# NHANES 1999–2000 Data Documentation

**Revised February 2005**

**Audiometry (AUX1)**

## Description

The NHANES 1999–2000 Audiometry Examination Component consists of four parts:

1) A pre-exam audiometric questionnaire: This is a series of questions to identify conditions that would affect how audiometric testing is conducted, or how results are interpreted. Questions include whether the subject has ear tubes, a current cold or ear problem, or recent loud noise exposure. Note that more extensive data relating to study subject's hearing status are contained in the audiometry questionnaire (AUQ) section of the NHANES Sample Person Interview Questionnaire. Questionnaire information regarding occupational noise exposure can be found in the Occupational (OCQ) section of the NHANES Sample Person Interview Questionnaire.

2) A brief otoscopic screening (physical) exam of the ear canals and eardrums: This was performed to identify abnormalities which would require alternate audiometric procedures, or influence interpretation of test results, and to identify conditions which might require medical referral. The exam screened for excessive or impacted ear cerumen (wax), physical abnormalities, or collapsing external ear canals.

3) Tympanometry: This is an objective assessment of middle ear function by testing the mobility of the eardrum in response to changes in air pressure within the ear canal. It was used to identify middle ear pathologies that might contribute to hearing loss. Tympanometric data, included in this primary Audiometry data file consists of quantitative measurement data for middle ear volume, pressure, compliance, and gradient.

4) Pure tone air conduction audiometry: This measures hearing sensitivity by presenting pure tone signals to the ear through earphones, and varying the intensity of the signals until a subject's hearing threshold at that frequency is determined. Testing was performed at frequencies across the range of human hearing.

## Eligible Sample and Component-Specific Exclusions:

The Audiometry Component tested a ½ sample of U.S. adults ages 20 to 69 years. Subjects using hearing aids who were not able to remove them for testing and subjects who had sufficient ear pain at the time of the exam that they could not tolerate headphones were excluded from the Audiometry Component. There were no other precluding conditions for any part of the audiologic exam.

## Examination Protocol

All Audiometry Component sections were performed by a trained examiner on examinees aged 20-69 in a dedicated, sound-isolating room in the mobile examination center (MEC). Hearing threshold testing was conducted on both ears of examinees at seven frequencies (500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz). Testing was conducted according to a modified Hughson Westlake procedure using the automated testing mode of the audiometer, except as indicated below. The effective range for automated audiometric testing was from –10 to 100 decibels (dB) at 500 to 6000 Hz and –10 to 90 dB at 8000 Hz. Thresholds could be tested through 120 dB (110 dB at 8000 Hz) using manual audiometric mode. Observed values therefore varied between –10 and 120 dB. If an examinee did not respond to the signal tone at any level for one or more frequencies because of deafness or severe hearing loss, a threshold level of 666 was entered. Manual testing was also conducted when the examinee could not operate the response switch or responded too slowly for the audiometer to accurately record the response.

In some instances, if a pure tone audiometric signal is sufficiently loud, it can “cross over” and be heard by the opposite ear via bone conduction. When this occurs, it is difficult to determine if the threshold obtained is truly the threshold of the test ear, or an artifact of the non-test ear (which may have better hearing). For the current study, a crossover retesting protocol was performed whenever the observed threshold at any given frequency was poorer in one ear than the other by 25 dB at 500 and 1000 Hz; or 40 dB at any higher frequency. Retesting was accomplished using insert earphones, which are smaller and have less direct contact with the head. Thus, a much louder stimulus is required before crossover occurs. Due to the complexity of the procedure, masking was not employed in this survey.

## Survey Staff

The MEC Health Technicians who performed the Audiometry Examination Component of NHANES were professionally trained by a certified audiologist from the National Institute for Occupational Safety & Health (NIOSH). NIOSH also conducted health technician performance monitoring of each technician on a regular basis. Field visits to each MEC were conducted by the NIOSH Audiologist at least three times per year. Additionally, NCHS Project Officers visited the MECs approximately twice per year to observe the audiometry examinations and verify that standard testing procedures were being followed. NIOSH consultants provided the MEC health technicians with annual retraining and protocol updates.

## Instrumentation and Quality Control Procedures

Instrumentation for the Audiometry Component included an Interacoustics Model AD226 audiometer with standard TDH-39 headphones and Etymotic EarTone 3A insert earphones. Tympanometry was performed using a Micro Audiometrics Earscan Acoustic Impedance

Tympanometer. All testing was performed within a sound-isolating booth, located in a dedicated room in the MEC. Audiometric calibration and background noise levels were checked using a Quest Model 1800 Precision Integrating Sound Level Meter and Model OB-300 1/3-1/1 octave filter set. Daily monitoring of calibration and ambient noise levels was accomplished with a Quest Model BA-201-25 Bioacoustic Simulator and Octave Band Monitor. All data from each of the 4 sections of the Audiometry Component were entered directly into the computerized NHANES survey database system. Data from the Interacoustics Model AD226 audiometer and Micro Audiometrics Earscan Acoustic Impedance tympanometer were captured electronically and uploaded into the survey information system automatically.

