

Sensory processing patterns in children with attention-deficit hyperactivity disorder: A case-control study



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ABSTRACT

Background: Sensory processing (SP) indicates the ability of the nervous system to receive, analyze, process, and respond to external sensory input and coordinates motor movements accordingly. Children with various neurodevelopmental disorders, like autism spectrum disorder, have SP issues. However, studies regarding SP issues in attention-deficit/hyperactivity disorder (ADHD) compared to typically developing children are relatively less. **Aims and Objectives:** To study the SP pattern of children with ADHD, to compare with the control group, and to study the correlation of symptom severity with SP deficit in children with ADHD. **Materials and Methods:** All children attending the child guidance clinic at R. G. Kar Medical College and Hospital were screened, and children with ADHD without any other comorbid disorder as diagnosed by Diagnostic and Statistical Manual 5 were selected. Their ADHD symptom severity was assessed using the ADHD test, and SP was assessed using the Short Sensory Profile (SSP). **Results:** The SSP mean score of the children with ADHD was significantly different than the mean score of the control group, and the percentage of children having a definite difference in SP was significantly different in the ADHD children group compared to the control group. The severity of the SP deficit also correlates with the severity of ADHD symptoms, as found by the correlation study. **Conclusion:** Children with ADHD have shown a definite difference in SP compared to controls, and the severity of the sensory problem is proportionate to the severity of the symptoms of ADHD.

Key words: Attention-deficit/hyperactivity disorder; Short sensory profile; The short sensory profile; Sensory processing

INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common childhood psychiatric disorders, affecting 5–10% of school-aged children worldwide. ADHD is defined as a persistent and age-inappropriate pattern of inattention, hyperactivity, impulsivity, or both with a conservative estimated prevalence rate between 3% and 7% of school-aged children. It is important to

understand the symptom profile of the children presenting ADHD along with the etiology of the symptoms for letter clinical intervention. ADHD affects 3–7% of school-aged children and accounts for approximately half of all pediatric referrals to mental health services.¹ Children diagnosed with ADHD are thought to have a central deficit in response inhibition as well as a motivational and state regulation deficit; however, the variability of symptoms within and across these core deficits is great.

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Typical characteristics of ADHD are developmentally inappropriate impulsivity, inattention, and hyperactivity.² Sensory processing (SP) is a widely used terminology in the literature to designate a neurological process and is defined as the ability of the central nervous system to assimilate, process, and organize appropriate responses to information. SP disorder is defined as difficulties in regulating and organizing the variety and intensity of responses to sensory input for compliance with environmental requirements. Children who have SP disorder show abnormal sensory responses, such as under or overresponsively, to sensory stimuli. SP problems are of three types: (a) sensory modulation disorder (SMD), (b) sensory-based motor disorder, and (c) sensory discrimination disorder, as per Miller's classification of SP disorders (Vide Figure 1).

SMD

It is characterized by difficulty regulating one's responses (i.e., duration, intensity, and/or type of response) in a flexible and adaptive manner to sensory experiences that occur in daily life. SMD is characterized by difficulty regulating and organizing responses to sensory input.³

SMD includes three subtypes:

1. Sensory-Over-Responsivity (SOR): Children with SOR feel sensations too intensely, for a longer duration than is typical and/or may over-respond with atypical behaviors such as temper tantrums, screaming, or moving away from stimulation
2. Sensory-Under-Responsivity (SUR): SUR describes children who respond less to or take longer to respond to input
3. Sensory-Seeking/Craving (SS/C): SS/C describes children who seek out high intensity or increased duration of sensory stimulation.⁴

Sensory-based motor disorder

It denotes difficulty with balance, motor coordination, and the performance of skilled, non-habitual, and habitual motor tasks. It is of 2 types: (a) dyspraxia and (b) postural disorder.⁴

Sensory discrimination disorder

It refers to the difficulty in interpreting the specific character of sensory stimuli and can be of any sensory modality.⁴

