A representative study of hearing ability in North West Germany

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The estimated hearing ability of German citizens is based on a comprehensive study published by von Stackelberg in 1986. At that time, 26.8% of West-Germany citizens were rated as hearing impaired. Because of the analyzing procedure used, these data cannot be used for comparison purposes with more recent international studies carried out e.g. by Uimonen et al. (1999), Wilson et al. (1999), Quaranta et al. (1996), and Johansson and Arlinger (2003). Other German data are based on non-representative evaluations or on subjective assessments. Therefore, the Institute of Hearing Technology and Audiology started HÖRSTAT, a two-year research project designed to fill this gap.

Objectives

The major objective of this epidemiological survey is to assess the current hearing and communication abilities in the adult German population using techniques and methods that allow international comparisons. In this context, the correlation between hearing test results and self-assessment of hearing abilities will be highlighted. In addition, HÖRSTAT aims to evaluate the German telephone version of the digit triplets test in comparison to the Göttingen sentence test in noise.

Study design and conduct

HÖRSTAT is conducted as a cross-sectional study including a total maximum of 2000 adult subjects (18 yrs. and above). The fieldwork focuses on two medium-sized cities in the north-west of Germany: Oldenburg (~156,000 inhabitants) and Emden (~51,000 inhabitants). These cities differ most notably in their economic structure. Whereas trade, services and administration characterize Oldenburg’s economic life, the industrial sector and in particular car industry and shipyards are predominant in Emden. Starting from the assumption that exposure to noise is more widespread in industrial than in the service sector, noise induced hearing loss might play a larger role in adult populations from industrial regions. With a view to the necessary representative level, two stratified random-samples of balanced size are drawn to approximate the national distribution of age, gender and employment in the industrial sector. German local registration offices provide certain personal data whenever public interest is approved, which is the case for this study. Pooled for age (five-year age groups) and gender, each group of both random samples amounts to between 30 and 104 potential study participants. To compensate for neutral drop-outs (e.g. relocation, severe language problems, decease) random samples are drawn with a 20% surplus. This surplus is blocked at the beginning of the field phase and activated on a case-by-case basis. Severe selection bias (under-representation that could barely be corrected by appropriate weighting) or an unsatisfactory participation of less than 70% suggests that further sampling is necessary.

Contacting potential participants is carried out in several steps. First, all subjects receive a written invitation. They are asked to phone or mail the HÖRSTAT coordination office to clarify any open questions and to make an appointment. If there is no response either confirming or refusing participation, a HÖRSTAT field worker then tries to get in touch personally by phone. Third, a reminder is sent to potential participants who don’t give any feedback and whose telephone number is not registered in the phone book or in the internet. If these attempts to approach the subjects fail, HÖRSTAT field workers stop by the subjects’ homes inviting them personally to take part in the study. Testing is carried out during home visits or in the institute’s own facilities. Certain personal data whenever public interest is approved, which is the case for this study. Participants in the study neither receive remuneration nor compensation for expenses, but do get a non-diagnostic feedback of their personal hearing status. In order to estimate non-responder bias, the HÖRSTAT staff is requested to do a very short non-responder interview (closed questions). Non-Participants are asked why they do not take part and whether they perceive hearing problems. Field work is done

Table 1. Pure tone audiometry in HÖRSTAT testing.

| Test frequencies [kHz] | 0.25 | 0.5 | 0.75 | 1 | 1.5 | 2 | 3 | 4 | 6 | 8 |
|------------------------|------|-----|------|---|----|---|---|---|---|---|
| Air conduction         | x    | x   | x    | x | x  | x | x | x | x | x |
| Bone conduction        | x    | x   | x    | x | x  | x | x | x | x | x |
by upper division students of the Institute of Hearing Technology and Audiology who are thoroughly trained in advance and receive continuous support at regular team meetings. They work on a contractual basis in parallel to their studies. The research design meets the Guidelines and Recommendations for the Safeguarding of Good Epidemiological Practice (GEP 2004) and passed examination both by the data protection officer of Jade University of Applied Sciences and the ethics commission of the Carl von Ossietzky University in Oldenburg.

