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ORIGINAL ARTICLE

## Epidemiology of acute otitis media among young children: A multiple database study in Taiwan

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### KEYWORDS

Children;  
Epidemiology;  
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*Background/Purpose:* Acute otitis media (AOM) is a common complication of upper respiratory tract infection (URTI) among children. The purpose of this study was to evaluate the epidemiology of AOM among young children in Taiwan, including the age incidence and seasonality by combining multiple databases.

*Methods:* Two country-based questionnaire survey studies had been conducted to evaluate the experience of otitis media (OM) among young children: one in 2007 and the other between 2005 and 2010. The number of OM cases (5% of population younger than 7 years) in 2005 and annual visiting rates for URTI from 2005 to 2010 obtained from the National Health Insurance Research Database of Taiwan were collected and comprised the third database. The fourth database comprised ambulatory visits of children with OM to a medical center in central Taiwan between 2005 and 2010.

*Results:* Data from a total of 1099 questionnaires were entered into Database I in 2007, and data from 9705 questionnaires between 2005 and 2010 comprised Database II. There were 86,702 children (younger than 7 years, representing 5% of the whole population for this age group) retrieved from Database III in 2007, and 5,904 cases of OM in children between 2005 and 2010 in a hospital. In Database I, 7.46% children experienced at least one episode of AOM compared with 9.21% in Database II for children aged 5 years and younger. In Database III, 13.2% children younger than 7 years had AOM in 2005. The peak season of AOM among children was from March to May (Databases III and IV).

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*Conclusion:* AOM was thought to be a very common disease among children; however, this comparative analysis showed that the overall prevalence of AOM among children younger than 5 years was only 20%, much lower than in other countries. AOM was more prevalent during the spring season, and still was similarly common after age 2 years.

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## Introduction

Acute otitis media (AOM) is a common complication usually following upper respiratory tract infection (URTI) during early childhood. It is also the most common reason for prescribing antibiotics for children.<sup>1,2</sup> It was estimated that the expenditure on otitis media (OM) per year in the United States was 2.8 billion US dollars, with the mean cost per child in 2006 being 350 US dollars.<sup>3</sup> There is little information about the true picture of OM in Taiwan. OM may further lead to more complications if left untreated, such as mastoiditis, hearing loss, sepsis, meningitis, brain abscess, and subdural empyema.<sup>4–6</sup> Teele et al conducted a prospective, cohort study in 1989 and estimated that 62% of children had a least of one episode of AOM by age 1 year, and up to 83% by age 3 years.<sup>7</sup> Recent studies from several other countries, however, have shown much lower incidence of AOM.<sup>8</sup> Wang et al, using the National Health Insurance (NHI) claims database of Taiwan, estimated that the age-specific annual incidence of OM was 71.7 per 1000 children aged <2 years, and 158.8 per 1000 3- to 5-year-olds, and 4.0 per 1000 children aged 6 to 12 years.<sup>9</sup> These data show a quite different incidence of OM among children in Taiwan as compared with other countries.

A few studies have tried to evaluate the prevalence and incidence of AOM in Taiwan. One study surveyed the incidence OM in kindergartens from May to July on 2001,<sup>10</sup> while another focused on the incidence at any age and the management of different medical specialties in giving a diagnosis of OM.<sup>9</sup> The purpose of this study was to evaluate the prevalence and incidence of OM, and the epidemiological pattern of OM among young children, and to compare the differences of the epidemiology of OM with previous survey studies in Taiwan.

## Methods

### Database I

A questionnaire-based survey was conducted in a pediatric outpatient setting in five medical centers in Taiwan (National Taiwan University Hospital, Taipei; Chang Gung Memorial Hospital, Taoyuan; Taichung Veterans General Hospital, Taichung; Chang Gung Memorial Hospital, Kaohsiung; and Tzu Chi General Hospital, Hualien) from January to June 2007. The patients' parents were requested to answer a predesigned questionnaire after the purpose of the study was explained to them and written informed consent had been obtained. The case numbers enrolled from each region were predetermined by assessing the

percentage of children of each region, and a total of 1200 children and questionnaires were required so that the total number comprised 0.1% of the pediatric population younger than 5 years in 2006 (approximately 1,290,000 persons, according to the data of the Ministry of the Interior, Taiwan). They were divided into 4 groups, according to the place of residence (40% from north Taiwan, 30% from central Taiwan, 25% from south Taiwan, and 5% from east Taiwan).