The audiometers used in this survey met the specifications of ANSI S3.6-1996 for Type 3 audiometers. An acoustic calibration check to measure the output and linearity of the audiometer (through both standard and insert earphones) was conducted before the examinations began at each MEC site using a Quest Model 1800 sound level meter kit; a complete acoustic calibration check was also conducted at the end of each stand. Throughout the stand, output of the audiometer was monitored daily using a Quest Model BA-201-25 bioacoustic simulator; and a daily listening check (tone quality, attenuator accuracy, headphone cords, crossover, etc.) was also performed. Standard and insert earphones were checked on an alternating basis. If a unit did not meet specifications, it was sent for service, and a fully calibrated backup unit was used for examinations. Manufacturer's calibration (traceable to the National Institute of Standards and Technology [NIST] was performed annually on each audiometer.

An environmental noise survey was also conducted at the beginning of each stand using the Quest 1800 sound level meter. The survey was repeated weekly throughout the stand. The audiometric test room was required to meet or exceed the specifications of ANSI S3.1-1991 for ears covered testing. A Quest Model BA-201-25 Bioacoustic Simulator and Octave Band Monitor was used to continuously measure the background noise levels in the audiometric test room during audiometric examinations. Pure tone audiometric testing was not performed if ambient noise levels in the test booth exceeded maximum permissible levels. A comprehensive calibration (traceable to NIST) of the sound level meter and bioacoustic simulator were performed annually by the manufacturer. The physical volume calibration of the Micro Audiometric Earscan tympanometer was checked at the start and end of each stand and daily throughout the stand. Air pressure was calibrated automatically by the unit each time it was turned on. The tympanometer also received an exhaustive NIST-traceable calibration check annually.

As an additional quality measure, all audiograms, whether conducted in automated or manual mode, tested the 1000 Hz frequency twice in each ear as a measure of the reliability of the subject's responses. Pure tone audiograms were not accepted if there was more than a 10 dB difference between them. For further details regarding any of these procedures, analysts should consult the NHANES Audiometry/Tympanometry Procedures Manual.[1]

The quantitative tympanometric measurements reported in this data file represent the single best of two curves obtained during testing. Subjective quality ratings for these tympanograms are the variables AUAREQC and AUALEQC. These represent a qualitative assessment of tympanogram quality by the consulting Audiologist. Please note, however,

that this rating process scored tympanograms on the basis of quality, not normality. Abnormal tympanograms were classified as "good" if they were consistent with a subject's audiometric data, including otoscopy, numeric tympanometry readings, and audiogram.

## Data Processing and Editing

All data was captured into the NHANES computerized database system, with audiometric and tympanometric data automatically uploaded. On a continuous basis, a consulting Audiologist performed a clinical review of all data for each subject as it was received, checking for quality and consistency. In addition, a computerized data editing program was developed to check for logical inconsistencies in the data and technician errors, and to cross-check other issues affecting data quality (consistency in identifying potential instances where crossover effects might have occurred, assurance of randomization of the initial test ear, etc.). Back-end edits of the data were performed as needed when errors were detected.

## Analytic Notes

This examination was administered to a ½ sample of participants in the mobile examination center. Therefore, the Audiometry sub-sample weights provided with the Audiometry data file should be used for data analysis. For more information on the use of sample weights in current NHANES data analysis, refer to the current NHANES Analytic and Reporting Guidelines.

Audiologic data analysis is a complex procedure and requires a thorough knowledge of the specialty content area for valid results to be obtained. If an analyst does not have professional experience in this area, it is recommended that audiologic consultation be obtained to help formulate and review the results of the analysis. Data analysts should be especially aware of the fact that the number "666" in all primary audiometric frequency data fields (AUXU1K1R through AUXU8KL) as well as in all repeat test frequencies (AUXR1K1R through AUXR8KL) is a qualitative code for non-response at a particular frequency, and does not represent actual measured decibel hearing threshold values. They should be appropriately edited prior to any numerical data analysis.

## References

1. National Center for Health Statistics. Audiometry/Tympanometry Procedures Manual. January 2001. http://www.cdc.gov/nchs/data/nhanes/au.pdf.