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Original Article

Audiological Assessment of Children With Autism Spectrum Disorder

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ABSTRACT

Background: Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is marked by social communication and interaction difficulties, along with restricted and repetitive behaviors and interests, and abnormal responses to certain sounds. Problems related to responses to sounds are common in ASD, especially in children, and can be a sign of actual hearing loss. As hearing is a prerequisite for speech, language, and communication, the presence of hearing loss along with autism can complicate the child's development even more. Hence, it is vital to assess the hearing of a child with autism objectively to differentiate between the actual hearing loss and behavioral responses to sounds, which are a feature of autism itself. Objective: The objective of the study was to assess the type and degree of hearing loss in children with autism spectrum disorder using objective audiological evaluation. Methods: A descriptive cross-sectional study was designed to assess the hearing of children with autism spectrum disorder, where a total of 71 children with ASD, ranging from 2 to 15 years, who underwent audiological evaluation in clinical settings in Lahore, Pakistan, during June 2024 to June 2025, were included in the study using a purposive sampling method. Audiological evaluation was done, and the degree of hearing loss was classified according to the standard decibel scale of hearing loss. The data were analyzed using SPSS version 25. The results were then presented in the form of frequencies and percentages. Result: The majority of the sample consisted of children aged between 2-6 years. Out of the total sample, 60.6% were within this age group. In otoscopic examination, normal results were found in 90.1%. In OAE tests, normal results were found in 71.8%. On the other hand, refer results were found in 28.2%. In ABR tests, normal results were found in 69%. Mild, severe, and profound hearing loss were found in 8.5%, 9.9%, and 12.7%, respectively. In hearing loss type, normal results were found in 70.4%. On the other hand, conductive and sensorineural hearing loss were found in 8.5% and 21.1%, respectively. In tympanometry tests, normal results were found in 87.3%. Conclusion: In the study, it has been found that the majority of the sample with ASD have normal hearing thresholds. However, a significant number of the sample have clinically significant hearing impairment. In this study, sensorineural hearing loss has been found

to be significant. Hence, it has been found that objective audiological tests are essential in the evaluation of hearing in ASD children.

Keywords:

Autism spectrum disorder, hearing loss, auditory brainstem response, otoacoustic emissions, audiological assessment, children.

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that manifests with persistent deficits in social communication and interaction along with restricted and repetitive patterns of behavior, interests, and sensory reactivity. Auditory over-responsiveness, response to verbal cues, orienting to name, and environmental noise tolerance have been commonly reported in children with ASD. These auditory concerns contribute significantly to the symptom profile of ASD and need to be addressed accordingly. As language acquisition, social interactions, and educational activities are all dependent on adequate hearing ability, the co-occurrence of hearing loss may add to the complexity of communication and thereby hinder the timely management of such children (1,2).

Autism spectrum disorder is now regarded as a major pediatric public health problem with a significant prevalence rate among children worldwide. Recent surveillance studies have emphasized the implications of ASD on the developmental and educational needs of children. Simultaneously, hearing loss is regarded as the most important sensory deficit that affects the quality of life in children worldwide. The co-occurrence of hearing loss and autism spectrum disorder poses a great challenge in the clinical management of such children. The co-occurrence of the two may result in a child not responding to speech and thereby being labeled as a behavior problem or a socially disengaged child. On the contrary, a child with increased auditory reactivity to environmental sounds may be assumed to have adequate hearing ability when the underlying auditory dysfunction may not have been ruled out during the clinical evaluation process (3,4).

The need to conduct an accurate hearing evaluation in children with ASD is further emphasized by reports of a co-occurrence of hearing impairment with autism more frequently than is currently appreciated in developmental care. Past research literature has noted varied audiological profiles in children with ASD, where children have been found to have normal peripheral hearing, conductive hearing loss with middle ear problems, sensorineural or cochlear hearing loss, hyperacusis, and subclinical auditory deficits, which might impact communication skills in children with ASD. What is of clinical significance is that children with developmental disabilities, such as ASD, are likely to have compromised access to gold standard hearing evaluation, which might further add to diagnostic complexities. This is clinically significant, as hearing loss in children with ASD might further impair compromised receptive and expressive communication, social, and educational skills in children with ASD (5,6).