SP difficulties occur in a host of neurodevelopmental problems such as autism spectrum disorder, learning disorders, ADHD, development coordination disorders, and such. These can also occur in children considered otherwise normal or neurotypical. Empirical evidence and assumptions are highlighted in SP and dysfunction among children with ADHD. Both SMD and ADHD include hyperactivity and impulsive behaviors and a high percentage of children with ADHD have SP problems. The presence of sensory symptoms may be as prevalent as ADHD.^{4,6} Studying the relationship between SP difficulties and ADHD traits is important as higher levels of sensory sensitivity symptoms have been linked to greater levels of aggressive or delinquent behavior.⁷ Among children, prevalence estimates of SP disorders based on clinical experience have ranged from 5% to 10% for children without disabilities. However, no prospective published data exist on the rate of SP disorders in a non-referred (e.g., typically developing) population. Although widespread skepticism exists among many health professionals about SPD and its treatment.⁸⁻¹² Although few studies in the literature have indicated the presence of SP difficulties in ADHD children, most researchers have worked with a general profile, and few have explored further characterizations of all components of SP and the relationship between ADHD symptom severity and SP problem severity.

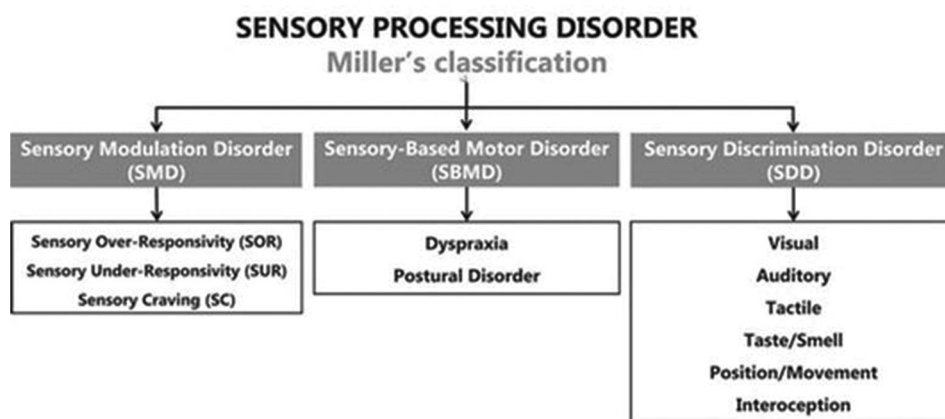


Figure 1: Miller's classification of sensory processing disorder

Aims and objectives

1. To study the SP pattern of children with ADHD and to compare it with the control group
2. To study the correlation of symptom severity with SP deficit in children with ADHD.

MATERIALS AND METHODS

Ethics

This study was done after taking ethics clearance from the Institutional Ethics Committee vide Memo no: RKS/75 and after taking informed assent from parents of all the participants.

Study type

It is a cross-sectional, observational, case–control study.

Study setting

Child guidance clinic, R. G. Kar Medical College and Hospital.

Sampling

During the study period, all consecutive children with ADHD who satisfied the inclusion and exclusion criteria were included in the study.

Study population

Children aged 3–12 years attending child guidance clinic of R.G Kar Medical College with ADHD were taken as cases and children attending pediatric medicine outpatient department (OPD) without any neurodevelopmental or other psychiatric disorder were taken as control.

Sample size

26 cases and 26 controls.

Study selection criteria

Cases

Inclusion criteria

1. Children aged 3–12 years
2. Children diagnosed with ADHD according to Diagnostic and Statistical Manual 5 (DSM 5)
3. Those children who have IQ 90 or more.

Exclusion criteria

1. Children having major neurological disorders
2. Other childhood psychiatric and neurodevelopmental disorders and comorbidities such as Autism, ODD, and CD (Vide Figure 2).

