



Accurate tympanometric criteria for Chinese schoolchildren

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Summary

Objective: Recent normative investigations have revealed significant differences between tympanometric values obtained from Chinese children and those obtained from Caucasians. Furthermore, it has been suggested that the use of non-population-specific tympanometric criteria to identify otitis media with effusion in Chinese children could contribute to the misdiagnosis of middle ear pathology. The current study aimed to establish whether population-specific pass/fail criteria are necessary for the tympanometric testing of Chinese schoolchildren.

Methods: A total of 154 Chinese children were recruited from a school in Nanjing, China. Participants ranged between 6 and 13 years of age with both genders equivalently represented. Participants with a history of hearing loss, otological problems, or previous referral to an otolaryngologist, and those with abnormal pneumatic otoscopy or pure tone audiometry results on the day of testing, were excluded from the normal database ($N = 125$). Tympanometry was performed using a Madsen Zodiac 901 Middle Ear Analyzer. The 90% range of the tympanometry results was used to produce two sets of tympanometric pass/fail criteria (OURPASS and OURPASS2). The test performance of OURPASS, OURPASS2, and two previously established criteria; ASHA [ASHA, Guidelines for audiologic screening, ASHA, Rockville, MD, 1997] and Shahnaz and Davies [N. Shahnaz, D. Davies, Standard and multifrequency tympanometric norms for Caucasian and Chinese young adults, *Ear Hear.* 27 (2006)

Abbreviations: A' , accuracy index; ANOVA, analysis of variance; EF, efficiency index; FA, false alarm rate; FN, false negative rate; HR, hit rate; OME, otitis media with effusion; Peak Y_{tm} , peak compensated static acoustic admittance; $Pr[D/+]$, positive predictive value; $Pr[N/-]$, negative predictive value; ROC, receiver operating characteristics; TN, true negative rate; TPP, tympanometric peak pressure; TW, tympanometric width; V_{ea} , equivalent ear canal volume.

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75–90], was determined against the gold standard of pneumatic otoscopy, using signal detection theory.

Results: The newly developed OURPASS tympanometric criteria, presented in the current study, possessed superior test performance in the prediction of otitis media with effusion than previously suggested Caucasian pediatric and Chinese adult criteria. An overall accuracy value of 0.68 and a hit rate of 0.79 were obtained.

Conclusions: The present study provides strong support for the use of a population-specific criterion for tympanometry testing in Chinese schoolchildren. Changes to the standard pass/fail criterion may be necessary following replication and expansion of the investigation.

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1. Introduction

The use of acoustic immittance tests, such as tympanometry, is a powerful adjunct to the use of behavioural tests in providing data about the middle ear system [1]. Tympanometry is an objective measure of middle ear function that is commonly used to assist in the diagnosis of otitis media with effusion (OME) in the clinical setting [1]. The four tympanometric measurements that pass/fail criteria are most frequently based on include: peak compensated static acoustic admittance (Peak Y_{tm}), tympanometric width (TW), equivalent ear canal volume (V_{ea}), and tympanometric peak pressure (TPP). Normative data for each of these tympanometric parameters, that is relevant to the target population, is required for the development of accurate pass/fail criteria. At present, however, the most commonly used guidelines and referral criteria for pediatric acoustic immittance testing are based on normative studies conducted in predominantly Caucasian children. Wong et al. [2], in their normative study of 278 Southern Chinese schoolchildren aged 6–15 years, have shown that there are differences between the normative data of Chinese children and values obtained from Western populations. In particular, Peak Y_{tm} values were lower and TW values were greater/wider in the Chinese pediatric samples. Therefore, it is feasible that inappropriate application of Caucasian norms and pass/fail criteria to Chinese children could result in misdiagnosis of middle ear pathology.

In fact, Tong [3], in an unpublished doctoral dissertation, found that up to 48% of children of Chinese ethnicity who failed tympanometry, based on the ASHA (Caucasian) pass/fail criterion [4], were misdiagnosed. The author also reported the prevalence of OME to be substantially lower in Chinese schoolchildren than in Caucasian children. Other studies [5–7] have suggested the prevalence of OME in Chinese schoolchildren to be as low as 2%, compared with Caucasian schoolchildren for whom the prevalence was cited as greater than 8%. Despite

the apparent lower prevalence, Tong et al. [8] identified OME as a significant problem in Chinese schoolchildren, with risk factors similar to Caucasian populations. Accurate diagnosis of OME is of particular importance in children because recurrent episodes of this middle ear pathology can frequently manifest a conductive hearing loss that may lead to defects in speech and language development [6], as well as behavioural problems and reduced academic achievement [4]. Undetected, OME may also result in medical complications, such as otitis externa, tympanosclerosis, tympanic membrane perforation, cholesteatoma, mastoiditis, cerebral abscess and, even, meningitis [9,10].

Recent studies have clearly identified racial heritage as a variable that may effect tympanometry outcomes and, hence, the accuracy of diagnostic decisions concerning OME [7,11–13]. The majority of these studies have shown that Caucasian adult tympanometric norms are not necessarily applicable to Chinese adults. For instance, Wan and Wong [13] demonstrated that Chinese subjects had smaller Peak Y_{tm} , wider TW and more positive TPP values compared to Caucasian subjects. Shahnaz and Davies [12] reported similar findings for a population of Northern Chinese young adults. It has been postulated that such differences might be a product of variation in the structure and function of the middle ear system, particularly anatomical differences in the Eustachian tube, between peoples of differing racial heritage [7,11,13]. Possible variation in average middle ear cavity size, associated with the smaller average body size of Chinese adults compared with Caucasian adults, has also been speculated in the literature [12,13].

Li et al. [14] investigated tympanometric norms in school-aged Chinese children. The authors, responding to an absence of normative values for tympanometric testing in Chinese pediatric populations, obtained normative data (for the four main tympanometric parameters) from a sample of 269 Chinese schoolchildren. They noted a small, yet significant, ear effect with larger V_{ea} values

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