Prevalence of Hearing Impairment Among Young Adults

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ABSTRACT **Background:** Noise-induced hearing loss (NIHL) is a prevalent hearing impairment, second only to age-related hearing loss. A change in the listening habits of adolescents may have contributed to the documented increase of hearing impairments in that age group.

Objectives: To examine the prevalence of NIHL among healthy young adults.

Methods: We conducted a retrospective study to examine audiograms of healthy candidates for the Israeli Air Force flight academy between 2018 and 2023. Hearing tests were performed by an expert audiologist using an audiometer.

Results: A total of 1940 audiograms were analyzed. The age range of the patients was 17–19 years. Using the British Society of Audiology classification, 174 (8.97%) audiograms and 313 frequencies were classified as impaired. The 8 kHz was the most affected frequency, accounting for 116 cases (37%).

Conclusions: Hearing impairment prevalence increased from 1% at entry into the education system to 8.45% at the end, respectively. Detecting hearing impairments early may minimize future disability and may reduce future disability and rehabilitation costs. Hearing screens for young adults due to the change in listening habits of adolescents may prove useful.

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KEY WORDS: hearing impairments, hearing screen, Israel Air Force (IAF), noise induced hearing loss (NIHL), young adults

Noise-induced hearing loss (NIHL) is a common hearing impairment, second only to age-related hearing loss, as identified by the U.S. National Institutes of Health [1]. NIHL can occur either suddenly or progressively, with prolonged exposure posing a greater risk than intermittent exposure. In addition, noise exposure during the first decade of life has been found to have a more harmful effect on hearing [2].

Noise exposure can result in temporary or permanent threshold shifts [3]. Studies have identified that the 4 kHz frequency range is frequently affected by noise exposure [4,5]. Moreover, evidence suggests that the 6 kHz frequency range may also serve as a marker for NIHL [6].

The classification of hearing impairment and hearing loss varies across health organizations. The American Speech-Language-Hearing Association (ASHA) defines hearing loss using seven categories, with impairment starting at 16 decibels. In contrast, the U.S. Centers for Disease Control and Prevention (CDC) uses a six-category classification, with impairment beginning at 26 decibels. The British Society of Audiology (BSA) employs a five-category system, where impairments start at 21 decibels.

Newborn hearing screening programs are widely implemented globally [7]. Approximately 0.3% of newborns exhibit some level of hearing loss in postpartum screenings [8]. In many countries, children undergo a second hearing screening on entering elementary school, where the prevalence of hearing impairment is reported to be approximately 1% [9].

In the United States, a national health survey conducted between 1988 and 1994 found that 12.5% of children aged 6 to 19 years experienced some form of hearing loss [10]. Another study indicated that the prevalence of hearing impairment among adolescents due to music exposure ranges from 9.3% to 14% [11]. More than half of the surveyed population reported exposure to loud music within 6 months prior to the study [12], and approximately one-third reported listening at loud

to very loud intensities, as documented in self-reported questionnaires on music-listening habits [11,13].

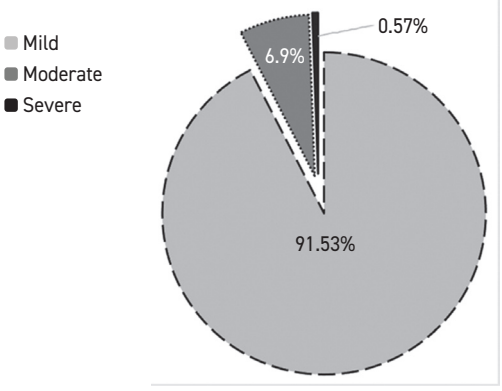
Environmental and behavioral factors, rather than aging alone, are key drivers of early sensorineural hearing changes in youth. In addition, accumulating evidence suggests that individual susceptibility to noise-induced hearing loss is modulated by genetic factors, with specific polymorphisms increasing vulnerability even at comparable exposure levels [14].