Controls

Inclusion criteria

1. Children between aged 3 and 12 years
2. Children with IQ 90 or more.

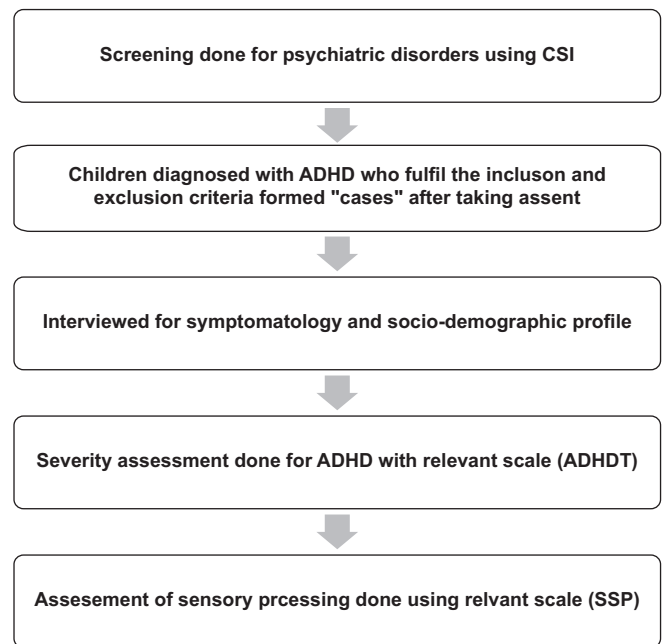


Figure 2: Selection of cases

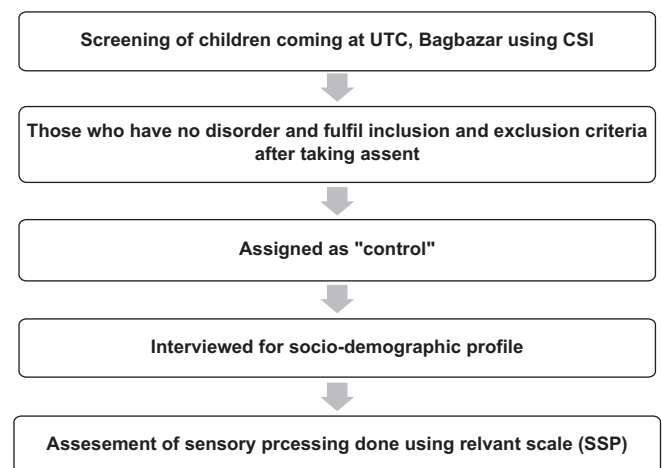


Figure 3: Selection of control

Exclusion criteria

1. Any mental or behavioral disorder
2. Known case of major neurological disorder
3. Any neurodevelopmental disorder (Vide Figure 3).

Study tools

1. Semi-structured pro forma for sociodemographic profile
2. Consent and Assent Forms
3. Child Symptom Inventory: This is a 97-item checklist that measures symptoms of 20 behavioral disorders. It is intended to be used for both male and female children from 5 to 12 years old in school-graded kindergarten to 6th grade
4. DSM V
5. The Short Sensory Profile (SSP) by Winnie Dunn: This is a shorter version of the Sensory Profile (Dunn,

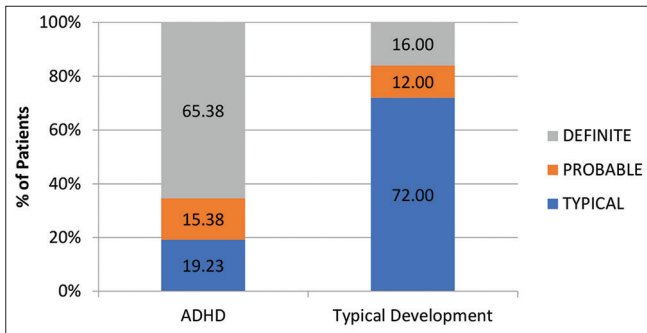


Figure 4: Comparison of short sensory profile category among attention-deficit/hyperactivity disorder group and control

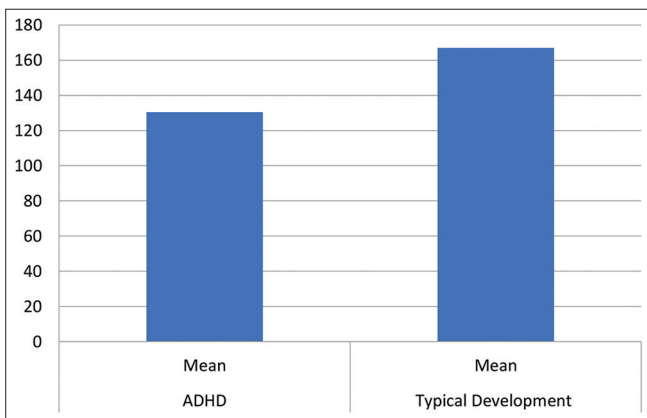


Figure 5: Comparison of short sensory profile raw score among attention-deficit/hyperactivity disorder and control

