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# Hearing impairments among Saudi preschool children

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ABSTRACT

*Background:* Hearing loss among school-entrant children in the developing world has been widely reported as a significant health problem. Failure to detect hearing loss, either congenital or acquired, in children may result in lifelong deficits in speech and language acquisition. The aims of this study were: (1) to estimate the prevalence of hearing loss and (2) to identify its different types.

*Methods:* This is a cross-sectional study that included all children ($n = 2574$) aged 4–8 years who attended the obligatory health examination for kindergarten (=370) and primary school ($n = 2204$) entry at the school health center of King Abdulaziz Medical City, Riyadh, Saudi Arabia, from March 2009 to December 2010. Pure-tone air conduction audiometry was conducted for each child in a sound-treated room followed by a diagnostic test. Tympanometry was performed as a complement to the overall objectives of a hearing screening program.

*Results:* A total of 45 children were diagnosed with hearing impairment (84.4% conductive and 15.6% sensori-neural), with an overall prevalence of 1.75% (95% C.I.: 1.25, 2.25). The majority of cases were females (71.1%), of school age (80.0%), with conductive deafness (84.4%). More than one-half of cases had bilateral deafness (55.6%) of mild degree (57.8%). As for conductive deafness, otitis media with effusion ranked first as a cause of deafness (34.9%), followed by wax and chronic otitis media (23.3% each), while traumatic perforated drum came last (2.3%). Sensorineural deafness constituted 16.2% of all cases.

*Conclusion:* Conductive hearing loss is the primary type of hearing loss among children and is easy to correct. The urgent development of audiological services in other school health centers in the country, particularly those with good referral systems to Ministry of Health hospitals, is needed. Evidence-based guidelines to identify, monitor, and manage otitis media with effusion (OME) in children in the primary healthcare setting and a strategy to prevent hearing loss are recommended.



## 1. Introduction

Hearing loss among school-entrant children in the developing world has been widely reported as a significant health problem [1–6]. Because mainstream schools are auditory–verbal environments, the failure to detect hearing loss, either congenital or acquired, in children may result in lifelong deficits in speech and language acquisition, poor academic performance, personal social maladjustments, and emotional difficulties [7].

Studies from different parts of the world have reported hearing impairments among school children with different rates. Theses figures ranged from 1.4% in China [8], 1.49% in UK [9], 2% in Sweden [10], 4.4% in Southwestern Saudi Arabia [11], 9.8% in Iran [12], 11.9% in India [13] and 20.9% in Egypt [14].

There is a consensus that the early detection of hearing impairment is desirable and can lead to improved communication skills, educational attainment and quality of life. Therefore, hearing screening at the time of school entry has been proposed for the early detection and rehabilitation of hearing impairments in school children in the developing world [15,16]. In the UK, for example, there is a long-established history of screening children for hearing impairment [17–19]. Some congenital hearing loss may not become evident until later in childhood. Hearing impairments can be acquired during infancy and/or childhood for various reasons. Infectious diseases (i.e., otitis media and meningitis) are a leading cause of acquired hearing loss. Traumatic injuries to the nervous system, damaging noise levels, and ototoxic drugs can all place a child at risk of developing acquired hearing loss. Otitis media is a common cause of typically reversible hearing loss.

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The US National Institutes of Health recommends hearing screening at the time of school entry [20], while the American Academy of Pediatrics currently advocates hearing screening at 4, 5, 6, 8, and 10 years of age and risk assessment at all other well child visits.

The aims of this study were: (1) to estimate the prevalence of hearing loss and ear problems among kindergarten and school entrants and (2) to identify the types of hearing loss.

## 2. Methodology

### 2.1. Study setting

Riyadh city has 6 million inhabitants. The population of the National Guard in Riyadh is approximately 180,000. Of those, 60,000 live in King Abdul-Aziz National Guard Housing City in the East Quarter of Riyadh, in which there is a total of 54 schools with a student population of approximately 18,000 children. Approximately 60% of all students attend 38 kindergarten and primary education for boys and girls.

### 2.2. Study population

Medical examination is obligatory for all kindergarten (4–5 years) and school entrants (6–8 years) in accordance with the government laws and is authorized by the educational and health authorities of the National Guard. This is the only school health center where audiology testing is routinely included in the medical examination. The sample consisted of 2574 Saudi preschool children (1073, 41.69% boys and 1501, 58.31% girls).