One of the limiting factors in achieving an accurate diagnosis is that conventional behavioral audiometry is based on cooperation, sustained attention, understanding of tasks, and consistent response patterns. It is possible that children with ASD might not be able to fulfill all of these criteria, especially if they are young or have high levels of sensory processing issues, anxiety, or communication problems. This might lead to an over- or underestimation of their hearing level and might also lead to inconclusive results. OAE and ABR are very useful in diagnosing children with ASD, especially because they don't require any kind of behavioral participation or cooperation with the test, unlike conventional behavioral audiometry. OAE measures the function of outer hair cells, while ABR measures neural conduction from the cochlea to the brainstem, enabling an estimation of hearing level in spite of poor test behavior. Past research has demonstrated the usefulness of OAE and ABR in children with ASD and has established that children with ASD have identifiable hearing loss, in spite of poor test behavior (7-9).

However, the existing literature remains inconsistent in reporting the prevalence, type, and degree of hearing loss in children with ASD. While some studies have reported normal or near-normal hearing with occasional subclinical deviations, others have reported significant rates of conductive, cochlear, or more profound hearing loss in these patients. Middle ear problems have also been reported to be common in autistic children and may cause reversible conductive hearing loss, which may compound the speech access problems in these patients. More recent reports on ASD patients also emphasize the need for repeated and objective audiological tests to obtain definitive results in these patients, as results may not always be obtained from a single behavioral test. These reports clearly emphasize that audiological testing in ASD patients should not be considered as a routine exclusion process but as an integral part of the overall assessment process for these patients (10-13).

Despite the accumulation of information globally, there is a scarcity of information regarding the extent and type of hearing loss in children with ASD evaluated in audiology clinics. This information gap has significant implications in regions where delayed diagnosis and limited access to audiological evaluation may be a problem. In this setting, the aim of this study was to identify the type and extent of hearing loss in children with autism spectrum disorders using objective audiological evaluation. The research question that this study set out to find answers to was what are the extent, type, and prevalence of hearing loss in children with autism spectrum disorders undergoing audiological evaluation in tertiary and specialized clinical settings (11,12,14).

MATERIALS AND METHODS

The research design selected for this study was a descriptive cross-sectional observational study to identify the type and extent of hearing loss in children with autism spectrum disorders. This study was conducted in audiology clinics in the city of Lahore, Pakistan. In this setting, children with developmental disorders are referred to audiology clinics for audiological evaluation. The study design selected for this research study allowed for the evaluation of the type and extent of hearing loss in children with autism spectrum disorders using objective audiological evaluation. This research design also allowed for the description of the type and extent of hearing loss in the selected population. This study selected this research design to allow for the description of the type and extent of hearing loss in the selected population. This research design also allowed for the evaluation of the type and extent of hearing loss in the selected population. In this setting, the prevalence of hearing loss in children with autism spectrum disorders would be identified. This research design also allowed for the description of the type and extent of hearing loss in the selected population. In this setting, the extent, type, and prevalence of hearing loss in children with autism spectrum disorders would be identified. This research design also allowed for the evaluation of the type and extent of hearing loss in the selected population. In this setting, the extent, type, and prevalence of hearing loss in children with autism spectrum disorders would be identified. This research design also allowed for the description of the type and extent of hearing loss in the selected population. In this setting, the extent, type, and prevalence of hearing loss in children with autism spectrum disorders would be identified. This research design also allowed for the evaluation of the type and extent of hearing loss in the selected population.

Children who were previously diagnosed with ASD and were scheduled to undergo a hearing assessment were included in the study. Both male and female children between 2 and 15 years of age were included. A diagnosis of ASD was made prior to referral by qualified professionals based on standard developmental and behavioral assessments. Non-probability purposive sampling was used to recruit children from audiology clinics. Children with autism undergoing hearing assessments within the study period were included if parents or guardians gave consent. Other children with known neurological, developmental, or medical conditions that may independently affect hearing were excluded from the study. This was to minimize confounding factors on hearing. Parents were educated about the purpose of the study, and consent was obtained from parents or guardians before children were included in the study. This was done to promote ethical research practices (16).

