevalence of OM was significantly associated with occurrence of ear discharge among the participants (P=0.038). The prevalence of the disease was found to be higher among subjects with ear discharge (76%) than those with no discharge (27%).

Discussion

Otitis media is a common infectious disease and frequent cause of emergency visits to hospitals among children in Nigeria (Idowu *et al.*, 2011). Children are known to be more vulnerable to OM due to the fact that their Eustachian tube is shorter with more flaccid cartilage which often impairs its opening, leading to ear infections (Goulioumis *et al.*, 2022). This study investigated the microbial etiology, risk factors, and prevalence of OM among children under the age of five years in the study area. The prevalence of OM- linked to microbial etiology- among the study participants was 63.3%, lower than the 72.9% rate previously reported from a similar study which included subjects of all ages in the same locality (Umoh *et al.*, 2023). This finding was rather surprising considering that the study participants were only children under 5 years of age, known to be most vulnerable to the disease, compared with other age groups. In comparison, a similar study previously carried out in Benin City, Nigeria, had reported a higher prevalence of 84.6% in the study population (Ogbogu *et al.*, 2013). Nevertheless, the relative lower prevalence rate of OM in this study may be attributed to inclusion of participants with no ear effusion, compared with the previous studies that strictly enlisted only subjects with symptoms of ear drainage or discharge.

Consistent with this fact, the prevalence of OM in this study was found to be significantly associated with symptoms of ear discharge among the participants (P= 0.04), in contrast to those who presented with only fever symptoms.

This study, however, found the highest prevalence of infection among subjects aged 2-3years (71.4%) amid other children under the age of 5 years. This finding is consistent with the fact that most cases of OM are known to occur in children between the ages of 6 months and 3yrs (Meherali *et al.*, 2019). Nonetheless, there was no significant association between the prevalence of OM and age of the participants in this study. Similarly, gender influence on the prevalence of infection was statistically insignificant, even though the disease was found in more males (65.4%) than the females (61.8%). In contrast, however, some studies carried out in Nigeria have reported higher prevalence of OM in females than males (Baraibar, 1997; Amusa *et al.*, 2005; Bendetal *et al.*, 2007). Variations in gender-based prevalence of OM in diverse epidemiological settings may be related to peculiar population dynamics that often expose one gender, than the other, to more environmental risks.

Several environmental factors including, but not limited to, poor and inadequate living apartments, overcrowding, poor sanitary conditions and indiscriminate playing habits of children have been adduced for the vulnerability of children to OM at their tender age, besides some recurring infections like measles that may affect the nasopharynx from where pathogens enter the middle ear (Waseem, 2020). In this study, a higher prevalence of infection was found among subjects who were cohorts of daycare facilities or exposed to dusty/smoky environments, compared to those without such exposures. The prevalence of OM among the participants correlated significantly with exposures of children to daycare facilities and environmental dusts, respectively. These findings may be consistent with the fact that daycare facilities, particularly substandard centers, are usually associated with overcrowding, poor sanitary conditions, negligence of care, and transmission of infectious diseases among children.

Evaluation of the microbial etiology of OM in this study yielded only three bacterial species including *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, and a fungal species, *Candida albicans*. By far, *S. aureus* was the predominant pathogen of OM among the participants, remotely followed by *P. aeruginosa*, *Escherichia coli* and *Candida albicans*, in descending order of prevalence. This finding contrasted with the report of a recent study that found *P. aeruginosa* as the most predominant pathogen of OM in this study area (Umoh *et al.*, 2023). Many studies, however, have reported *P. aeruginosa* and *S. aureus* among the most common agents of OM in Nigeria and elsewhere in Sub-Saharan Africa (Hailu *et al.*, 2016; Osazuwa *et al.*, 2016; Tesfa, *et al.*, 2020; Atta & Umar, 2021).

In spite of the variable susceptibility profiles of the bacterial pathogens to antibiotic drugs used in this study, meropenem, ceftriaxone, and ciprofloxacin showed the best activity against the isolates, including the predominant pathogen. The excellent activity of these drugs, particularly ciprofloxacin, against these pathogens, has been variously documented.

Limitation

Regrettably, due to limited resource, this study could not evaluate the susceptibility of the fungal isolates to antifungal drugs. Recent

epidemiological data worldwide have highlighted the emergence of fungal diseases that are increasingly resistant to standard antifungal treatments (Kainz *et al.*, 2020). Future studies on microbial etiology of OM in the population should include evaluation of fungal isolates for resistance to antifungal drugs.

Conclusion

The prevalence of OM was 63.3%, with *Staphylococcus aureus* as the most common etiologic agent of the disease in the study population. The prevalence of the disease correlated significantly with attendance of daycare facilities and exposure to dusty environments. The high susceptibility of the bacterial pathogens to meropenem, ciprofloxacin and ceftriaxone, found in this study, may underscore their value as antibiotic drugs of choice for prompt treatment of OM in the population. Due diligence for care and protection of infants against overcrowding, dusty environments, and other poor sanitary conditions often associated with daycare facilities, particularly the substandard centers, would likely reduce the burden of OM among children in the population.

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Competing interests

None declared by the authors

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