



# Tinnitus and hyperacusis in autism spectrum disorders with emphasis on high functioning individuals diagnosed with Asperger's Syndrome



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## ABSTRACT

**Objectives:** To evaluate the prevalence of tinnitus and hyperacusis in individuals with Asperger's Syndrome (AS).

**Methods:** A home-developed case-history survey and three item-weighted questionnaires: Tinnitus Reaction Questionnaire (TRQ), Tinnitus Handicap Inventory (THI), and the Hyperacusis Questionnaire (HQ) were employed. These tools categorize the subjective response to tinnitus and hyperacusis. The research tools were mailed to a mailing list of individuals with Asperger's Syndrome.

**Results:** A total of 55 subjects diagnosed with AS were included in the analysis (15.5% response rate). Sixty-nine percent of all respondents (38/55) reported hyperacusis with an average HQ score of 20.7. Furthermore, 35% (19/55) reported perceiving tinnitus with average scores of 27 for the TRQ and 23 for the THI. Thirty-one percent (17/55) reported both hyperacusis and tinnitus. The prevalence of hyperacusis in the AS respondents remained relatively constant across age groups.

**Conclusions:** Hyperacusis and tinnitus are more prevalent in the ASD population subgroup diagnosed with AS under DSM-IV criteria than in the general public. Hyperacusis also appears to be more prevalent in the AS population than in the ASD population at large. Future research is warranted to provide insight into the possible correlation between tinnitus and hyperacusis symptoms and the abnormal social interactions observed in this group.

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## 1. Introduction

Autism spectrum disorder (ASD) is characterized by deficits in social communication and interaction along with restricted, repetitive patterns of behavior, interests, or activities. Previously, the Diagnostic and Statistical Manual of Mental Disorders-Text Revision (DSM-IV-TR) defined separate diagnoses (autistic disorder, Asperger's Syndrome, Pervasive Developmental Disorder Not Otherwise Specified [PDD-NOS], childhood disintegrative disorder, and Rett syndrome) under the umbrella of ASD.

The more recent DSM-5 has done away with these distinctions and the diagnosis of ASD is now made along a continuous spectrum with specifiers of severity and associated features. According to the DSM-IV-TR, Asperger's Syndrome (AS) was differentiated from

other ASD diagnoses primarily by the absence of significant general language delay and absence of significant delay in cognitive development or in development of age appropriate adaptive behavior, self-help skills, and childhood curiosity about the environment. The AS population accounts for approximately 17% of the ASD population and is considered by some scientists to be synonymous with high-functioning autism [1,2].

Auditory manifestations in children with ASD are well documented in the literature and have been extensively reviewed [3–6]. These include difficulties with hearing abilities, tinnitus, auditory processing and hypersensitivity to loud sounds. One study which showed hearing loss to be more prevalent in those with ASD also reported that 18% of the ASD group and none of the typically developing group were affected by hyperacusis [7]. Hyperacusis or hypersensitivity to sounds is defined as consistently exaggerated or inappropriate responses to sounds that are neither threatening nor uncomfortably loud to a typical person [8,9]. A wide range of prevalence estimates for hyperacusis in the

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ASD population have been reported and this variation seems to be due to differences in criteria used for evaluation [10]. Hyperacusis evaluation can be somewhat complicated. Hyperacusis, in some cases can be a self-reported condition or an observed behavior by parents of an individual in autism spectrum. On the other hand, hyperacusis can be a laboratory established diagnosis based on the measurement of Loudness Discomfort Levels (LDLs) using acoustic stimuli [6]. Hyperacusis can limit a persons' social interactions and diminish their abilities in understanding speech in noisy environments. For individuals with ASD these limitations will essentially exacerbate their functionality and may aggravate their symptomology. Tinnitus is defined as the conscious perception of an auditory sensation in the absence of corresponding external stimulus. Prevalence estimates vary although most studies suggest tinnitus is experienced by 10–15% of the general population [11]. Current literature does not reveal an estimated prevalence of tinnitus in ASD population. In addition to these auditory manifestations, sensory processing issues have also been associated with AS specifically [12].

Due to the lack of data on the prevalence of tinnitus and hyperacusis in AS population, gathering data using the current criteria will be an important contribution to the existing body of knowledge because tinnitus and hyperacusis could be significant factors hindering development, education, and social function in this population.