### Database II

From July 2005 to December 2010, young children, aged between 2 months and 5 years, who visited a well-child or general pediatric outpatient clinic at one of three medical centers in different regions in Taiwan (Chang Gung Memorial Hospital, Taoyuan; Taichung Veterans General Hospital, Taichung; and Chang Gung Memorial Hospital, Kaohsiung) were invited to participate in this study. Subjects were stratified equally into seven age groups in each hospital: >6 months, 6–12 months, 12–18 months, 18–24 months, 2–3 years, 3–4 years, and 4–5 years. Children with underlying medical conditions, including chronic renal failure, dialysis, nephritic syndrome, indwelling devices, thalassemia major, chronic cardiovascular diseases, chronic lung disease, liver cirrhosis, diabetes mellitus, congenital immunodeficiency, human immunodeficiency virus infection, asplenia, and malignancy, or receiving immunosuppressant agents were excluded.

In Database I, the patients' basic demographic data were collected and parents were asked whether their child had any history of AOM and, if so, how frequent the episodes were. In Database II, which covered 5.5 years, caregivers were asked whether the patient had any history of AOM, and were whether nasopharyngeal bacterial carriage survey studies had been performed.

### Database III

We used a representative database extracted randomly from the entire NHI Research Database (NHIRD) in Taiwan was used as the third database in this study. The database included approximately 5% of Taiwan's young children population aged up to 7 years. Claims data were retrieved from patients aged <7 years with a diagnosis of AOM or OM [International Classification of Diseases, Ninth Revision, Clinical Modification codes (ICD-9-CM): 381.00–381.06, 381.4, 382.00–382.02, 382.4, 382.9] from January to December 2005. Each person in the database was deemed to be with or without OM in 2005, even for patients who may have made multiple visits for OM. Statistical data from

Taiwan's NHI including URTIs (ICD-9-CM: 463–464) and other acute URTIs (ICD-9-CM: 460–462,465) obtained from the Department of Health were also used for comparison.

#### Database IV

This was a retrospective cross-sectional descriptive study of children aged <7 years at ambulatory visits to Taichung Veterans General Hospital from January 2005 to December 2010 with a primary or secondary diagnosis of AOM or OM (ICD-9-CM: 381.00–381.06, 381.4, 382.00–382.02, 382.4, 382.9).

#### Statistical analysis

All statistical analyses in this study were performed using the SPSS version 11 (SPSS Inc., Chicago, IL, USA). Differences between groups were analyzed by Chi-square test. A *p* value of <0.05 was considered to be significant.

#### Results

In Database I, a total of 1099 questionnaires for children younger than 5 years were completed from January to June 2007. The demographic data and experience of OM are summarized in Table 1. Forty-four boys (7.91%) and 38 girls (7.25%) had experience of AOM. Among the 1099 children younger than 5 years, 82 (7.46%) had experienced at least one episode of AOM. By age 5 years, 20.17% of the children had suffered at least one episode of AOM. The prevalence of AOM differed according to region, with 10.16% of the studied children in north Taiwan, 5.41% in central Taiwan, 4.31% in south Taiwan, and 13.33% in east Taiwan. There was a higher prevalence of AOM among children in east Taiwan compared with rates in other regions. Among

children who had experienced AOM, 55 (67%) experienced only one episode of AOM, while 14 (17%) had two episodes, and 13 children (16%) had more than two episodes.

In Database II, a total of 9705 questionnaires were completed from July 2005 to December 2010 for children aged between 2 months and 5 years. The demographic data and experience of OM are summarized in Table 1. There were 516 boys (9.78%) and 378 girls (8.53%) with experience of AOM. There were 894 children (9.21%) who had experienced at least one episode of AOM. By the age of 5 years, 20.37% of these children had experienced AOM. The prevalence of AOM also was different among regions: 10.24% in north Taiwan, 6.36% in central Taiwan, and 10.91% in south Taiwan.