Audiological assessment was carried out using standardized procedures. For the participants, otoscopic examination was performed using a diagnostic otoscope to observe the condition of the external auditory canal and tympanic membrane and to check for any obstruction, infection, or abnormalities that might affect the outcome of the hearing assessment. Tympanometry was then performed to determine the

middle ear condition, and the tympanogram patterns obtained were classified according to conventional types, where Type A indicated normal middle ear function and Type B suggested the possibility of middle ear pathology and conductive hearing impairment. Objective cochlear function was measured using OAE, which is the measurement of the sounds emitted from the cochlea due to the stimulation of outer hair cells. OAE results were classified as "pass" when the OAEs are present and as "refer" when OAEs are absent, indicating cochlear dysfunction and middle ear pathology (17).

The evaluation of neural conduction in the auditory pathway was also performed using the auditory brainstem response (ABR) test. The ABR test is an electrophysiological procedure used to measure the electrical activity of the auditory nerve and the brainstem in reaction to sound stimuli. The procedure requires the placement of surface electrodes on the scalp, as per standardized audiological procedures, and the administration of sound stimuli through insert earphones. The waveform responses obtained during the procedure are used to measure the hearing thresholds and assess the presence of abnormal neural conduction in the auditory pathway. The hearing thresholds obtained during the ABR procedure are classified into conventional categories of hearing level, expressed in decibels hearing level (dB HL). The range of hearing thresholds between −10 and 15 dB HL is classified as normal hearing, slight hearing loss is classified as a range of 16 to 25 dB HL, mild hearing loss is classified as a range of 26 to 40 dB HL, moderate hearing loss is classified as a range of 41 to 70 dB HL, severe hearing loss is classified as a range of 71 to 90 dB HL, and profound hearing loss is classified as a range greater than 91 dB HL. Based on the audiological procedures, hearing loss is classified into conductive, sensorineural, and normal auditory functions (18).

The main outcome measures included the degree of hearing loss as established through ABR threshold estimation and the type of hearing loss as categorized through audiological findings. Other descriptive measures included age distribution, otoscopic findings, and tympanometric classification.

These measures were defined using established audiological measures to ensure that there was no variability in defining the measures and interpretation of findings. All testing for participants followed standardized testing measures, and audiology professionals were used for all testing to ensure that there was no bias in testing procedures (19).

Determination of the sample size for this study was established through previously established measures of hearing loss in children with autism spectrum disorder. A confidence level with a high degree of confidence and minimal error margin was established using a previously established 33% prevalence of hearing loss in children with autism spectrum disorder. The established sample size for this study was seventy-one participants (20). All participants who met the inclusion criteria for this study and were encountered during the study period were included in this study.

The data collected during the clinical assessment process was documented on data collection forms and later entered into a structured dataset for analysis. The statistical analysis of the data was done using the Statistical Package for Social Sciences (SPSS) software version 25. The process of validating the data for accuracy in entry and consistency in classification for various data sets was included in the analysis process. The analysis process mainly involved descriptive statistics for the audiological findings in the population (21).

Ethical principles that guide biomedical research with human participants were stringently followed during the study. Ethical approval was sought from the institutional review ethics committee before the study was conducted. The study was voluntary, and the participants gave their consent for the study by the parents or guardians of the children who participated in the study. The confidentiality of the participants was ensured by the use of coded identifiers for each participant and access to identifiable information was restricted. The audiological tests that were performed during the study were standard tests that were used for the diagnosis of the participants and did not put the participants at risk (22).

RESULTS

Table 1. Age Distribution of Participants

Age Group (years)	Frequency (n)	Percentage (%)	95% CI (%)	p-value*
2–6	43	60.6	49.1–71.0	<0.001
7–10	3	4.2	1.4–11.6	
11–15	25	35.2	25.2–46.7	
Total	71	100	—	

This table represents the distribution of children included in this study based on age. It was found that most of the population belonged to the age group of 2–6 years, which comprised 43 (60.6%) of the total

sample population. Children belonging to the age group of 11–15 years comprised 25 (35.2%) of the total sample population. Only 3 (4.2%) of the total sample population belonged to the age group of 7–10 years.

