A Report of WHO Ear and Hearing Disorders Survey in Guizhou Province

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Abstract
Objective To report a population-based survey on the prevalence, pathogenic factors and medical needs of ear diseases and hearing loss. Methods Using the probability proportion to size (PPS) method, 6626 residents were investigated in 30 clusters in accordance with the WHO protocol. Results The prevalence of hearing loss was 17.1% (compatible with the national standardized rate of 17.6%), including mild (11.0%), moderate (4.2%), severe (1.4%), and profound (0.5%) impairment. Of the 1131 individuals with hearing loss, 663 (20.2%) were male and 468 (14.0%) were female. The prevalence of hearing disability was 6.1% (again compatible with the national standardized rate of 6.5%). The causes of hearing loss were ear diseases (31.4%), non-infectious ear disorders (42.5%), genetic disorders (6.7%), infectious disease (0.4%) and undetermined causes (29.3%). Of the hearing impaired people, 13.8% needed otologic and/or audiologic interventions and 9.1% needed hearing aids. Conclusion The prevalence of hearing loss and hearing disability have increased in the past twenty years. The data provide important information for authorities in formulating policies for prevention and management of deafness.

Key words WHO Protocol; hearing loss; hearing disability; epidemiology; Guizhou

The last nationwide survey on ear diseases and hearing disorders in China was in 1987. At that time, 2.04% of the population (about 17.7 million people) were found to suffer from disabling hearing loss (DHI), and hearing disabilities were the most common of all kinds of disabilities. According to a WHO report, there are about 0.25 billion people with DHI around the world. Hearing disabilities and hearing disorders have become an international public health problem. The WHO Ear & Hearing Disorders Survey Protocol was put forward in 1991. Since then large-scale epidemiological surveys on hearing disorders have been carried out in developing countries using the protocol [1]. In China, four provinces including Jiangsu, Guizhou, Sichuan and Jilin province have been involved in the survey and Ear & Hearing Disorders Survey and Service Protocol in Jiangsu Province, Sichuan Province, Guizhou Province and Jilin Province has been approved by WHO. The chief executive department in Guizhou province—Hearing Rehabilitation Research Center of Guizhou Provincial Peoples’ Hospital has conducted a population-based survey in 30 clusters on the prevalence, pathogenic factors and medical needs of ear diseases and hearing loss and provided basic medical services for the subjects with ear diseases and hearing disorders identified in the survey from 2004 to 2006, based on the success of a pilot survey in 2004 [2]. The report on the study is presented.

1 Objects and Methods

1.1 Sampling and Subjects
Using a probability proportion to size (PPS) de-
sign, a total of 6,000 people were sampled in 30 clusters, based upon the population data in the Guizhou Province Annals published in 2001. The size of a cluster was about 200 persons. The average household size in Guizhou was 3.72 persons in 2001 and therefore 60 households were visited in each cluster. Every person who had lived in the house for more than 6 months was included in the survey.

1.2 Methods and Survey Flow

1.2.1 Organization and Training

The survey teams were organized by community leaders, local health workers, otolaryngologists, audiologists, biostatisticians and enumerators. All team members received training on the WHO Ear & Hearing Disorders Survey Protocol(China) and had a sound understanding of Filling Directions of Examination Tablet. At the end of the training, all members were familiar with the significance and procedures of the survey.

1.2.2 Visit by the Advance Team

Team supervisors visited the survey clusters in advance of the arrival of the main survey team to make local leaders and people aware of the purposes, significance and requirements of the survey and to win their support. In addition, training courses were held for local workers, subjects determined, household register lists obtained, working places located (field environment noise level below 40 dBA), and traffic and accommodations secured.

1.2.3 Testing equipment

Audiometers(GSI17 screening audiometer covering 0.5, 1, 2 and 4 kHz) and all other instruments (MAICO ERO.Scan™ for OAE testing and ND13 sound level meter) were calibrated before pilot study. The WHO Ear and Hearing Disorders Examination Form(7.1 Edition) was used, appended with OAE measurement and 0.5 kHz pure tone threshold [3].