The study included all children aged 4–8 years who attended the obligatory health examination for kindergarten and primary school entry from March 2009 to December 2010. All children younger than 4 years of age, older than 8 years were excluded. Disabled children were also excluded to include only the typically developing children in this study. The data used in this study were collected from the relevant clinical data that were routinely collected during the medical examination.

### 2.3. Techniques

At the beginning of each year, kindergarten and school entrants are brought by their parents to the school health center for routine medical examination including hearing screening. The child is seated with their head still and steady, and he/she can rest on the back of the chair or against the adult's chest if the child is small or irritable. Pure-tone air conduction audiometry was conducted for each child in a sound-treated room in the school health center by trained examiners using a standardized protocol of two phases:

### 2.4. Screening phase

The purpose of this phase is to identify children who require further testing. The procedures and criteria used were adopted from ASHA's (1997) guidelines [21]. All children were screened using a Clinical Audiometer AC 40. The child is asked to raise his or her hand high when a sound is heard and then quickly put it down. The test was performed in a quiet environment (audiometric room ECKEL Model) using earphones because ambient noise can significantly affect test performance, particularly at lower frequencies (i.e., 1 kHz). We used the following screening patterns: right ear, 1000, 2000, and 4000 Hz; left ear, 4000, 2000 and 1000 Hz. All children whose air-conduction hearing threshold levels were greater than 20 dB (20 dB pure tone) at any of these frequencies were categorized as having possible hearing loss. Such patients were referred for a longer diagnostic visit, during which repeat diagnostic audiometry and diagnostic tests were performed.

Children were classified according to hearing impairment as having mild (26–40 dB), moderate (41–55 dB), moderately severe (56–70 dB), severe (71–90 dB), and profound deafness (91 dB and above) [21].

### 2.5. Diagnostic phase

Objective middle ear assessment has been tested by tympanometry as a complement to the overall objectives of a hearing screening program, and tympanometry measures relative changes in tympanic membrane movement as air pressure is varied in the external auditory canal. Every child was tested by tympanometry using an Impedance Audiometer AT 235h. Tympanograms can be classified as types A, B, and C [22,23] depending on the curve shape relative to 0 as the pressure is changed. The presence of a type A, high-peak tympanogram significantly decreases the probability that middle-ear effusion is the cause of hearing loss. A type B, flat tympanogram indicates the highest probability of a middle ear effusion or tympanic membrane perforation, which are both likely to cause some degree of hearing loss. A type C tympanogram, with a peak shifted toward negative pressure, has a low probability of middle ear fluid and associated hearing loss. Type B and C tympanograms require clinical correlation and possibly further evaluation and treatment. Traditionally, tympanograms have been obtained using low-frequency probe tones.

A student who passed the two tone presentations at 20 dB at each tested frequency in each ear, he or she was labeled normal. A student who met the failure criteria at the second testing if he or she failed to hear the two tone presentations at 20 dB at one or more of the frequencies (1000, 2000 and 4000 Hz) in either ear. Such patients were referred for evaluation to an ENT specialist.

Chronic suppurative otitis media (COM) was defined as chronic inflammation of the middle ear and mastoid mucosa in which the tympanic membrane is not intact and discharge is present [24]. Chronic serous otitis media was defined as a middle ear effusion without perforation that was reported to persist for more than 1–3 months [24].

All positive cases were referred to an ENT physician for assessment and final diagnosis and management.

### 2.6. Data analysis

SPSS software (version 17.0, SPSS Inc, Chicago, IL) was used for data analysis. The $\chi^2$ test was used to compare the categorical data. Prevalence of hearing impairment in each category was estimated with its corresponding 95% confidence interval. For all of the statistical analyses, a $p \leq 0.05$ was considered to be statistically significant.

## 3. Results

Table 1 shows the distribution of the 2574 screened kindergarten and school entrants (1073 boys and 1501 girls) according to the

**Table 1**
Distribution of kindergarten and school-entrants according to the overall results of hearing screening.

| Gender | Total screened | Referred | | Abnormal | |
|---|---|---|---|---|---|
| | No. | No. (%) | 95% CI | No. (%) | 95% CI |
| Boys | 1073 | 19 (1.77%) | (0.98, 2.56) | 13 (1.21) | (0.51, 1.91) |
| Girls | 1501 | 47 (3.13%) | (2.25, 4.01) | 32 (2.13) | (1. 43, 2.83) |
| Total | 2574 | 66 (2.56%) | (1.95, 3.17) | 45 (1.75) | (1.25, 2.25) |