Table 2. Type and Severity of Hearing Loss Determined Through ABR

Type of Hearing Loss Determined Through ABR	Hearing Loss Type	Frequency (n)	Percentage (%)	95% CI (%)	Odds Ratio	p-value*
	Normal auditory function	50	70.4	58.9–80.0	Reference	<0.001
	Cochlear (sensorineural) loss	15	21.1	13.2–31.9	0.30	
	Conductive hearing loss	6	8.5	3.9–17.4	0.12	
Hearing Loss Severity Determined Through ABR	Normal hearing	49	69.0	57.4–78.7	0.42	<0.001
	Mild hearing loss	6	8.5	3.9–17.4		
	Severe hearing loss	7	9.9	4.8–19.3		
	Profound hearing loss	9	12.7	6.7–22.5		

This table shows the type of hearing loss that was determined using the ABR test. Normal auditory function was observed in 50 participants (70.4%). Cochlear or sensorineural hearing loss was observed in 15 children (21.1%). Conductive hearing loss was observed in 6 participants (8.5%). The above table indicates that sensorineural loss was more common than conductive loss among the participants. Normal hearing thresholds were observed in 49 participants (69.0%). Mild hearing loss was observed in 6 children (8.5%), while severe hearing loss was observed in 7 children (9.9%). Profound hearing loss was observed in 9 participants (12.7%). From the above table, it is evident that most participants had normal hearing; however, a considerable percentage had a high degree of hearing loss.

Table 3. Tympanometry Findings

Tympanogram Type	Frequency (n)	Percentage (%)	95% CI (%)	Odds Ratio	p-value*
Type A (normal middle ear function)	62	87.3	77.4–93.4	Reference	<0.001
Type B (possible middle ear pathology)	9	12.7	6.7–22.5	0.15	

This table presents the tympanometric findings of the study participants. Type A tympanograms, indicating normal middle ear function, were found in 62 children (87.3%). Type B tympanograms, suggestive of middle ear pathology, were observed in 9 children (12.7%).

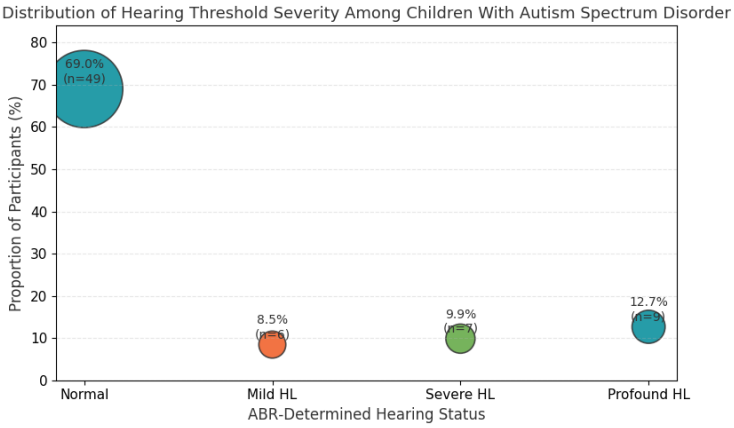

Figure 1

This figure shows that Normal hearing was the dominant group, which comprised 49 (69.0%) of the participants, clearly separating from all the other severity groups, thus indicating that most of the children did not experience any measurable degree of peripheral hearing loss. Mild hearing loss was experienced by 6 (8.5%) of the children, and severe hearing loss was experienced by 7 (9.9%) of the participants. Profound hearing loss was the greatest abnormal group, accounting for 9 (12.7%) of the children.

DISCUSSION

The results of this current study clearly demonstrated that a majority of children with ASD had normal hearing thresholds, based on auditory brainstem response testing, with 69% of children in this study showing normal hearing levels. Despite this high level of normal auditory functioning, a clinically significant percentage of children in this sample had measurable hearing impairment. Approximately 31% of children in this sample had some level of hearing loss, with 8.5% showing mild hearing loss, 9.9% showing severe hearing loss, and 12.7% showing profound hearing loss.