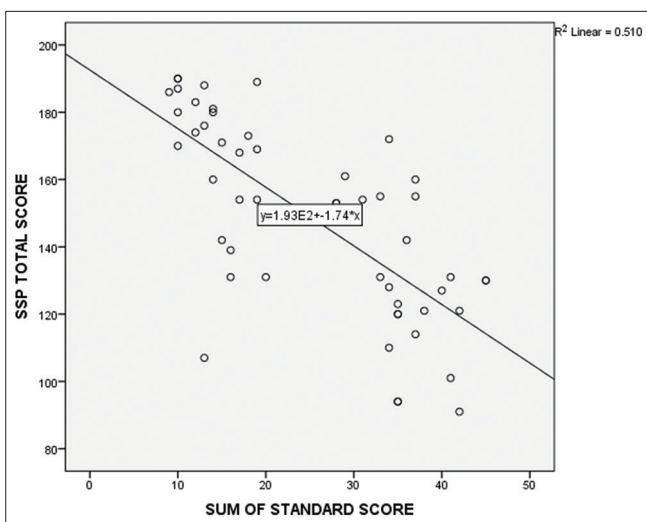


Figure 6: Scatter diagram showing correlation of short sensory profile total score and sum of standard score of attention-deficit/hyperactivity disorder test scale

1999), an instrument that provides a standard method to measure a child’s SP patterns as expressed in daily life. The SSP is filled by the child’s main caregiver.

- ADHD Test (ADHDT): Parents, teachers, and teaching assistants completed the ADHDT (Gilliam, 1996),

an assessment instrument based on DSM-IV (APA, 1994) criteria for ADHD. The ADHDT contains 36 items and has subsets of items measuring hyperactivity, impulsivity, and inattention.

Methods

After getting clearance from ethics committee, data collection was started. Informed consent from each child and informed consent from their parents were taken. 26 children were selected as cases from R. G. Kar Medical College and Hospital Child Guidance Clinic after screening with CSI and making a formal diagnosis of ADHD according to DSM 5 and fulfilling inclusion and exclusion criteria. Control children were taken from children attending pediatric OPD of R. G. Kar Medical College and Hospital. After taking informed assent from each child and informed consent from their parents, children were screened using CSI. Those having no neurodevelopmental disorder and fulfilling the inclusion and exclusion criteria for controls were selected as control. Parents of all cases and controls were interviewed for complete history with sociodemographic profile and other clinical data. Physical examination was done.

Children with ADHD were assessed with ADHDT for ADHD symptom severity, and their sensory issues were assessed using the SSP. The control group was also assessed with the SSP for the assessment of sensory issues.

Statistical analysis

Data were entered into MS Excel (Microsoft Inc.) and cleaned. The statistical software SPSS version 22 has been used for the analysis. Categorical variables are expressed as numbers and percentages and compared across the groups using Pearson’s Chi-square test for independence of attributes or Fisher’s exact test as appropriate. Continuous variables are expressed as mean, median, and standard deviation and compared across the groups using the Mann–Whitney U test or Kruskal–Wallis test as appropriate. The correlation between continuous variables was captured using Spearman’s rank correlation coefficient.

An alpha level of 5% has been taken, i.e., if any $P < 0.05$, it has been considered as significant.

RESULTS

Among the 26 cases, 21 were male (80.77%) and 5 were female (19.23%). 76.9% of the cases were in age group 6–9 years and rest were in 10–12-year age group. Children with ADHD were categorized as per their total score on the SSP scale. The mean score was found to be 130.4 (± 22.52). Among the 26 ADHD children, 21 had a score of < 155 in SSP,

Table 1: Comparison of short sensory profile category among ADHD group and control

Short sensory/Profile category	Group		P-value	Significance
	ADHD n (%)	Typical development n (%)		
Typical	5 (19.23)	18 (72)	<0.001	Significant
Probable Difference	4 (15.38)	3 (12)		
Definite Difference	17 (65.38)	4 (16)		
Total	26 (100)	25 (100)		

ADHD: Attention-deficit/hyperactivity disorder

Table 2: Comparison of short sensory profile raw score among ADHD and control

ADHD		Typically Developing children		P-value
Mean	SD	Mean	SD	
130.42	22.52	166.92	22.10	<0.001

ADHD: Attention-deficit/hyperactivity disorder

indicating some form of dysfunction in SP. Among them, 17 children that are 65.38% had a definite difference, and 4 children (15.38%) had a probable difference.