1.2.4 Field Work of Survey Teams

Each survey team consisted of eight persons: one team supervisor, two otolaryngologists, two audiologists, and two field workers (local health workers) and a community leader. The survey flow chart was as follows: registration of subjects according to the listing of household members → pure tone audiometry (0.5–4 kHz) if older than 4 (sometimes 7) years or behavioral observation and OAE measurement if younger → ear examination, otoscopy and interview → appropriate treatment, counseling and relative medical treatment → data archiving & entry. Subjects with cerumen, foreign body or pus in the external ear canal received a second audiometric test after medical treatment. Hydrogen peroxide (3%, 100mL) and 2 ampoules of chloramphenicol auristillae were provided free for subjects with purulent otitis media.

1.2.5 Data Collection, Handling and Analysis

The EARFORM v6.00d software was used for data entry and basic data analysis. Data entry and processing were duplicated on the Epidata software to minimize errors. All data were analyzed using the SPSS11.5 software. The standardized prevalence (p' = \sum (standard population structure ratio×non-standardized prevalence)) was calculated using direct method of standardization based upon population structure from the fifth national population census in 2000. Subjects were divided by age in 10 year intervals, with the 80 years group containing all individuals at 80 and older ages. Db greater than 95 dB counted as 95dB in audiometry.

1.3 Diagnosis Criteria

Definitions of DHI and the grades of hearing loss were based upon WHO/ PDH97.3 recommendations [4].

Definitions of DHI: Adults: average hearing threshold level at 0.5, 1, 2, 4 kHz at 41 dB or greater for the better ear; Children(below 15 years): average hearing threshold level at 0.5, 1, 2, 4 kHz at 31 dB or greater for the better ears. Hearing loss was divided into Grade0 (≤25 dB
2.1 General Information

A total of 30 clusters (1800 households) in Guizhou Province were selected. According to the list of household members, 6725 persons listed on household registration, 89 (1.3%) were absent at the time of the survey and 10 (0.1%) declined, yielding an actual sample size of 6626 subjects (98.5%), including 3290 males (49.7%) and 3336 females (50.3%) with an age range from 1 month to 90 years (see Tab.1).

2.2 Prevalence and Etiologies

2.2.1 Prevalence

Among the 6626 subjects, 1131 (17.1%) were identified as having hearing loss according to WHO definitions, in comparison to the national standardized rate of 17.6% and that of Guizhou province at 16.1%. Of the subjects having hearing loss, 730 (11.0%) were mild, 275 (4.2%) were moderate, 95 (1.4%) were severe, and 31 (0.5%) were profound. The prevalence of hearing disability was 6.1%, in comparison to the national standardized rate of 6.5% and that of Guizhou province at 5.9%. Prevalence of Ear diseases was 13.4%. When judging by the worse ear, the prevalence of hearing loss was 26.9% (1781 of the investigated subjects).

2.2.2 Age Distribution

See Tab.2 for distribution of hearing loss and hearing disabilities among different age groups. The hearing loss prevalence among age groups was significantly different ($X^2 = 2049.866$, $p < 0.01$), increasing gradually with the increase of age. The prevalence reached 72.6%, with a hearing disabilities rate of 29.9%, among those at 60 years or older), while the same rates were 2.5% and 0.5%, respectively, among those at 6 years or younger.

2.2.3 Sex Differences

The hearing loss rate (by the better ear) was higher for male (20.2%, $n=663$) than for female (14.0%, $n=468$) ($X^2_{MH} = 102.72$, $p < 0.01$, OR$_{MH} = 2.27$, 95% CI = 1.94–2.65), despite the influence of age. The risk for male is 2.27 times of that for female.

2.2.4 Differences between Urban and Rural Areas

There was no significant difference in hearing impairment prevalence between urban (19.7%, $n=433$) and rural areas (15.7%, $n=698$) ($X^2 = 1.543$,
Journal of Otology 2010 Vol.5 No.2

Hearing loss 

$\chi^2 = 2049.866 \quad P = 0.000$

Hearing disabilities 

$\chi^2 = 1103.098 \quad P = 0.000$

Trend pattern test 

$\chi^2 = 1532.71 \quad P = 0.00$

$\chi^2 = 580.60 \quad P = 0.000$

Figure 1  Hearing loss/ hearing disabilities among different occupations in Guizhou.

Figure 2  Hearing loss/ hearing disabilities in different ethnic groups.

