ORIGINAL ARTICLE

Sleep Disturbances and Sensory Processing among Autism Spectrum Disorder Children

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Keywords
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ABSTRACT

INTRODUCTION: Research on sleep disturbances and sensory processing disorder (SPD) among children with autism spectrum disorder (ASD) has received little attention. Identification of sensory components that cause sleep disturbances among ASD children will guide the therapists to select the best intervention for the condition. This study aims to identify the pattern of sensory processing that is responsible for sleep disturbance among ASD children. **MATERIALS AND METHODS**: A cross-sectional study was conducted among 55 ASD children between three and 18 years old who participated in the study. SPD was analyzed using Short Sensory Profile (SSP) while sleep disturbances utilized the Sleep Disturbance Scale for Children (SDSC). **RESULTS**: The subscale of SPD showed a strong correlation with the score for overall sleep disturbances. The subscales SPD are movements sensitivity with a positive association and auditory filtering with a negative correlation association ($p<0.05$). However, no significant association between total SPD and sleep disturbances ($p>0.05$) were noted. **CONCLUSION:** This finding may therefore shed light that SPD and sleep disturbances need to be addressed reciprocally. Increasing the number of participants and battery of tests are required to accurately determine the relationship between SPD and sleep disturbances.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder. The symptoms of ASD have been categorized into two main characteristics which are repetitive and restricted behaviour (RRB), and social communication disorders.[1] The diagnostic criteria for autism spectrum disorder (ASD) are broken down into two categories in the Diagnostic Statistical Manual (DSM-5) 2013 and the two categories are A) Disorder in social communication and interaction that persists across multiple settings; and B) Displaying restricted, and/or repetitive forms of behaviour, activity, or interest.[2]

There are about 50 to 90% of ASD children who suffered from sensory processing disorder or sensory integration issue.[3, 4, 5, 6, 7] Sensory processing disorders (SPD) in ASD may be defined as the capacity of the brain's central processing to receive input from sensory receptors, and then decode and organize it into functional behaviour.[8,9,10] For individuals with SPD, they struggle to set down and modulate the incoming sensory input, thus resulting in difficulty to successfully translate into adaptive behaviour to environmental demands.[11] Due to their struggle to understand and manage adequate sensory information, ASD children demonstrated difficulty carrying out daily tasks such as self-care, social interaction, and academic involvement.[12]

Sleep disturbances, seizures, and emotional disorders are common comorbidities among children with ASD in addition to sensory issues.[13] Sleep disturbances are the most commonly reported of these problems, with an incidence of up to 80% in the population of ASD children.[13,14,15,16,17,18] They may be more susceptible to sleep disturbances because of their biological rhythm and

behavioural traits.[34] These difficulties may hamper their ability to perform well in the aspect of self-care, social communication skills, and academic performance.[21] According to anecdotal data, some ASD children experience greater sleep disturbances when their daily routine is altered. Some parents have stated that taking their children to new environments can disrupt their sleep.[22]

Given the high frequency of sleep disturbances in the ASD population, it may be related to issues related to sensory processing, among other things.[24] The association between sensory processing and sleep disturbances in ASD has not received much attention in the literature. A thorough literature search revealed that there are inconsistent findings concluding that children with ASD have SPD and sleep disturbances.[19] Although there is no direct proof of a causative connection in a study by Manelis-Baram et., al. (2022), it does show a correlation between changes in the intensity of the two symptom domains. Exploring the prevalence of sleep disturbances and their connection to sensory processing is necessary since it affects how these children are managed for functional outcomes. The findings promote awareness of sleep disturbances in children with ASD and improve treatment options. The contribution of this research could advance knowledge of SPD and sleep disturbances in children with ASD. This study sought to determine the relationship between sleep disturbances in children with ASD and the general and particular areas of SPD.

MATERIALS AND METHODS

Design and participant

A cross-sectional study design was implemented in this study. The prevalence of SPD and sleep disturbances was examined in samples from Community Based Rehabilitation Centers (CBR) using population-based interviews. Purposive sampling was employed for this study.[23]

Researchers performed the measurement at a single point in time for SPD and sleep disturbances in children with ASD from their carer as target respondents at Community Based Rehabilitation Centers (CBR) or Pusat Pemulihan Dalam Komuniti (PDK) in the Kuala Selangor district. This includes CBR Taman Penggawa, CBR Tanjong Karang, CBR Seri Cahaya, CBR Saujana Utama, and CBR Puncak Alam.