Testing methods and survey instruments

HÖRSTAT includes otoscopy, audiometric test procedures, digit triplets test, Göttingen sentence test, a questionnaire survey and a face-to-face interview. The whole testing procedure takes about 70 minutes.

Audiometry

If otoscopic examinations are without pathological findings, hearing tests start with pure tone audiometry. Hearing thresholds of air and bone conduction are determined at ten and five test frequencies respectively (Table 1). If necessary, thresholds are repeatedly determined using masking narrow-band noise.

Pure tone audiometry is followed by the Göttingen sentence test in noise. Lists of 20 everyday sentences are used to measure the signal-to-noise-ratio corresponding to 50% intelligibility (monaural presentation). Both tone and speech audiometry are performed with portable Ear 2.0 audiometers provided by Auritec, HDA 200 circumaural audiometry headphones manufactured by Sennheiser and B-71 bone-conduction receivers from RadioEar. Acoustic conditions for audiometric testing are controlled by third-octave level measurements before or after each audiometric session in 26 bands starting at a center frequency of 50 Hz. Participants in the study receive a personal hearing status statement that follows, by and large, the WHO classification of hearing impairment (see Table 2), so the mean air-conduction threshold at the frequencies 500 Hz, 1 kHz, 2 kHz and 4 kHz is most indicative. The written statement is advisory in nature and ranges from (WHO grade 0) to (WHO grade 1) up to further hearing testing highly recommended (WHO grades 2-4). In contrast to the WHO classification, which focuses on hearing level of the better ear, in the HÖRSTAT study the criteria are applied separately to each ear.

Digit triplets test by telephone

This telephone hearing test is a simple and non-committal chance for those who want to have their hearing checked without consulting an audiologist or an ENT doctor. The German digit triplets test was launched in 2008 and is accessible to everyone. HÖRSTAT participants' results are recorded separately from the public version.

Table 2. WHO grades of hearing impairment (WHO 1991).

| Grade of impairment       | Corresponding audiometric ISO value (average of 500, 1000, 2000, 4000 Hz) | Performance                                                                 |
|--------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 0 - No impairment        | 25 dB or better (better ear)                                           | No or very slight hearing problems. Able to hear whispers.                  |
| 1 - Slight impairment    | 26-40 dB (better ear)                                                  | Able to hear and repeat words spoken in normal voice at 1 metre.            |
| 2 - Moderate impairment  | 41-60 dB (better ear)                                                  | Able to hear and repeat words spoken in raised voice at 1 metre.           |
| 3 - Severe impairment    | 61-80 dB (better ear)                                                  | Able to hear some words when shouted into better ear.                      |
| 4 - Profound impairment  | 81 dB or greater (better ear)                                          | Unable to hear and understand even a shouted voice.                        |

Questionnaires

The HÖRSTAT study uses two different questionnaires. To evaluate the self-assessment hearing and communication abilities across several domains, HÖRSTAT makes use of a short version of the Speech, Spatial, and Qualities of Hearing Scale (SSQ). The SSQ, originally developed by Gatehouse and Noble (2004), is a comprehensive and time-consuming tool. Recently, a multi-disciplinary working group around M. Meis (Oldenburg), H. Meister (Cologne) and J. Kießling (Gießen) worked out a German short version (currently unpublished) that comprises 17 questions. This shortened SSQ is sent to all potential participants with the invitation letter. Participants are asked to fill out this questionnaire before the appointment for the audiometric hearing tests to avoid any knowledge of the personal audiogram influencing participants’ responsiveness. In addition, another questionnaire is used which has been designed specifically for the project. The HÖRSTAT Questionnaire covers current health status, ear diseases and perceived hearing problems, potential hearing aid use and satisfaction, noise exposure and socio-economic aspects. Unlike the shortened SSQ, the HÖRSTAT questionnaire is filled out by the HÖRSTAT field workers during a face-to-face interview. With the intention of being able to compare the results with results from other studies under way or completed, some questions are adopted from other questionnaires. The face-to-face interview is divided into several sections. Most of the 38 questions are asked between the audiometric session and the telephone test to allow for a break from testing.

Project state

An eight week pilot phase started in September 2010.

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