2.2.6 Differences among ethnic groups

Individuals from 17 local ethnic groups were involved in the survey. See Fig.2 for distribution of prevalence of hearing impairment/disabilities among these ethnic groups. The top three groups with high prevalence were the Dongs (25.9%), Tujias (19.4%) and Bais (18.5%) ($\chi^2 = 22.22, \quad P < 0.05$). See Fig.1 for hearing impairment/disabilities prevalence distribution in different occupations in Guizhou.

2.2.7 Onset Time of hearing loss

From answers on the questionnaire, hearing impairment could start in childhood (n=119, 10.5%), adulthood (n=462, 40.8%), or senile period (n=349, 30.9%). The onset time was uncertain in 138 subjects (12.2%). The answer to this question was not available from 63 subjects.

2.2.8 Ear Diseases

Among all the 6626 subjects, 886 (13.4%) subjects were found to have ear diseases including deformity of external ear (n=39, 0.6%), cerumen (n=362, 5.5%), foreign body (n=11, 0.2%), otitis externa (n=33, 0.5%), mycotic infection (n=10, 0.2%), acute otitis media (n=20, 0.3%), secretory otitis media (n=322, 4.9%), chronic suppurrative otitis media (n=97, 1.5%), and dry perforation of tympanic membrane (n=98, 1.5%).

2.3 Main Causes leading to Ear Diseases and/or Hearing Loss

The main causes of hearing loss in the 1131 hearing impaired subjects included: ear diseases (n=355, 31.4%); non-infectious ear problems (n=481, 42.5%); including presbycusis (27.3%), noise-induced hearing loss (6.2%), oto-

Table 2  Distribution of hearing loss and hearing disabilities in different age groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Subject Number</th>
<th>Mild (number)</th>
<th>Moderate (number)</th>
<th>Severe (number)</th>
<th>Profound (number)</th>
<th>Prevalence of Hearing Loss%</th>
<th>Prevalence of Hearing Disabilities%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ~</td>
<td>1267</td>
<td>24</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>2.9</td>
<td>1.0</td>
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<tr>
<td>10 ~</td>
<td>1168</td>
<td>20</td>
<td>15</td>
<td>7</td>
<td>10</td>
<td>4.5</td>
<td>2.7</td>
</tr>
<tr>
<td>20 ~</td>
<td>653</td>
<td>37</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>8.1</td>
<td>2.5</td>
</tr>
<tr>
<td>30 ~</td>
<td>1441</td>
<td>111</td>
<td>23</td>
<td>7</td>
<td>3</td>
<td>10.0</td>
<td>2.3</td>
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<tr>
<td>40 ~</td>
<td>796</td>
<td>98</td>
<td>32</td>
<td>6</td>
<td>0</td>
<td>17.1</td>
<td>4.8</td>
</tr>
<tr>
<td>50 ~</td>
<td>629</td>
<td>153</td>
<td>44</td>
<td>21</td>
<td>3</td>
<td>35.1</td>
<td>10.8</td>
</tr>
<tr>
<td>60 ~</td>
<td>431</td>
<td>195</td>
<td>70</td>
<td>15</td>
<td>4</td>
<td>65.9</td>
<td>20.6</td>
</tr>
<tr>
<td>70 ~</td>
<td>204</td>
<td>87</td>
<td>55</td>
<td>23</td>
<td>4</td>
<td>82.8</td>
<td>40.2</td>
</tr>
<tr>
<td>≥80</td>
<td>37</td>
<td>5</td>
<td>18</td>
<td>9</td>
<td>3</td>
<td>94.6</td>
<td>81.1</td>
</tr>
<tr>
<td>合计</td>
<td>6626</td>
<td>730</td>
<td>275</td>
<td>95</td>
<td>31</td>
<td>17.1</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Hearing loss 

$\chi^2 = 2049.866 \quad P = 0.000$

Trend pattern test 

$\chi^2 = 1532.71 \quad P = 0.00$

Hearing disabilities 

$\chi^2 = 1103.098 \quad P = 0.000$

Trend pattern test 

$\chi^2 = 580.60 \quad P = 0.000$
Table 3  Pathogenic causes for 401 subjects with hearing disabilities

