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Health and Nutrition Examination Survey of 1971–75: Part II. Tinnitus, Subjective Hearing Loss, and Well-Being

J.C. Cooper, Jr.*

Abstract

The Health and Nutrition Examination Survey of 1971–75 contains valuable information because it provides unbiased estimates of the state of hearing in the general population. Here, three facets of the subjective aspects of hearing loss are examined: frequent and bothersome tinnitus, ratings of hearing, and general well-being. The period prevalence of frequent, bothersome tinnitus varied with race and gender (13 to 17%) with higher rates among blacks* and females. The mean air-conduction thresholds (0.5 to 4 kHz) of those reporting frequent and bothersome tinnitus did not exceed 32 dB HL. Mean audiograms associated with those who rated both ears good, fair, poor, or deaf were significantly different from each other. Mean poorer ear audiograms for those rating one ear as good were significantly better than those for comparable symmetrical ratings. Last, there was no clear, consistent relationship between audiometric thresholds and measures of well-being.

*Though inconsistent, terms used to denote race are those used in the original federal government reports.

Key Words: Hearing and well-being, subjective hearing loss, tinnitus.

The value of the Health and Nutrition Examination Survey of 1971–75 (HANES) lies in the ability to generalize results to 25- to 74-year-old, noninstitutionalized civilians in the continental United States. Its design (Miller, 1973; Anoymous, 1977; Engel et al, 1978) was summarized in Part I (Cooper, 1994). The salient feature of the multistage, stratified, probability sample is that while certain segments of the population were oversampled, appropriate statistical procedures can provide estimates of *population* parameters (versus the *sample* descriptors found in most studies). They can also compensate for missing data while maintaining the generality of the descriptive parameters they generate. As part of the design, audiograms were obtained from 6913 25- to 74-year-olds (a subset of the entire sample). Thus, although dated and containing thresholds from only 0.5 to 4 kHz, the database is valuable, because it is the most recent, least biased sample of the general population. Unfortunately, only two examinations of its information have been published (Rowland, 1980; Cooper, 1994). Both dealt with what might be termed the objective aspects of hearing: thresholds.

The data pertinent to three subjective aspects of hearing are the subject of this report: tinnitus, ratings of hearing loss, and general well-being. There is no logical link among the three beyond their subjective quality; they were selected because the database was at hand and it included the information. The data in each category was so limited that it would probably not warrant a Brief Report. The quality of the sampling and the insight available into patterns in the general population, however, should be made available to the audiologic community. Thus, this report is intended to be a multifaceted look at the subjective aspects of hearing.

* Department of Otolaryngology — Head and Neck Surgery, The University of Texas Health Science Center at San Antonio, San Antonio, Texas

Address correspondence to: J. Cooper, Department of Otolaryngology – Head and Neck Surgery, The University of Texas Health Science Center at San Antonio, San Antonio, TX 78284-7777

TINNITUS

Tinnitus is, arguably, the most troubling of auditory symptoms. It is axiomatic that significant proportions of the population have tinnitus and that the affliction is often present without objective hearing loss or an identifiable disease. Leske (1981), however, found little in the way of systematic studies of its prevalence. She summarized the results of the National Health Examination Survey of 1960–62 and noted that about 32 percent of the population reported tinnitus, that 6 percent reported "severe" tinnitus, and that there was a gender effect. Females were more likely to report tinnitus both in general (approximately 35% versus 30% in males) and when it was "severe" (6.5% versus 4.7% in males). In Great Britain, Coles (1984a, b) reported similar rates of "moderate" or "severe" tinnitus (5.6% to 7.4%) among individuals randomly sampled by mail, but reported smaller gender differences (0.8% to 1.2%). With respect to any associated hearing loss, tinnitus is often reported when thresholds are normal or near normal. For example, Hawthorne et al (1987) reported mean thresholds from about 15 (2 kHz) to 30 dB HL (8 kHz) among patients with "idiopathic" tinnitus. Coles et al (1981) reported average 0.5 to 4 kHz thresholds of 17 and 25 dB for the better and poorer ears, respectively, of those with no auditory problems beyond tinnitus. The HANES data allow for the examination of the prevalence of tinnitus, thresholds of those reporting tinnitus, and the gender effect in a population study. They also allow for examination of a potential race effect, as was seen in thresholds in Part I (Cooper, 1994).