In Database III, there were 86,702 children, which included 45,420 boys and 41,282 girls aged younger than 7 years in 2005. A total of 6326 boys (15.2%) and 5157 girls (13.5%) had OM in 2005 (Table 2). Boys had a significantly greater prevalence of OM (*p* < 0.001). Three percent of babies had suffered from OM by the age 1 year. Children aged between 1 and 5 years experienced approximate prevalence of OM (14.9–17.8%) at each age from 1 through 5 years old (Table 2). The peak season of AOM was observed during March to May (Fig. 1).

In Database IV, there were 5904 children, and 42.6% of them were girls. Children aged between 4 and 5 years had more ambulatory visits for AOM (Table 2). The peak season of AOM was in spring, which was the same as that observed in Database III (Fig. 1).

#### Discussion

AOM is a common respiratory disease among young children, and requires the initiation of antimicrobial therapy. Previous studies have shown a high prevalence of AOM among young children. The 7-valent pneumococcal

**Table 1** Demographic data of children with acute otitis media (AOM) in 2007 (Database I) and from 2005 to 2010 (Database II)

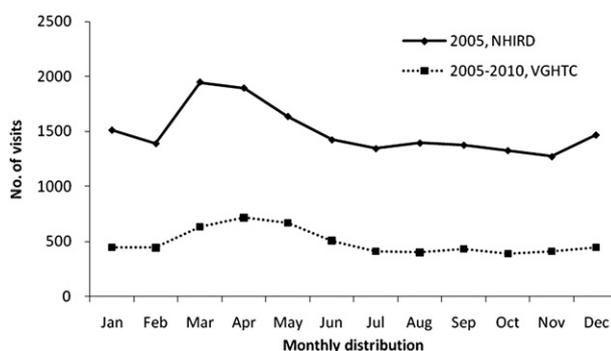
Characteristic	Database I		Database II	
	No. of patients	AOM-experience No. of patients (%)	No. of patients	AOM-experience No. of patients (%)
Sex				
Boys	556	44 (7.91%)	5276	516 (9.78%)
Girls	524	38 (7.25%)	4429	378 (8.53%)
Age (years)				
<0.5	105	0 (0%)	1371	8 (0.58%)
0.5–1	147	5 (3.40%)	1418	31 (2.19%)
1–2	345	17 (4.93%)	2763	220 (7.96%)
2–3	237	22 (9.28%)	1415	159 (11.24%)
3–4	146	14 (9.59%)	1378	199 (14.44%)
4–5	119	24 (20.17%)	1360	277 (20.37%)
Region				
North Taiwan	433	44 (10.16%)	3281	336 (10.24%)
Central Taiwan	351	19 (5.41%)	3144	200 (6.36%)
South Taiwan	255	11 (4.31%)	3280	358 (10.91%)
East Taiwan	60	8 (13.33%)	—	—
Total	1099	82 (7.46%)	9705	894 (9.21%)

**Table 2** Demographic data of children with acute otitis media (OM) in 2005 in National Health Insurance Research Database (database III) and from 2005 to 2010 in Veterans General Hospital, Taichung (database IV)

Characteristic	Database III		Database IV
	No. of subjects	No. of patients with OM (%)	No. of patients with OM
<b>Sex</b>			
Boys	45,420	6326 (13.9%)	3352
Girls	41,282	5157 (12.5%)	2552
<b>Age (years)</b>			
<0.5	8417	251 (3.0%)	76
0.5–1	9357	1522 (16.3%)	731
1–2	9898	1605 (16.2%)	864
2–3			
3–4	10,529	1570 (14.9%)	734
4–5	11,143	1987 (17.8%)	1028
5–6	13,215	2078 (15.7%)	1157
6–7	12,423	1482 (11.9%)	806
7–8	11,720	988 (8.4%)	508
Total	86,702	11,483 (13.2%)	5904

conjugate vaccine (PCV7) has demonstrated some efficacy in preventing OM.<sup>11,12</sup> However, the incidence of OM remains high. In 2008/2009 (8 years since PCV-7 was introduced in Canada), it was still estimated that 50% of Canadian children had at least one OM episode by the age of 3 years.<sup>13</sup>