<table>
<thead>
<tr>
<th></th>
<th>No. of Cases</th>
<th>Prevalence%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ear Diseases</td>
<td>139</td>
<td>34.7</td>
</tr>
<tr>
<td>Systemic Infection</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Hereditary Disorders</td>
<td>48</td>
<td>12.0</td>
</tr>
<tr>
<td>Non–infectious Disorders</td>
<td>172</td>
<td>42.9</td>
</tr>
<tr>
<td>Presbycusis</td>
<td>123</td>
<td>30.7</td>
</tr>
<tr>
<td>NIHL</td>
<td>14</td>
<td>3.5</td>
</tr>
<tr>
<td>Ototoxicity</td>
<td>21</td>
<td>5.2</td>
</tr>
<tr>
<td>Meniere Disease</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Cerebral Trauma</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Sudden Deafness</td>
<td>3</td>
<td>0.7</td>
</tr>
<tr>
<td>Systemic Diseases</td>
<td>5</td>
<td>1.2</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Undetermined factors</td>
<td>88</td>
<td>21.9</td>
</tr>
</tbody>
</table>

toxicity (3.4%) and Meniere disease (0.1%); sudden hearing loss (1.2%), trauma (0.8%), non–infectious systemic diseases (3.3%); genetic disorders (n=76, 6.7%); infectious diseases (n=5, 0.4%); and other causes (0.2%). In some subjects, there was an overlap between ear diseases and other disorders. In 331 subjects (29.3%), the cause of hearing loss was not clear. The possible pathogenic causes in the 401 subjects with hearing disabilities are shown in Tab3. Acute/chronic otitis media were determined to be the cause of ear diseases in 126 subjects (31.4%).

2.4 Needs for Otologic and/or Audiologic Interventions

Otologic and/or audiologic interventions were needed in 13.8% of the investigated people. They included hearing aids (n=604, 9.1%), medications (n=243, 3.7%), surgery (n=95, 1.4%), linguistic rehabilitation (n=17, 0.3%), special education (n=8, 0.1%), and other forms of actions (n=54, 0.8%). About 300 subjects received medications on spot. Only 5 subjects wore hearing aid, accounting for 1.2% of subjects with DHI. Speech disability was identified in 20 subjects (known as deaf–mute persons) who had never received any forms of special education (only 2 subjects wore hearing aids in both ears).

2.5 Additional OAE Measurement

The WHO protocol recommends questionnaire survey for hearing estimation in children between 6 months and 3 years 11 months old. In accordance with the protocol, objective audiometry (DPOAE screening) was conducted in 318 children from one month to 3 years old who were unable to cooperate in pure tone audiometry. Of these children, 303 passed the screening and 15 failed (4 with acute secretory otitis, 7 with secretory otitis media, 1 with hereditary deafness, and 3 for undetermined causes). The 15 children who had failed the OAE test passed behavioral hearing assessment. Another 6 children who were older than 3 years but unable to complete pure tone audiometry due to mental disabilities also passed DPOAE screening.

3 Discussion

3.1 Prevalence of Hearing Loss & Hearing Disabilities

The current study is the first to strictly follow the WHO protocol. The study indicates that the prevalence of hearing loss in the studied population is 17.1% (national standardized prevalence 17.6%), and prevalence of hearing disabilities is 6.1% (national standardized prevalence 6.5%), and the prevalence of ear diseases was 13.4%. The prevalence of hearing disabilities is 2.5 times of that in a 1987 survey (2.04%). Possible explanations for the difference may include:

(1) Different survey procedures. The survey in 1987 involved two phases: a house visit screening using questionnaires by trained local health workers, followed by pure tone audiometry and otoscopy in those suspected of having hearing problems later by otolaryngologists and audiologists. Whereas in the current study, the WHO protocol calls for one phase survey by the specialists.

(2) Different definitions of hearing loss. In the 1987 survey, only three frequencies (0.5, 1 and 2
kHz) were measured to assess DHI. The diagnostic criteria of disabling hearing loss were revised by WHO in 1991 to include 4 kHz in the WHO/PHD97.3 criteria, which help minimize the chance of missing age-related hearing loss and early-stage noisy hearing loss. Also, differentiation between adults and children were added with improved criteria of DHI for children. In this study, 13 children (15 years or younger) with PTA between 31 dB and 41 dB HL were classified as having DHI, increasing the prevalence by 0.2%.