In this study, we evaluated the prevalence of hearing impairment among a population of young, healthy recruits in the Israel Air Force (IAF) flight academy. Furthermore, we examined the potential need for additional hearing screenings prior to enlistment.

Table 1. Patient characteristics and audiometry results

Characteristics	Values
Age in years (n=1940)	
Mean ± standard deviation	17.85 ± 0.36
Range	17–19
Total hearing tests (n=1940)	
Normal, n (%)	1766 (91.03%)
Impaired, n (%)	174 (8.97%)
Total responses (n=15,520)	
Normal, n (%)	15,207 (97.98%)
Impaired, n (%)	313 (2.02%)

Figure 1. Distribution of audiometric abnormalities by severity (mild, moderate, severe) among impaired audiograms



PATIENTS AND METHODS

STUDY DESIGN

In this retrospective study, we reviewed medical records of IAF flight academy candidates between January 2018 and April 2023.

STUDY POPULATION

All patients were healthy with no active medical problems. They all underwent a general medical assessment including audiometry at the IAF Aeromedical Center (AMC).

AUDIOMETRY

Audiometry included 8 frequencies (250, 500, 1000, 2000, 3000, 4000, 6000, 8000 Hz) and was performed by an experienced audiologist using an Interacoustics Clinical Audiometer (model AC40; Assens, Denmark). Data from hearing tests were saved to an electronic medical database. In cases of significant inconsistent or doubtful responses (e.g., suspected inattention or fatigue), the candidate was scheduled for a repeat audiometric evaluation on a different day, and only the better-quality audiogram was included in the analysis.

Hearing impairment was defined using the BSA classification system consisting of five categories: Normal (0–20 dB), mild impairment (21–40 dB), moderate impairment (41–70 dB), severe impairment (71–95 dB), and 96+ dB indicating profound impairment. The overall hearing status was classified based on the most severely affected frequency. For the purposes of this screening-based prevalence study, an audiogram was considered to show an audiometric abnormality if at least one frequency had a threshold > 20 dB.

STATISTICAL ANALYSIS

Data were expressed as frequencies and percentages for nonparametric variables. The chi-square test was used to compare the categorical variables between groups. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 27 (SPSS, IBM Corp, Armonk, NY, USA). A P-value < 0.05 was considered statistically significant for all tests.

ETHICS CONSIDERATIONS

The study was approved by the Israel Defense Force Medical Corps Institutional Review Board (approval number: No. 2128-2020).

RESULTS

A total of 1940 hearing tests were analyzed. The age range for the patients was 17–19. There were 174 (8.97%) tests that were classified as impaired according to the BSA classification system. In 25 tests, more than one abnormal frequency was recorded. Thus, a total of 313 abnormal frequency-specific thresholds were counted in total [Table 1].

The most prevalent hearing impairment category was mild hearing loss (91.53%), followed by moderate (6.9%) and severe (0.57%) [Figure 1]. The 8 kHz was the most prevalent frequency to be affected (37%), followed by the 6 kHz and the 250 Hz [Figure 2]. This difference was found to be statistically significant by a chi-square test ($P < 0.00001$).

Figure 2. Number of abnormal thresholds per frequency among all tested ears

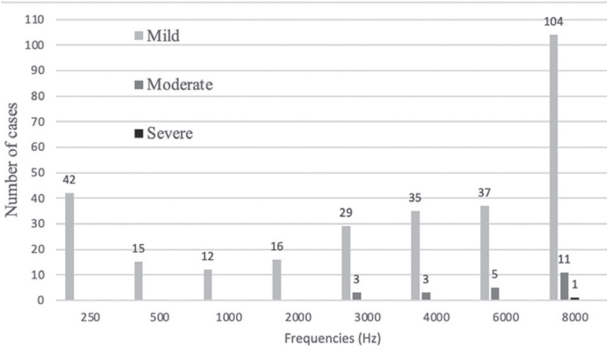
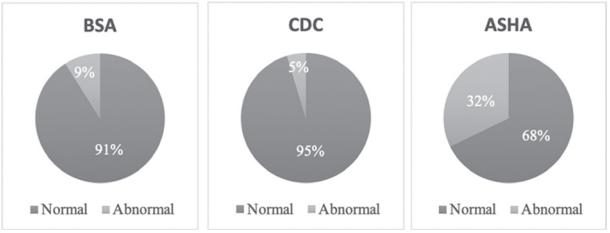