In addition, an analysis of the type of hearing loss was also conducted and demonstrated that 21.1% of children in this sample had cochlear/sensorineural hearing loss, while 8.5% had conductive hearing loss. This demonstrates that sensorineural hearing loss was the most frequently occurring type of hearing impairment in children with abnormal audiological test results. This is similar to other research that investigated audiological profiles of children with ASD (23,24). Other research that utilized objective auditory measures to investigate children with ASD demonstrated that while a majority of children with ASD had normal hearing, a significant percentage had cochlear/sensorineural hearing loss or abnormalities in auditory neural conduction.

The current study demonstrated a slightly higher level of cochlear/sensorineural hearing loss compared to conductive hearing loss, and this is consistent with other research that demonstrated that sensorineural mechanisms are responsible for auditory abnormalities in children with ASD(25).

The results of the otoacoustic emissions tests also supported the results obtained in this study, as the majority of the children, i.e., 71.8%, scored a pass in the results, indicating normal cochlear outer hair cell function, while 28.2% of the sample were referred, suggesting possible cochlear dysfunction/middle ear pathology. The presence of abnormal OAE results in almost one-third of the sample also emphasizes the importance of objective audiologic tests in children with ASD.

The results of the present study correlate with the earlier studies that suggested that the incidence of hearing impairment in children with ASD may be higher compared to the general population of children. According to the study by Demopoulos and Lewine, a considerable number of children with ASD show abnormalities in audiological tests, even when pure tone thresholds are within the normal limits (26). Similarly, a study by Rosenhall et al. suggested that the incidence of hearing impairment and hyperacusis was higher in autistic persons and emphasized the complex nature of hearing in such persons (27).

One of the important implications of the present study is the importance of the complexity of hearing evaluation in children with developmental disorders such as ASD. The behavioral test for hearing evaluation requires the participation and attention of the child and an understanding of the instructions for the test, which may not be possible for many children with ASD. The importance of objective tests such as ABR and OAE in the evaluation of hearing in such children is thus clear. The electrophysiological test provides an opportunity for the evaluation of the hearing of the child without the need for a behavioral test and thus prevents the chances of misdiagnosis and delayed detection of hearing impairment (28).

From a clinical perspective, the presence of hearing impairment and autism may have a number of implications for the therapeutic process and the formulation of an intervention plan for the child with ASD and hearing loss. The child may need more complex therapeutic interventions that address the combined effects of the hearing loss and the autism spectrum disorder. The timely identification of hearing loss enables the clinician to provide appropriate interventions such as the provision of an amplification device, medical management for conductive hearing loss, and evaluation for cochlear implantation.

This study contributes to the body of literature on the study of the hearing condition of children with ASD in the clinical context. The study provides useful information for the development of appropriate clinical management and interventions for the condition. The study provides objective data on the hearing condition of the sample of children with ASD and contributes to the body of literature on the importance of the evaluation of the hearing condition of children with ASD.

However, a number of limitations need to be taken into account when analyzing the results of the study. The study had a relatively small sample population of seventy-one participants and a non-probability purposive sample design. The study was not able to assess the effects of the passage of time on the hearing condition and the progression of the hearing dysfunction in the sample of participants with ASD and hearing loss. The level of cooperation of the participants and the level of severity of the autism may have affected the results of the study. Future studies with larger sample populations and a longitudinal study design may provide a better understanding of the effects of autism and hearing loss.

Despite such limitations, the study underscores the significance of objective audiological assessment in children with ASD. It is evident from the study that, while a considerable number of children with autism have normal hearing, a significant proportion of them suffer from clinically significant hearing impairment. Thus, screening of children with autism using objective audiological measures is of great significance in their accurate diagnosis and management.

CONCLUSION

The study on the type and degree of hearing loss in children with autism spectrum disorder using objective audiological tests has revealed that the majority of children with ASD possess normal hearing status; however, a significant number of children have shown some degree of hearing loss. Severe and profound hearing loss has been a significant proportion of the total hearing loss in children with ASD. Sensorineural hearing loss has been more prevalent in children with ASD in comparison to conductive hearing loss; however, normal middle ear function has been evident in the majority of children with ASD.

The study has revealed that a significant number of children with ASD possess some degree of hearing loss; hence, there is a need for objective audiological tests to determine the status of hearing in children with ASD. The study has revealed that a significant number of children with ASD possess normal hearing status; however, there is a need for objective audiological tests to determine the status of hearing in children with ASD.

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