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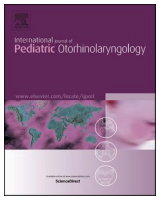

Sensory processing in Autism Spectrum Disorder: Insights into misophonia, and hyperacusis in a pediatric population

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ABSTRACT

Objective: This study aims to investigate the prevalence of misophonia and hyperacusis in children with Autism Spectrum Disorder (ASD), focusing on gender differences and sensory processing challenges. The research further explores how these sensory sensitivities impact daily functioning and how they may differ across genders in a pediatric population.

Methods: A total of 60 children aged 2–12 years, diagnosed with ASD, intellectual disability, borderline intellectual functioning, or co-occurring ADHD, participated in the study. Parental consent was obtained, and parents completed the Misophonia Impact and Hyperacusis Impact Questionnaires, which assess the presence and severity of sound sensitivities. Data analysis included frequency distributions and Spearman's rank correlation to examine potential associations between age and the severity of sensory symptoms.

Results: The study found that 45 % of participants exhibited misophonia, and 38 % showed signs of hyperacusis. A slightly higher prevalence of misophonia and hyperacusis was observed in female participants (50 % and 43 %, respectively) compared to males (43 % and 37 %, respectively). No significant correlation was found between the age of participants and the severity of misophonia ($r = 0.22$, $p > 0.05$) or hyperacusis ($r = 0.19$, $p > 0.05$).

Conclusions: Misophonia and hyperacusis are prevalent sensory challenges among children with ASD, with a slightly higher occurrence in females. These findings suggest that sensory sensitivities persist across developmental stages and may be more pronounced in females. Early identification and gender-sensitive, sensory-focused interventions are critical for improving the quality of life and daily functioning of children with ASD. Future research should explore the underlying mechanisms of these sensory sensitivities to enhance intervention strategies across diverse populations.

1. Introduction

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterized primarily by social-communication challenges and restricted, repetitive behaviors, forming the core criteria for its diagnosis. Variations in intellectual and language abilities contribute to the diversity in ASD presentations [1,2]. Symptoms of ASD typically manifest before age 3 and persist throughout life, though severity may vary over time [3]. ASD affects individuals across multiple domains, impacting communication, reciprocal social interactions, and learning; these limitations are compounded by repetitive or stereotyped behaviors that vary widely among affected individuals [4,5].

While the exact causes of ASD remain elusive, multiple risk factors have been identified, including advanced paternal age, maternal health conditions (e.g., diabetes and thyroid dysfunction during pregnancy), and environmental exposures [6]. Genetic predisposition is also considered substantial, with recent research emphasizing the importance of gene-environment interactions in ASD development [7,8]. Additionally, emerging studies suggest that early-life environmental factors, such as excessive screen time between ages 1–2, may contribute to the risk or exacerbation of ASD symptoms [9,10]. The global prevalence of ASD is estimated at 1 in 100 children, making it a significant public health concern [11,12].

Atypical sensory processing is common in ASD, with many individuals exhibiting sensitivity to environmental stimuli, such as sounds. Recent studies indicate that 50–70 % of individuals with ASD experience decreased sound tolerance (DST), which can lead to considerable distress and functional impairment, manifesting in anxiety,

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behavioral challenges, and difficulties in community participation, education, and employment [13,14]. This hypersensitivity is particularly relevant when exploring the link between ASD and misophonia, a condition characterized by extreme discomfort in response to specific sounds. In a recent study, Ertürk et al. identified a correlation between the severity of misophonia symptoms and the presence of autistic traits, underscoring the potential overlap in sensory processing differences across these conditions [15,16].

Investigating the neurobiological mechanisms, developmental trajectories, emotional and cognitive dimensions, and environmental triggers associated with sensory sensitivities in ASD is essential. Such research will not only deepen our understanding of ASD but also inform effective, culturally sensitive interventions tailored to diverse populations [17,18]. This study aims to examine the relationship between misophonia, hyperacusis, and ASD in Indian children aged 2–10 years and to compare these findings with data from Western populations. Understanding these cross-cultural presentations will provide valuable insights into the impact of cultural context on sensory sensitivities in ASD and guide intervention strategies globally [19,20].

2. Methods

This study included 60 participants diagnosed with Spoken Language Disorder secondary to Autism Spectrum Disorder (SLD 2° to ASD), ASD with Intellectual Disability (ID), ASD with Borderline Intellectual Functioning (BIF), and ASD with Attention Deficit Hyperactivity Disorder (ADHD). Table 1 provides a breakdown of these co-existing diagnoses. Of the 60 participants, 14 were female, and 46 were male, with an age range of 2–12 years (mean age = 5.8 years).

The target population included children with ASD, those exhibiting significant autistic features, or those with an autism component in diagnoses involving ASD, ID, BIF, or ADHD. Parental consent was obtained for all participants prior to study commencement.