Given that both tinnitus along with hyperacusis are commonly comorbid conditions in the general population, we hypothesize that the prevalence of hyperacusis and tinnitus will be greater in the AS population than in the general population. The purpose of the current study was to evaluate the prevalence of tinnitus perceptions and hyperacusis as well as other auditory manifestations in individuals diagnosed with AS under DSM-IV TR criteria.

## 2. Methods

A home-developed case-history survey and three item-weighted questionnaires: Tinnitus Reaction Questionnaire (TRQ), Tinnitus Handicap Inventory (THI), and the Hyperacusis Questionnaire (HQ) were employed. These tools categorize subjective response to tinnitus and hyperacusis.

### 2.1. Tinnitus Reaction Questionnaire (TRQ)

The TRQ was developed and validated to assess psychological distress associated with tinnitus [13]. This questionnaire has a total of 26 items. Each item is rated on a 5 point scale: 0 = not at all, 1 = a little of the time, 2 = some of the time, 3 = a good deal of the time, 4 = almost all of the time. The values of all 26 individual items are added for a final score. A higher score indicates more distress and the maximum score is 104. A score of greater than or equal to 17 is considered significant enough to receive formal treatment [14].

### 2.2. Tinnitus Handicap Inventory (THI)

The THI was developed and validated to assess an individual's perceived handicap due to tinnitus [15]. This questionnaire contains 25 items. Possible responses to each item are "yes", "sometimes", and "no". A "yes" response is given 4 points; sometimes, 2 points; and "no", 0 points. Thus, the maximum score is 100 with higher scores indicating greater perceived handicap [15]. Scores are also divided into 5 grades of tinnitus severity (Table 1).

### 2.3. Hyperacusis Questionnaire (HQ)

The HQ was developed and validated to quantify and evaluate various hyperacusis symptoms. The questionnaire has 14 items assessing three dimensions (attentional, social, and emotional) and answers are given on a 4 point scale (0 = no, 1 = yes, a little, 2 = yes, quite a lot, 3 = yes, a lot). The maximum score is 42, with a score above 28 indicating strong auditory hypersensitivity [16].

### 2.4. Home-developed history survey

This survey was designed in such a manner as to explore the relationships concerning hearing loss, tinnitus, and hyperacusis in this population and included questions regarding comorbidities and use of medications which could potentially result in hearing loss, tinnitus, and hyperacusis due to ototoxic interactions.

The questionnaires were mailed to 356 families and individuals registered with and appearing on the mailing lists of the Center for Autism and Related Disabilities (CARD) at Florida Atlantic University (FAU) and the University of Miami (UM). Participants were all previously diagnosed with AS by appropriate specialists using tools such as Autism Diagnostic Observation Schedule (ADOS) or Autism Diagnostic Inventory (ADI). Subjects completed a consent form approved by FAU Institutional Review Board (IRB). For those participants who were unable to complete the questionnaires independently, a family member or caregiver provided assistance. Subgroup analysis was also performed by subjects' chronological age. The participants were from the mailing list of CARD center with a primary diagnosis of the AS. This mailing list includes both families and individuals with AS. A short advertisement was printed in CARD newsletter inviting individuals to participate in the study. We had used a similar advertisement in the past for recruiting ASD population for a couple of other studies. The terms tinnitus and hyperacusis were defined in the survey package as hearing sounds such as ringing or noise in the ears or head and being sensitive to the loudness of sounds which are not considered loud by others, respectively.

## 3. Results

A total of 55 subjects diagnosed with AS were included in the analysis (15.5% response rate). Forty-six were males and 9 were females (gender ratio 5:1). The age range of subjects was 4–42

**Table 1**  
Tinnitus Handicap Inventory (THI) scoring [15].

THI score	Significance	Grade
0–16	Slight (only heard in quiet environments)	Grade 1
18–36	Mild (easily masked by environmental sound and easily forgotten with daily activities)	Grade 2
38–56	Moderate (noticed in presence of background noise, although daily activities can still be performed)	Grade 3
58–76	Severe (Almost always heard, leads to disturbed sleep patterns and can interfere with daily activities)	Grade 4
78–100	Catastrophic (Always heard, disturbed sleep patterns, difficulty with any activities)	Grade 5

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