(3) Real increase in DHI prevalence. This may have resulted from an aging society, increased noise pollution, and an increase in traumatic accidents. This is supported by the fact that presbycusis and noise induced hearing loss were the top two causes for non-infectious cause of hearing loss. Data in the Second National Disabilities Sampling Survey by the State Statistical Bureau show that the total number persons with disabilities has increased by 1.252 million compared to 1987, citing increased size and aging of the population as the causes among others [5].

3.2 Analysis of Etiologic Causes

In 1987 survey data [8], the main causes for hearing loss at that time included: presbycusis (23.5%), otitis media (12.7%), infectious diseases (10.0%), family inheritance/interrmarriage (8.6%), endemic diseases (6.6%), congenital diseases (1.5%), ototoxicity (1.6%), trauma (2.5%), noise induced hearing loss (0.9%), undetermined causes (27.6%), and other causes (4.6%). The prevalence of hearing disabilities for children (0–6 years) was 4.6%. In the current survey, presbycusis, otitis media and hereditary hearing loss were the top three pathologic causes. Infection–related diseases appear to be under effective control, but hereditary conditions remain a main cause for DHI in Guizhou. In 2006, we found that the prevalence of hereditary hearing loss was comparatively high in Guiyang (capital of Guizhou) with a mutation rate higher than the national average level [7].

Although the rate of DHI children (0.5%) has decreased, it remains comparatively high compared with other major metropolis in China (0.1%) [8]. These data indicate a long way for deafness–prevention in Guizhou.

Most DHI individuals were found in the age group of 60 years or older (72.6%), suggesting that the increasing senile deafness has become a serious social problem as China becomes an aging society with prolonged life span and increasing industrial and daily noise exposure. Senile deafness is a physiological aging phenomenon as well as a pathological phenomenon related to exposure to various harmful hereditary and life factors. It has been reported that senile population in China has reached 0.13 billion (about 11% of the total population). Accordingly, senile deafness has become a health problem for families and the society.

The study results also show that ear diseases account for 31.4% of people with hearing loss, which are often preventable or treatable through medications or surgery. Improving healthcare at primary levels, especially among target populations in rural areas, is therefore the key to reduce deafness.

3.3 The Ethnic Factor

The Dongs demonstrated the highest DHI prevalence (25.9%) in the current study, consistent with a 1994 national survey on minority health status in which [9] (the prevalence of congenital DHI among the Dongs in Guizhou was higher than the prevalence of other hereditary diseases. Further analysis will be reported later. We hope that local governments in areas with high minority DHI prevalences nationality attach more importance to this problem to effectively prevent and control DHI.

3.4 Objective Audiometry

In accordance to the WHO Ear and Hearing Disorders Survey and Service Protocol in Jiangsu Province, Sichuan Province, Guizhou Province and Jilin Province, children who were unable to
complete pure tone audiometry in the study received DPOAE screening, including those with normal behavioral hearing assessment. This should help improve reliability of the study. In this study, OAE assessment proved to be a useful tool in obtaining hearing data in individuals incapable of performing pure tone audiometry, and identified 15 children with potential hearing disorder who would otherwise be missed. OAE tests are fast and easy to perform, with good specificity. Its application is an important supplement to pediatric audiometry and its simple requirements for testing condition makes it suitable for field audiometry.

3.5 Needs for Intervention

The need of hearing aids is the highest among all needs for otologic/audiologic interventions. This is in agreement with a 1987 survey in the Guizhou province which also demonstrated the highest need for hearing aids (40.7%) although only 0.7% people with DHI had actually been fitted. Only 1.2% of subjects with DHI in this study wore hearing aid, indicating little improvement. We hope that the society and government become aware of this problem and that special education be made possible to increasing number of individuals in need.

4 Conclusion

Following a new WHO protocol, detailed epidemiological data on prevalences of DHI, ear disease and hearing loss were obtained. Significantly increased prevalence of DHI was noticed compared with previous nationwide survey results. These data are highly valuable to the entire society. Many hearing disabilities and hearing loss can be prevented and WHO aims to reduce avoidable hearing loss by 50% before 2010 in its DHI working plan. Accordingly, DHI prevention is of vital importance for all audiology workers. The study provides information on the prevalence of DHI in various age groups, frequent causes of deafness, and rehabilitation needs. The study data also provide research evidence for formulating provincial and national strategies in the prevention of deafness and hearing loss, as well as an extension of international survey experience.

Acknowledgement

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References