Figure 3. Hearing impairment according to the different societies

BSA = British Society of Audiology, CDC = U.S. Centers for Disease Control and Prevention, ASHA = American Speech-Language-Hearing Association



DISCUSSION

In the present study we defined hearing impairment according to the BSA classification due to its common use in practice among Israeli audiologists. We found the prevalence of hearing impairments to be almost 9% among a population of highly selected healthy candidates for the IAF flight academy.

The threshold for impaired hearing may considerably affect the results of population studies in the field of hearing. Audiological societies worldwide use different criteria for the threshold of hearing impairment. Among the three audiological societies, the CDC classification is the most lenient, while ASHA is the strictest. The percentage of impaired patients (9% according to BSA) would have been much higher (32%) had we used the ASHA classification [Figure 3]. Using the CDC classification would have resulted in a relatively low percentage (5%) of impaired tests.

The incidence of hearing impairment is reported to be 0.3% at birth but increases to approximately 1% in school-aged children. Our findings support the trend that was reported in various studies, indicating a further increase during adolescence. Regardless of the threshold selected, the percentage of impairment at the age of enlistment in the military (18 years) was found to be much higher (between 5% and 32%) in this study.

While standardized screening schedules exist through adolescence, formal guidance for young adults (≥ 18 years) is limited; thus, a targeted hearing screen at enlistment may be warranted [15]. The findings of this study, which align with prior research, suggest the need for a third hearing screening. This recommendation is particularly compelling considering that candidates for the IAF flight academy, being in optimal health, are not representative of the general adolescent population. Consequently, it is plausible that the prevalence of hearing impairments in the general population may be even higher.

Significant changes in adolescent listening habits over recent decades may explain the audiometric findings of this study [16,17]. These changes include the increased use of portable music devices capable of producing high sound levels. In its early stages, NIHL is typically characterized by a threshold change at the 4 kHz frequency [10]. In advanced stages, a downsloping audiogram is observed, with the 8 kHz frequency being most affected [18,19]. In this study, changes at the 8 kHz frequency were the most prevalent, accounting for more than one-third of the abnormal responses. In previous studies of NIHL, early changes often appear around 4 kHz and later extend

toward higher frequencies, resulting in a downsloping high-frequency pattern [18,19]. The predominance of 8 kHz abnormalities in our cohort is therefore compatible with a high frequency downsloping configuration; however, our cross-sectional design does not allow us to demonstrate progression over time. Therefore, we can interpret this finding cautiously as consistent with, rather than diagnostic of, advanced NIHL.

High-frequency thresholds are known to be more sensitive to noise effects. Research on ultra-high frequencies has demonstrated that threshold changes in these frequencies can occur years before standard audiometric changes are detected [20]. Further investigation is required to determine the role of ultra-high frequencies in the early detection of NIHL.

LIMITATIONS

Limitations of this study include the highly selected healthy patients who do not represent the general population, the retrospective nature of the study, and the lack of data regarding previous exposures (e.g., noise, smoking, medications). These limitations make it difficult to determine the exact cause for the hearing impairments. In addition, information on family history of hearing loss was not routinely documented and was therefore unavailable for analysis. Last, we lacked detailed data on environmental and behavioral exposures, including recreational listening habits, occupational or military noise, and other ototoxic factors, which limits our ability to determine the etiology of the observed audiometric abnormalities

CONCLUSIONS

Prevalence hearing impairment increases from 1% at entry into the education system to 8.45% at military enlistment. This finding may be correlated with the change in hearing habits of adolescents worldwide. Adding a third hearing screen at enlistment may help detect hearing impairments at an early stage, thus minimizing future disability and rehabilitation costs.

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