There are 55 children with ASD in a total of five CBR in the Kuala Selangor district. The chosen samples included were determined using Krejcie and Morgan's (1970) formula for the enrolment accuracy of the sample size. The participants are selected based on the inclusion and exclusion criteria set by the researchers. The inclusion criteria comprised of parents who can comprehend English with children aged between 3 to 18 years old that fit the characteristics of ASD. The diagnosis of ASD requires a doctor or psychiatrist todiagnose the children with autism spectrum disorde. Participants whose children have various disabilities or comorbidities associated with ASD as well as who are on any kind of medication fall under the exclusion criteria.

Informed consent was obtained after delivering verbal and written information to the potential caregivers before data collection. Caregivers were interviewed for Short Sensory Profile (SSP) and the Sleep Disturbance Scale for Children (SDSC) for about 30 minutes with a 5-minute break with each session.

Instrumentation

Short Sensory Profile (SSP)

SSP evaluates a child's sensory processing abilities as they manifest in their ability to carry out daily tasks in a functional manner. The questionnaire consisted of 38 items that presented variations in sensory processing characteristics. It offers a total score as well as the results of the following subscales: Tactile Sensitivity, Taste/Smell Sensitivity, Movement Sensitivity, Under-responsive/ Seeks Sensation, Auditory Filtering, Low Energy/Weak, and Visual/Auditory Sensitivity. Using a 5-point Likert scale, parents or carers must rate how frequently their children exhibit sensory-related behaviours from "always" to "never." It has been established that SSP has good

psychometric qualities in terms of validity and reliability [26] and is suitable to be applied in multiple cultures and populations.[27] SSP has an internal consistency of the total test and sections from .70 to .90 of Cronbach's alpha.[26] For the validity of SSP, a study by Dunn (1997) indicated the discriminant validity is >95% in detecting children with and without sensory modulation disorder.

Sleep Disturbance Scale for Children (SDSC)

SDSC was developed by Bruni et al., (1996), and is used to measure sleep disturbances in children and adolescents aged 3 to 18 years from 26 items that make up the questionnaire. It has six components that make up the most prevalent types of sleep disturbances in children and teenagers and they are; 1) disorders of initiating and maintaining sleep. 2) sleep-breathing disorders, 3) disorders of arousal, 4) sleep-wake transition disorders, 5) disorders of excessive somnolence, and 6) sleep hyperhidrosis. Internal reliability for the SDSC is good ranging from 0.71 to 0.79 (Cronbach's alpha) and the test/retest reliability was adequate for the total (r = 0.71).

Data analysis

The Statistical Package for the Social Sciences (SPSS) version 21 software was used for all statistical analyses. Descriptive analysis was used to analyze demographic information. The relationship between Short Sensory Profile (SSP) and the Sleep Disturbance Scale for Children (SDSC) employed Spearman's ranks correlation coefficient by the researchers to identify the strength of the association, for absolute values of r, 0-0.19 is regarded as very weak, 0.2-0.39 as weak, 0.40-0.59 as moderate, 0.6-0.79 as strong and 0.8-1 as very strong correlation.

Ethical consideration

The Institutional Review Board of Universiti Teknologi MARA (UiTM) has received and approved the application for ethical consideration (reference no: REC/155/18) and the Social Welfare Department Putrajaya.

RESULTS

Demographic information

This study enrolled 55 children with ASD aged 3 to 18 years old. There were 47 male (85.5.8%) and 8 female (15.5%) children in this study. All of them had attended community-based rehabilitation centres (CBR) from the five (5) community centres in the Kuala Selangor district. Children aged 3 to 6 years made up the largest age group of responders (n=33 (60.0%)), followed by a group age of 7 to12 years old (n=16 (29.1%)), and the age group between 13 and 18 years old had the fewest ASD children (n=6 (10.9%)). The respondents were the parents or caregivers of ASD children. 44(80.0%) of the respondents were females making them the majority with only 11 males (20.0%) participated in this study.

Descriptive statistics of Sensory Processing Disorders and Sleep Disturbances

The level of SPD of ASD children based on SSP was calculated from the total of all sections, with a mean score of 140.04 (SD=13.41). Children with total scores falling within the SSP category "typical performance" were reported to be in only eight samples, n=8 (14.5%) with a mean of 159.13 (SD=4.42). The majority of samples lie within "probable difference" and "definite difference" categories with the distribution revealed by n=19 (34.5%) with a mean of 147.05(SD=3.89) for "probable difference", and n=28 (51.0%) with a mean of 129.82 (SD=9.68) for "definite difference". Table I reports the SSP score distribution among the samples.