To elucidate the true incidence and prevalence of OM in Taiwan, we combined and compared multiple databases. The potential confounding factors of OM, including age, gender, seasonality, multiple outpatient visits, and hospital-based and nonhospital-based pediatric populations, were evaluated. This study showed that the incidence of OM among young children in Taiwan was much lower than those in Europe and America (Table 2).<sup>7,13–15</sup> The two questionnaire studies revealed that only 20% of children suffered OM by the age of 5 years. A cross-sectional study in Taiwan in 2001 showed that the prevalence of OM among 3013 children (aged 3–6 years) among

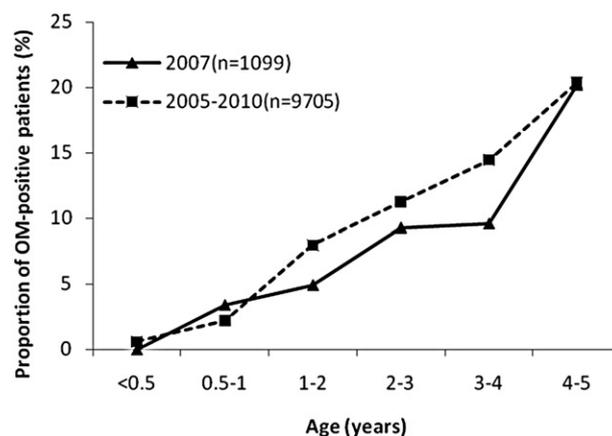


**Figure 1.** Monthly distribution of acute otitis media among children in 2005 by National Health Insurance Research Database (NHIRD) and in Veterans General Hospital, Taichung (VGHTC) from 2005 to 2010.

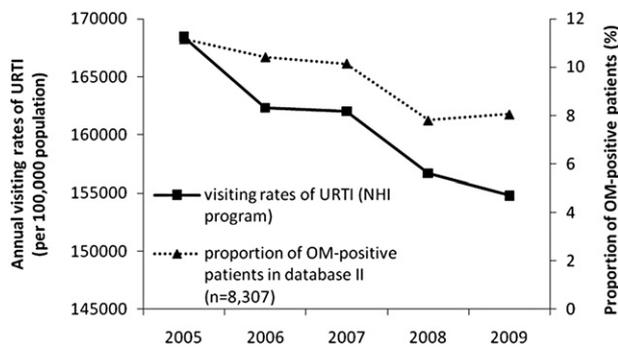
19 kindergartens in Kaohsiung was 9.82%.<sup>10</sup> However, this cross-sectional survey, due to the nature of the study design, only revealed the incidence at that time. Many studies have demonstrated that the incidence of OM among children peaked before the age of 2 years.<sup>7,15–17</sup> The easy accessibility of medical care in Taiwan, due to the NHI program, can wrongly indicate a high incidence of AOM due to multiple clinical visits. The NHIRD data revealed that children aged 1 to 7 years experienced a similar rate of OM among each age group (Table 2). Another study in Taiwan demonstrated that a peak age incidence of AOM among children was 3 to 5 years.<sup>9</sup> The two questionnaire studies showed that most of children in Taiwan had their first AOM episode after infancy (Fig. 2). However, it did demonstrate the peak age of AOM was those aged 1 to 2 years among children in Taiwan, and was compatible with the other studies.