SUBJECTIVE HEARING LOSS

The HANES data also bear on two facets of self-assessment instruments: (1) their use as screening instruments; and (2) the subjective confirmation of the adverse effects of unilateral hearing loss (e.g., Bess, 1982; Bardon, 1986; Oyler et al, 1988). In the first case, self-assessment is attractive, because it is cost effective. Most applications of self-assessment to screening have been developed by isolating the most relevant questions from longer, more probing, instruments (e.g., Mulrow et al, 1990). The ultimate simplification of self-assessment screening is that developed by Schein et al (1970). A person rates the hearing in each ear by selecting one of four alternative statements (good to deaf). They recommended the technique over a scaling system, because it provided poorer ear information (typically unavailable in currently used instruments) and was "simpler to administer, easier to comprehend, and possibly offers more face validity ...." Their rating technique was employed in HANES, but the results have not been reported.

In spite of the growing appreciation of the insight into hearing loss provided by self-assessment instruments, there appears to be no recent application of the technique to unilateral hearing loss. Schein et al (1970) did note that poorer ear ratings were influenced by the status of the better ear: the larger the difference between ears, the poorer the rating of the poorer ear.

HANES provides the data to explore both these applications of subjective rating scales in a population study.

WELL-BEING

Last, the literature is replete with descriptions of the psychological and social consequences of hearing loss. They range from paranoia through withdrawal and increased rigidity to behavior indistinguishable from controls. After an extensive and critical review, Wylde (1987) concluded that "while there *may* be a tendency for the individual with significant hearing loss to experience psychological difficulties ... we would be remiss to view [them as] suffering from ... problems *because* of their hearing loss ..." (emphasis added). The qualifications were based on her observation that few studies compared those with and without documented hearing loss. HANES permits a large-scale examination of the possible relationship between hearing thresholds and general well-being.

METHOD

Procedures

The data sets for the three facets of this report were drawn from the pool of 6342 HANES records with audiograms judged to be valid in Part I (Cooper, 1994). Acknowledging the inconsistency, the terminology of the survey's classification of race was used in the tinnitus analyses: black, white (including those of Hispanic heritage), or other (including Oriental, Native American, etc.). Inclusion in the tinnitus, sub-

Table 1 Questions Selected from HANES Database

Tinnitus

1. At any time over the past few years, have you ever noticed ringing in your ears, or have you been bothered by other funny noises in your ears?

   a. How often? — Every few days; Less often

   b. Does it bother you? — Quite a bit; Just a little; Not at all

Subjective Hearing Loss

1. How would you rate the hearing in your right (left) ear?

   Good
   A little decreased
   A lot decreased
   Deaf

General Well-Being

1. How have you been feeling in general? During the past month?

   In excellent spirits
   In very good spirits
   In good spirits mostly
   I have been up and down in spirits a lot
   In low spirits mostly
   In very low spirits

2. Have you felt so sad, discouraged, hopeless, or had so many problems that you wondered if anything was worthwhile? During the past month?

   Extremely so -- to the point that I have just about given up
   Very much so
   Quite a bit
   Some -- enough to bother me
   A little bit
   Not at all

3. Have you ever seen a psychiatrist, psychologist, or psychoanalyst about any personal, emotional, behavior, or mental problem concerning yourself?

   Yes
   No

jective hearing loss, and well-being groups was based on whether the subject had answered the survey questions listed in Table 1. The first group was made up of 1014 subjects who reported bothersome (either a little or quite a bit) tinnitus that occurred every few days and whose average air-bone gaps were less than 6 dB in both ears. In the absence of ratings such as "moderate" or "severe" (Leske, 1981; Coles, 1984a, b), this criterion was used on the assumption that it constituted a significant symptom. The subjective hearing loss group was made up of 1027 who rated their hearing in each ear. For convenience, good, fair, poor, and deaf are used below instead of the categories listed in Table 1. The well-being group included all 6342 records, because they included responses to three well-being questions listed in Table 1. Thus, the groups were not mutually exclusive. A single subject could be represented in all three groups.

ANALYSES

Super Carp (Hidiroglou et al, 1980), a computer program with routines that take into account the HANES design parameters, was used to calculate the *period* prevalence of tinnitus. Because the data were collected over a period of years, prevalence, in the sense of the number with tinnitus at some instant in time (point prevalence), could not be established. The question about the occurrence of tinnitus also reflected the meaning of period prevalence: "At any time over the *past few years* have you ever noticed ringing ..." (emphasis added). The program also takes into account missing records such as those excluded, because, though they included answers to the tinnitus questions, no valid audiograms were available.