Table I: Distribution of SSP total score

	n(%)	Mean(SD)
Typical performance	8(14.5)	159.13(4.42)
Probable difference	19(34.5)	147.05(3.89)
Definite difference	28(51.0)	129.82(9.68)

Note. SSP=Short Sensory Profile; n=sample; SD=standard deviation

Refer to Table II for the average distribution of the SSP subscales. The samples displayed a deficit in almost all the domains of SPD. Most samples had results with "definite difference" in the sensory processing pattern at

subdomain of auditory filtering, taste/smell sensitivity, and under-responsive/seek sensation. While the tactile sensitivity showed a "probable difference" in the form of SPD, the majority of the ASD children scored "typical performance" in sections of movement sensitivity, low endurance/weak and visual/auditory sensitivity of sensory processing.

Table II: The pattern of Sensory Processing Disorder of Children with ASD

	Mean(SD)
Tactile Sensitivity	28.04(4.22)**
Taste/Smell Sensitivity	9.84(3.99)*
Movement Sensitivity	13.05(2.64)***
Under-responsive/Seek Sensation	23.85(5.29)*
Auditory Filtering	18.04(4.28)*
Low Endurance/Weak	27.93(3.60)***
Visual/Auditory Sensitivity	19.33(4.16)***

Note. ASD=autism spectrum disorder; SD=standard deviation
***Typical performance
**Probable difference
*Definite difference

The majority of the ASD children, n=35 (63.6%) obtained a score of 39 or higher on the SDSC, indicating that they experienced a sleep disturbance with a mean of 46.94 (SD=6.61). The remaining children with ASD, n=20 (36.4%) did not display any disturbance in their sleep by attaining a score of below 39 on the SDSC with a mean of 28.8 (SD=2.26). The result was shown in Table III.

Table III: Distribution of Total Score Indication of SDSC

	n(%)	Mean(SD)
Below 39	20 (36.4)	28.8(2.26)
39 and above	35 (63.6)	46.94(6.61)

Note. SDSC= Sleep Disturbance Scale for Children; n=sample; SD=standard deviation

Inferential statistics of Sensory Processing Disorders and Sleep Disturbances

The Spearman's rho correlation coefficient test was used to examine the relationship between SPD and sleep disturbances. The normality test (Shapiro-Wilk test) on the total score of SDSC violated its assumptions with a p-value of 0.004 ($p<0.05$). Table IV shows the Spearman's rho correlation coefficient test according to the total score/ subscales of SSP and total score of SDSC. The SDSC could not find a significant correlation between the total score of SSP and the sleep disturbances with rs = .072, $p>0.05$, two-tailed and very weak positive correlation. However, there is a significant relationship between the two SSP subscales and the SDSC overall score. There is an incidence of weak positive correlation with movement sensitivity, rs=.300, p=0.026, two-tailed, n=55, and weak negative correlation with auditory filtering, rs=-.321, p=0.017, two-tailed, n=55. Nevertheless, there is no significant association between the other subscales of sensory SSP (tactile sensitivity, taste/smell sensitivity, under-responsive/seek sensation, low endurance/weak, and visual/auditory sensitivity) with SDSC.

Table IV: Association Between Subscales/ Total score of SPD and Total score Sleep Disturbances

	Sleep Disturbances *rs* (*p*-value)
The total score of Short Sensory Profile (SSP)	.072 (.604)
Tactile Sensitivity	-.111(.420)
Taste/Smell Sensitivity	.132 (.366)
Movement Sensitivity	.300*(.026)
Under-responsive/Seek Sensation	.132(.336)
Auditory Filtering	-.321*(.017)
Low Endurance/Weak	.084(.540)
Visual/Auditory Sensitivity	.050(.717)

Note. SPD=sensory processing disorder; *rs* =Spearman's rho value; *p*-value= significant value of correlation
*Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

The current study found that 28 of the children were having definite differences in their SSP scores. This supports some previous studies that children with ASD also experience SPD.29,30 A study found that their samples of 47 ASD children age 6 to 17 reported more sensory processing disorders than older age groups representative of typical samples. They proposed that the neural responses in the sensory processing region, particularly the somatosensory cortical area and thalamus, are connected with habituation in sensory over-responsivity symptoms in children with ASD, with an increase in response in the insula cortex and amygdala.31

This study showed that the majority of children with ASD displayed the three most impaired types of sensory processing. There are sensory processing disorders in subcategories of auditory filtering, taste/smell sensitivity, and under-responsive/seek sensation. These results are in agreement with some earlier findings that children with ASD have main SPD issues in auditory filtering, taste/smell sensitivity, and under-responsive/seeking

sensation.[32,33,34] Based on the auditory filtering problem pattern, this could explain why children with ASD have trouble paying attention and responding to what is spoken to them and verbal information in a variety of noisy environments and from any source of auditory input as specified in the SSP.