Invasive pneumococcal disease (IPD) was enrolled into the National Notifiable Disease Surveillance System in 2008, and this surveillance and the study of Hsieh et al showed the peak age of IPD among children were those aged 2 to 4 years.<sup>18</sup> The peak incidence of IPD and OM in Taiwan was among children aged between 2 and 5 years old, and it was quite different from that in other countries. Chiou (1998) collected 2905 nasopharyngeal (NP) swabs from children attending day-care centers, kindergartens, and outpatient clinics in south Taiwan, and showed a 21% NP carriage rate of *Streptococcus pneumoniae*.<sup>19</sup> An island-wide prospective surveillance study during 2005 to 2010<sup>20</sup> demonstrated a 12.8% NP carriage rates of *S. pneumoniae* among children younger than 2 years old, compared with a higher NP carriage of 19% among children aged 2 to 5 years old.<sup>20</sup> Some studies have demonstrated a positive relationship between the bacteriology of NP carriage, AOM and the crowdedness of children, whether in the home or at an out-of-home daycare unit.<sup>20–24</sup> The decreasing birth rate, reduced number of siblings and delayed babysitter attendance were part of the reasonable explanation of the low rate of NP carriage *S. pneumoniae* in Taiwan.

AOM, sinusitis, and pneumonia were three of the most common complications following respiratory tract virus diseases (common cold).<sup>17,23</sup> Comparing the annual visiting



**Figure 2.** Accumulative experience of otitis media (OM) among children in 2007 (Database I) and from 2005 to 2010 (Database II).



**Figure 3.** Annual outpatient clinic visiting rates due to acute upper respiratory tract infection (URTI) and the experience of otitis media (OM) among young children (Database II) from 2005 to 2009. NHI = National Health Insurance.

rates of URTI from the NHI database<sup>25</sup> with the annual proportions of OM-positive patients in Database II, we found a similar age-peak trend (Fig. 3). The seasonal incidence of AOM was compared from databases III (NHIRD) and IV (TCVGH), as shown in Fig. 1, and demonstrated the higher incidence in spring. This finding was also compatible with the peak season of pneumococcal pneumonia and empyema in Taiwan.<sup>26</sup>

There were significant differences in the proportions of OM-experience children between different regions from these two questionnaires, especially in south Taiwan. This could be due to warmer weather and fewer URTI episodes in the southern part of Taiwan. Other possible reasons for these differences include a relative small sample size and potential recall bias.

Many studies have shown that the risk of getting AOM is higher in boys than girls,<sup>7,9,13,14,27</sup> while others contradict this.<sup>28,29</sup> This study showed a higher incidence of AOM in boys than girls, which is compatible with previous studies in Taiwan.<sup>9,10</sup> The core pathogens of AOM were *S. pneumoniae*, *Haemophilus influenzae* and *Moraxella catarrhalis*.<sup>23,30,31</sup> The persistently high percentage of drug resistance of these bacteria is a challenge for clinical management in Taiwan, due to inadequate antibiotics, suboptimal dose, long term exposure to antibiotics and drug concentration in the middle ear.<sup>32</sup> The PCV-7 vaccine has proved the good efficacy in preventing IPD (meningitis, bacteremia, pneumonia etc.) in the United States.<sup>33</sup> However, it showed only limited efficacy on AOM (6–7%).<sup>11,34</sup> The relatively low efficacy of PCV7 is partly due to the presence of nonvaccine *S. pneumoniae* serotypes and nontypable *H. influenzae* of AOM.<sup>35–37</sup> Newly licensed pneumococcal conjugate vaccines (PCV-10 and PCV-13) have proved to be effective in preventing AOM in some countries<sup>38–40</sup> and the domestic epidemiology is an essential factor for estimating the cost-effectiveness of these vaccines in Taiwan.

One limitation of this study was related to the questionnaire-based assessment of AOM episodes. Some of the questionnaire respondents were not the principle caregivers and might therefore have forgotten episodes of AOM. Some respondents may not have understood the questionnaire. In addition, the questionnaire-based databases and data from VGHTC were extracted from hospital-based outpatient clinics, which may not adequately reflect

the true prevalence among all children. The sample sizes in these three databases may not be sufficiently large to avoid bias. Another limitation was that some data were obtained from the NHI database. Although this is a useful data source for estimating epidemiological characteristics of AOM, the accuracy of diagnostic coding by physicians can affect the validity of data. Also, multiple visits may amplify the effect of season.

In conclusion, AOM was believed to be a very common disease among children; however, this comparative analysis showed that the overall prevalence of AOM among Taiwanese children younger than 5 years was only 20%, much lower than other countries. AOM was more prevalent during spring, and still was similarly common after the age of 2 years.

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