Parents completed two questionnaires: the Misophonia Impact Questionnaire (Parent version) and the Hyperacusis Impact Questionnaire (Parent version), developed by the Hashir International Specialist Clinics and Research Institute for Misophonia, Tinnitus, and Hyperacusis [21]. The Misophonia Impact Questionnaire assesses responses to disliked sounds (e.g., cooker whistles, mixer grinders), including difficulty ignoring these sounds, disruptions to daily activities, and feelings of anxiety, anger, irritation, or low mood. It also queries whether the participant avoids family members who speak loudly. The Hyperacusis Impact Questionnaire assesses discomfort, anxiety, fatigue, low mood, and difficulty with daily activities due to loud sounds, as well as challenges in maintaining concentration. Both questionnaires are based on a 4-point rating scale: 0–1 day (score 0), 2–6 days (score 1), 7–10 days (score 2), and 11–14 days (score 3), with each containing eight questions. Completion of both questionnaires took approximately 15 min.

3. Results

The results of the study showed that 27 out of 60 children showed presence of Misophonia. Out of 27, seven were females and 20 were males. This shows that 50 % (7 out of 14) female children and 43 % (20 out of 46) male children reported of Misophonia (Fig. 1). We also found that 23 out of 60 children showed presence of hyperacusis. Out of 23, six were females and 17 were males. 43 % (6 out of 14) female children and 37 % (17 out of 46) reported of hyperacusis (Fig. 2). This supports that the prevalence of hyperacusis and misophonia was slightly more for female children with ASD compared to males.

Table 1
Number of children with associated clinical diagnoses.

Diagnosis	Number of children
SLD 2° to ASD	42
SLD 2° to ASD (?)	4
SLD 2° to ASD with ID	7
SLD 2° to ID with ASD	3
SLD 2° to ASD with BIF	2
SLD 2° to ASD with ADHD	1
SLD 2° to ID	1
Borderline SLD with ASD	1

Spearman's rank correlation was done to determine if there is any correlation between the age of the participants and the misophonia and hyperacusis scores. The results of the study also showed that there was no correlation between the age of the participants and the misophonia scores ($r = 0.22$, $p > 0.05$) and hyperacusis scores ($r = 0.19$, $p > 0.05$).

4. Discussion

The study results revealed that 45 % of children with Autism Spectrum Disorder (ASD) in the sample exhibited misophonia, while 38 % demonstrated hyperacusis. Demopoulos and Lewine [22] reported that 37 % of participants with ASD had sound sensitivity in at least one ear. Danesh et al. [23] found that 69 % of individuals with Asperger's Syndrome reported hyperacusis. A meta-analysis by Williams et al. [24] estimated the current prevalence of hyperacusis in individuals with ASD to be 41.42 % which is similar to results obtained in our study. Williams et al. [25] examined the overlap between autistic traits and misophonia in adults and suggested that rates of autism might be elevated in individuals with misophonia. While specific prevalence percentages in children with ASD were not provided, the study highlights a notable association. Further targeted studies are needed to provide precise prevalence rates for misophonia in individuals with ASD, particularly among children.

It was found in the study that 50 % of female participants (7 out of 14) and 43 % of male participants (20 out of 46) were affected by misophonia, suggesting a slightly higher prevalence in females with ASD. Similarly, hyperacusis was observed in 43 % of female participants and 37 % of males, indicating a marginally higher occurrence in females. This gender difference may reflect variations in sensory processing among children with ASD, as recent studies also report gender-based differences in sensory sensitivity and response patterns in ASD [19,26,27].

Sensory processing challenges, including hyperacusis and misophonia, are known to be prominent in children with ASD, impacting daily functioning and quality of life [24]. Such sensory sensitivities are linked to emotional distress, social withdrawal, and increased anxiety, making targeted support essential for improving daily experiences for affected children [28,29]. Studies indicate that sensory processing difficulties in ASD do not typically diminish over time but remain stable, as seen in the lack of correlation between participant age and the severity of misophonia ($r = 0.22$, $p > 0.05$) or hyperacusis ($r = 0.19$, $p > 0.05$) in this study. This finding supports prior work demonstrating that sensory sensitivities persist across developmental stages in ASD [30,31].

The slightly higher prevalence of misophonia and hyperacusis among female participants is noteworthy. Emerging research suggests that females with ASD may experience greater sensory sensitivity than their male counterparts, which may exacerbate anxiety and affect social engagement, school participation, and functional outcomes [19,26]. Given these findings, early identification and intervention for sensory sensitivities in ASD, particularly for females, may offer substantial benefits.