Additionally,, in this study, more than half of the children with ASD have sleep disturbances as in the SDSC. This is in line with several previous studies that have found that up to 40% to 80% of children with ASD suffer from sleep disturbances.[22,35,36,37,38,39] Based on a study conducted in China, children with ASD had up to 67.4% more sleep disturbances than typical children, which had only 51% more sleep disturbances. They highlighted that sleep disturbances were caused by a wide variety of interconnected internal and external factors. Genetic, environmental, and neurophysiological variables such as abnormal melatonin production in the brain, all contribute to the sleep disturbance. Melatonin is a neurotransmitter that is crucial for sleep, thus issues with its production or release could have an impact on the overall sleep quality of an individual.[35]

The results of this study are consistent with those of a prior study conducted in Iran by Ghanbari & Rezaei (2016), which discovered no association between sleep disturbances and the overall SPD score. However, only a few studies have discovered a relationship between SPD and sleep disturbances which opposes our study.[24,41,42,43] For SPD among children with ASD, Dwyer, et al. (2021) summarize that children with ASD scored lower in SSP and displayed increased sleep disturbances. This may be because their study explores sleep disturbances in the longitudinal period through the EEG compared to our study which only evaluates using a questionnaire at a point in time. In addition, Wang et al., (2019) summarize that sensory processing problems are associated with a total score of sleep disturbances in ASD groups. Their sample is higher which are 81 children with ASD and only focuses on children aged 3-7 years old, compared to our samples which are 55 and aged between 3-17 years old children. This might be the reason why they were able to find the correlation between sensory processing disorder and sleep disturbances among children with ASD.

The subscales of SPD which are movement sensitivity and auditory filtering are associated with the overall sleep disturbances score. Few of the previous research has the same perspective as this study.[16,24,43,45] As demonstrated in the current study, movement sensitivity, and auditory filtering were correlated with sleep disturbances in children with ASD, an outcome that is only partially consistent with a recent study's findings[43] reporting that all subdomains except visual/auditory sensitivity in SSP are associated with sleep problems in children with ASD. Equally important, children with ASD who have atypical sensory phenotypes to multiple environmental stimuli, may display nervousness and defensiveness during the night before the sleep period causing discomfort that interferes with sleep. Moreover, Mazurek & Petroski (2015) discover that touch sensitivity, taste/smell sensitivity, movement sensitivity, and visual/auditory sensitivity were significantly associated with the subcategories of sleep disturbances in CSHQ. However, this study's findings revealed that the only subdomains associated with sleep disturbances were movement sensitivity and auditory filtering. Compared to our study, their study has recruited large numbers of samples which might be the reason they were able to find other sensory domains correlated with sleep disturbances. The limitations of this study were the use of SSP as it was insufficient in describing sleep disturbance findings among children with ASD.[24] Also, similar to comparable findings from earlier studies, a number of discoveries have not shown statistically significant results. This could be a result of the study's small sample size, which may be impacting the normality assumptions, thus limiting the significant analysis and preventing a presentation to the entire population. Additionally, the study's sample of ASD children is limited to the five CBR populations in a suburban district and may not represent the ASD population as a whole.

CONCLUSION

The SDSC cut-off is determined by the overall score based on their sleep pattern over the previous six months indicating the sleep disturbances of children with ASD. The study findings indicate the total score of SPD in SSP and the total score of sleep disturbances did not

significantly correlate. Nonetheless, the subscales of SPD showed a strong correlation with a score for overall sleep disturbances. Movement sensitivity and auditory filtering are two subscales of SPD that have a significant correlation with SDSC.

In conclusion, SPD and sleep disturbances do not occur separately. It is critical to include sleep disturbances, which are directly linked to movement sensitivity and auditory filtering, as one of the treatment objectives. To accurately examine the link between SPD and sleep disturbances, future research will require a larger number of individuals and additional battery of tests. Finally, it is hoped that this discovery would shed light on the fact that SPD and sleep disturbances need to be addressed interchangeably.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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