Among the 25 controls, 19 (76%) were male and the rest 6 (24%) were female. 72% of the control didn't show any problems in SP and had a score >155, indicating typical performance, while 12% of children had a probable difference and 16% had a definite difference. As shown in Table 1 and Figure 4.

The mean SSP raw score among ADHD children was 130.42 (SD 22.52), whereas among the control children, the mean score was 166.92 (SD 22.10). The Chi-square test of significance showed that the difference was significant with a $P < 0.001$. Signifying that ADHD children had a significant deficit in SP compared to the control group. As shown in Table 2 and Figure 5.

The correlation study indicates that (Figure 6) the SSP score had a negative correlation with the ADHD symptom severity score (Spearman rho -0.394 , $P = 0.046$). It indicates that the greater the ADHD symptom severity, the greater the deficit in SP, as shown in Figure 6.

DISCUSSION

This study was done to find the SP issues present in children them with ADHD and compare with controls to find out whether they differ significantly or not. For this purpose, a child presenting to the child guidance clinic of R. G. Kar Medical College and Hospital child guidance clinic was screened, and a child formally diagnosed with ADHD by DSM V was assessed using the ADHD-T test for ADHD symptom severity and the using The SSP by Winnie and Dunn's SP score was found out. Appropriate age and

gender-matched controls were included after screening children from pediatric department who were typically developing and had no neuro-psychiatric comorbidities. This study included 26 ADHD children as cases and 25 typically developing children as controls. Among ADHD children, 5 were female and 21 were male, constituting 19.23% and 80.77% of the study population, respectively. The control group had a gender composition 24% female and 76% male.

The children with ADHD were categorized as per their score in the SSP. The mean score was found to be 130.4 (± 22.52). Among the 26 ADHD children, 21 had a score of <155 in SSP, indicating some form of dysfunction in SP. Among the 21 children, 17 children, that are 65.38%, had a definite difference, and 4 children (15.38%) had a probable difference. In contrast, among the control, 72% did not show any problems in SP and had scores >155, indicating typical performance, while 12% of the children had a probable difference and 16% had a definite difference. The mean SSP raw score for control was 166.92, with standard deviations of 22.10. The statistical analysis showed that the difference was statistically significant ($P < 0.001$). Indicating that ADHD children had a definite deficit in SP. This result corroborates previous studies. In 2001, studies by Mangeot et al., found that 20 out of 26 ADHD children had some form of SP difficulty.⁶ Dunn and Bennett in 2002 and Yochman et al., in 2004 also found a significant difference in sensory responsiveness in ADHD children compared to controls.^{9,10}

The correlation study indicates that (Figure 3) the SSP score had a negative correlation with the ADHD symptom severity score (Spearman rho -0.394 , $P = 0.046$). It means that the greater the ADHD symptom severity, the greater the deficit in SP. Previously, a study done by Panagiotidi et al., found a significant correlation between sensory difficulty and ADHD traits.¹¹

Limitations of the study

1. Small sample size.
2. The study could have been strengthened by adding teacher-rated SSP
3. Different areas of SP have not been explored in the study.

CONCLUSION

The children with ADHD were found to have a significant deficit in SP compared to the control group, which leads to a definite SP problem. The degree of the SP problem also corresponds to the degree of ADHD symptom severity as measured by the ADHDT score. The greater the ADHD symptom severity, the greater the SP problem. Thus, managing the sensory issues of ADHD children may lead to a reduction in the SP problem, thus leading to symptom reduction, but this is yet to be tested.

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Authors Contributions:

AB- Literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, preparation of figures, manuscript revision; **SN-** Definition of intellectual content, concept, design, clinical protocol, manuscript preparation, editing and manuscript revision; **USM-** Statistical analysis and interpretation, manuscript preparation and editing, coordination; **SG-** Data collection, data analysis and interpretation, review manuscript editing; **AD-** Statistical analysis and interpretation, manuscript preparation and editing; **SM-** statistical analysis and interpretation, manuscript preparation and editing, coordination.

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