Unlike Part I (Cooper, 1994), where all analyses were based on population parameters, the thresholds of the tinnitus and subjective hearing loss groups were examined with sample techniques, because they constituted the population under investigation. They could not be taken, as was the case with degree of threshold shift in Part I, as representative of a population in which each member had some quality to one degree or another. Continuing with the technique whose rationale was described in Part I, mean threshold differences were evaluated by creating confidence intervals about one mean equal to twice the smaller standard error of the mean (SEM). If the interval excluded the second mean, then it was assumed that the two were different ($p < .046$). While the validity of the significance of a particular difference is suspect, a pattern of significant differences should reflect real trends in the data. The goal of this study was to discern such patterns.

The relationship between responses to the three well-being questions and thresholds was examined in two ways: one-way analysis of

variance (ANOVA) and regression analysis. Conventional and nonparametric (Spearman) regressions were used for the first two questions. The last question permitted the use of logistic regression. The better ear average of thresholds from 1 to 4 kHz was used as a single index of hearing.

RESULTS

Tinnitus

The first part of Table 2 presents the population period prevalence of frequent, bothersome tinnitus for the entire group and for partitions by gender or a black–white dichotomy. The other racial category was not treated separately because of its heterogeneity and small size (n = 6). Prevalence ranged from 13 to 17 percent. Using a 2 standard error confidence interval, females reported the presence of tinnitus significantly more often than males, even though the mean male thresholds of both races were poorer than the comparable mean female thresholds at 2 and 4 kHz in both ears. From a different point of view, blacks reported the presence of bothersome tinnitus significantly more often than whites. There was no pattern of mean threshold differences between races of either gender.

On the assumption that the group represented a single diagnostic category, sample mean thresholds and SEMs for the entire group were calculated and are presented in the second part of Table 2. Values for both ears are presented, although there were no between-ear differences. As can be seen, the group was characterized by mild, high-frequency hearing loss. While noise-induced hearing loss is a common substrate to tinnitus, the limited frequency range of thresholds and the absence of noise-exposure history precluded any productive extension of the examination of thresholds.

Subjective Hearing Loss

Two groups were extracted from the pool of 1027 raters. The first had symmetrical ratings (good-good, etc.) (n = 510). The second rated only one ear as good (n = 403). Because there were no significant, between-ear differences for mean thresholds in the first group, the average of the right and left ears was used as a single measure of threshold for those with symmetrical ratings. The ear data were collapsed to permit comparison of symmetrical raters to those with one good ear. Sample threshold means and SEMs for both groups are presented in Table 3. Comparisons of the means at each frequency in either group demonstrated that threshold sets associated with each rating were different (> 2 SEMs); mean good, fair, poor, and deaf audiograms were distinct among those with symmetrical ratings, as well as among those with unilateral hearing loss.

The unilateral hearing loss group displayed a consistent pattern of less tolerance of hearing loss. In 9 of 12 comparisons, their mean thresholds for a given rating were better (> 2 SEMs) than those of symmetrical raters using the same category. The mean fair audiogram for unilateral hearing loss raters fell between good and fair for symmetrical raters. Similarly, unilateral poor and deaf audiograms fell between the fair and poor and the poor and deaf audiograms for symmetrical raters.

Table 2 Period Prevalences/SEs and Sample Means/SEMs of Air-Conduction Thresholds (dB HL) for Those Bothered by Tinnitus

Period Prevalence				
All	*Female*	*Male*	*Black*	*White*
0.149/0.006	0.171/0.008	0.126/0.008	0.172/0.018	0.148/0.006
Air-Conduction Thresholds				
Ear	*500*	*1000*	*2000*	*4000 Hz*
Right	17.03/0.49	16.87/0.51	21.97/0.63	30.10/0.77
Left	16.83/0.48	16.42/0.52	22.29/0.65	31.43/0.77

Table 3 Sample Means/SEMs of Air-Conduction Thresholds (dB HL) by Hearing Rating

Frequency (Hz)				
500	*1000*	*2000*	*4000*	*Rating*
Symmetrical ratings*				
11.65/0.76	11.33/0.84	14.17/1.14	21.57/1.83	Good
17.62/0.68	18.52/0.76	29.33/1.06	45.43/1.25	Fair
37.62/2.84	43.28/3.05	55.09/2.82	64.62/2.84	Poor
67.81/10.88	71.19/9.71	81.19/6.59	86.38/6.24	Deaf
Only one rated as good				
19.67/0.81	18.75/0.88	24.28/1.09	37.84/1.42	Fair
30.47/2.06	28.84/1.96	38.94/2.33	49.33/2.68	Poor
55.25/7.61	56.81/6.76	57.75/5.99	69.25/6.48	Deaf

* Bilaterally good, fair, etc.