Recent studies advocate for sensory-focused therapies, which have shown promise in managing sensitivities and promoting better social integration and emotional well-being [18,28]. Addressing these sensory needs through personalized therapy could reduce behavioral challenges and enhance engagement in daily activities. However, further research into the neurobiological underpinnings of sensory processing in ASD and gender-based response patterns is needed to guide more effective interventions across diverse populations [27,29].

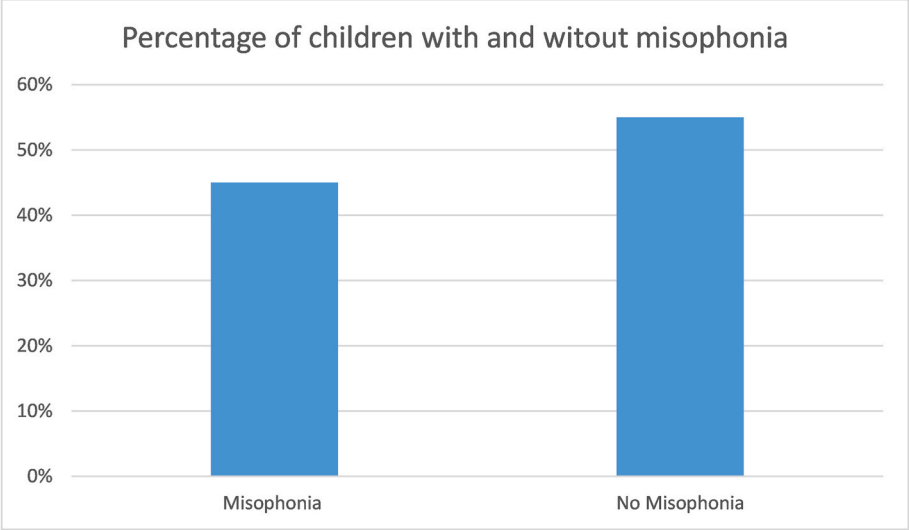

Fig. 1. Percentage of children with ASD with and without Misophonia.

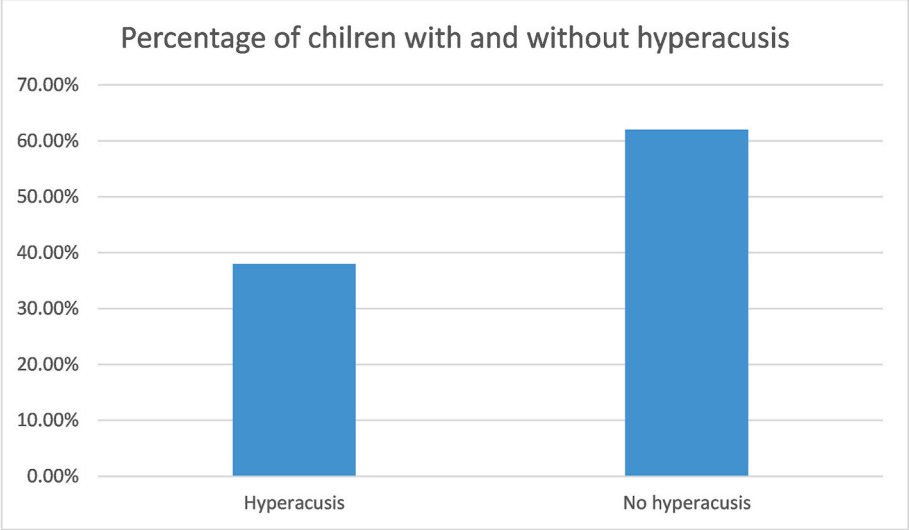

Fig. 2. Percentage of children with ASD with and without Hyperacusis.

5. Conclusions

This study highlights the significant presence of sensory processing challenges, specifically misophonia and hyperacusis, among children with ASD. Nearly half of the children displayed misophonia, while over a third experienced hyperacusis, with a slightly higher prevalence observed in female participants. This finding suggests that girls with ASD may exhibit greater sensory sensitivity compared to boys.

The persistence of these sensory sensitivities, regardless of age, indicates the need for ongoing support as children with ASD grow. Addressing these sensory challenges is crucial, as they can contribute to increased anxiety, social withdrawal, and difficulties with school and community engagement. Early identification and intervention for these sensitivities could improve daily functioning and overall quality of life.

Implementing sensory-focused therapies tailored to individual sensory profiles may help alleviate the impact of sensory sensitivities on these children's lives. Future research should explore the underlying mechanisms of sensory processing in ASD and examine how cultural, environmental, and gender-related factors influence sensory responses. By developing targeted and culturally responsive interventions, it is possible to support better outcomes and enhance the well-being of individuals with ASD globally.

CRediT authorship contribution statement

Manasi Sadanand Katikar: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Anuprarthana Devi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Prashanth Prabhu:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

This is an original work that has not been published nor submitted to another journal.

There is no conflict of interest to disclose.

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