Well-Being

All ANOVAs were significant ($p < .006$). As might be expected, as the degree to which a person felt sad (question 2) increased, mean tonal averages increased (13 to 20 dB HL). It is remarkable, however, that (1) there was a trend of increasing mean tonal averages with increasingly better spirits (question 1); and (2) those who had sought professional counselling had better mean thresholds. Since it might be argued that a state of well-being is related to age, those correlations were examined before proceeding. None were significant.

Neither the conventional nor the nonparametric regression analyses of average thresholds and responses to the first question (regarding spirits) were significant. The significant relationships (all $p < .000$) obtained between average thresholds and responses to the other two well-being questions are tempered by the unexpected trend of thresholds mentioned above. The magnitudes of the threshold differences between extremes of the response categories for the three questions were also of little clinical significance. None exceeded 7 dB.

DISCUSSION

Tinnitus

This examination of the prevalence of tinnitus produced values approximately twice those reported in other studies. As is obvious (e.g., Chung et al, 1984), prevalence is related to the criteria used to select those with a significant symptom. This report used frequent, bothersome tinnitus as the basis for determining prevalence, rather than any tinnitus or tinnitus that was not bothersome, since "It is widely believed that mild, occasional tinnitus is experienced by nearly everybody at some time or another ..." (McFadden, 1982). Because the categories of response do not match those of previous studies, no direct comparisons are possible. To the degree that "bothersome" encompasses more cases than "severe," however, the present values should and do exceed those reported by Coles (1984a) and Leske (1981). The gender effect noted by Leske (1981) and evident in Coles's (1984b) report was repeated in Table 2, although the magnitude of the difference (4.5 percent) was closer to Leske's summary than Coles's values. The one remarkable aspect of the prevalence was that blacks reported more bothersome tinnitus than did whites. If this observation can be verified in other studies, then the factors behind the observation would merit investigation.

The degree of hearing loss associated with tinnitus in this study is similar to that reported by others for subjects without identifiable auditory pathology. Further, mean audiograms suggested that there was little subjective hearing loss associated with bothersome tinnitus; mean thresholds were better than those with fair ratings and were only 5 to 9 dB poorer than those with good ratings.

Subjective Hearing Loss

The discrete sets of audiograms associated with each rating suggest that the categories of response are useful indices of subjective hearing loss. This is supported by examining the articulation indices for the mean audiograms associated with the ratings. Estimated word-

recognition scores for those with symmetrical ratings, based on Mueller and Killion's (1990) method, are 97, 66, 13, and 0 percent for good through deaf ratings. For those with unilateral hearing loss, the scores are 78, 47, and 0 percent for fair through deaf ratings. Assuming a 12 percent measurement error (based on Thornton and Raffin, 1978), the estimates retain the discreteness among ratings (i.e., good remains distinct from fair, etc.) for both symmetrical and unilateral groups. The estimated scores for those with symmetrical ratings are also consistent with Davis's (1970) observation that word-recognition scores of 50 percent are "... about the level at which we can easily understand connected speech"; only poor and deaf raters were below that level. Such was not the case among those with unilateral loss. An estimated score of 47 percent was associated with a poor rating.

Importantly, the ratings of those with only one good ear contribute to the understanding of those with unilateral hearing loss. They are less tolerant of threshold shifts in the poorer ear; i.e., their mean audiogram for a given rating category was better than that of those with symmetrical subjective hearing loss. Similarly, their estimated, poorer ear word-recognition scores were higher. Clearly, the asymmetry is perceived along dimensions beyond either thresholds or word recognition. This finding provides additional support for the contention that unilateral hearing loss is not trivial.

Well-Being

It is clear that, at the global level reflected by the three questions selected for this study, there is no practical relationship between threshold shifts and general well-being. While ANOVA and regression analyses often yielded statistically significant effects, the relationship between questions and thresholds was opposite to the expected direction for the first and third questions. Further, differences among mean average thresholds for the extremes of the categories of response did not exceed 7 dB. Nothing could better summarize this aspect of subjective hearing loss than repeating Wylde's (1987) admonition: "... we would be remiss to view [the hearing impaired as] suffering from ... problems because of their hearing loss ...."

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