Original Article

DOI: 10.7860/JCDR/2024/73160.19987

The Impact of Sensory Processing on Sleep among Children with Autism Spectrum Disorder: A Systematic Review

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ABSTRACT

Introduction: Sleep disturbances are highly prevalent among children with Autism Spectrum Disorder (ASD). Many studies on sleep in children with ASD have reported a high incidence of irregular sleep patterns and poor sleep quality. Recent research has highlighted the potential link between Sensory Processing (SP) difficulties and sleep disturbances in children with ASD. Therefore, a comprehensive knowledge of the evidence exploring the relationship between SP and sleep in children with ASD is needed to provide insights into targeted interventions and support strategies to improve sleep outcomes and the overall quality of life in children with ASD.

Aim: This systematic review aims to investigate the relationship between SP and sleep in children with ASD aged 3 to 12 years.

Materials and Methods: A comprehensive search of articles was conducted across databases, including Scopus, PubMed, and OTseeker. The following major keywords were used during the database searches: Sensory processing, sensory integration, sensory processing disorder, sensory integration disorder, sleep, sleep disorder, sleep problems, sleep disturbances, and autism spectrum disorder. The McMaster Critical Review Form for Quantitative Studies was utilised to evaluate the methodological quality of the included articles.

Results: Through electronic and manual searches, 2,612 articles were identified after removing duplicates. Among these, nine articles published between January 2012 and December 2022 met the predetermined inclusion criteria. Of these, eight studies reported a statistically significant correlation between SP difficulties and sleep disturbances.

Conclusion: This review underscores the significant impact of SP challenges on the sleep quality of children diagnosed with ASD, aged 3 to 12 years.

Keywords: Autistic disorder, Perception, Sleep wake disorders

INTRODUCTION

Sleep is a regular and reversible state of consciousness characterised by diminished responsiveness to external stimuli, accompanied by changes in brainwave patterns and a temporary elimination of voluntary movements and sensory awareness [1,2]. During sleep, the body experiences distinct physiological changes, such as variations in heart rate, breathing, and brain activity, which play a crucial role in facilitating essential restorative functions that contribute to overall health and wellbeing [3,4]. Numerous studies have found that inadequate or low-quality sleep can significantly impact a person's physical health, emotional wellbeing, and cognitive abilities [5,6]. Persistent sleep deprivation has been linked to a higher likelihood of obesity, diabetes, cardiovascular disorders, and compromised immune function [7,8].

A significant number of children with neurodevelopmental disorders encounter challenges with sleep. Notably, the prevalence of sleep problems is considerably higher among children diagnosed with ASD compared to typically developing children [9,10]. Research indicates that approximately 50 to 80% of children with autism experience some form of sleep difficulty [11]. Sleep difficulties in children with ASD can manifest in various ways, including challenges in falling asleep, frequent awakenings during the night, limited sleep duration, irregular sleep-wake cycles, and anxiety related to sleep [11,12]. Disruptions in sleep can contribute to increase in challenging behaviours, such as irritability, hyperactivity, and aggression among children diagnosed with autism [13]. Furthermore, these sleep disruptions have the potential to increase the symptoms of autism, including difficulties in communication, limited interests, and repetitive behaviours [14]. Therefore, the consequences of sleep deprivation in children with ASD impede their occupational and social participation.

Studies have found a significant correlation between SP challenges and sleep difficulties, applicable to both typically developing children and those with ASD [15,16]. The research underscores the importance of considering unusual sensory behaviours when designing tailored interventions to address sleep problems in children with ASD. However, the effectiveness of sensory-based interventions and sensory integration therapy on sleep behaviours is supported by only a limited amount of evidence. This is primarily due to a limited understanding of the relationship between SP challenges and sleep problems in children with ASD. To address these concerns, a comprehensive systematic review is needed, specifically focusing on children with ASD. Therefore, a systematic review was conducted to evaluate the impact of SP on sleep in children with autism spectrum disorder aged 3 to 12 years.

MATERIALS AND METHODS

This systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which are recognised standards for conducting systematic reviews. The review is registered with PROSPERO under the ID number CRD42023441142. A comprehensive search for articles was performed in Scopus, PubMed, Embase, and OTseeker. Furthermore, a manual search for articles was conducted in printed journals, including the American Journal of Occupational Therapy, the British Journal of Occupational Therapy, the Canadian Journal of Occupational Therapy, and the Australian Journal of Occupational Therapy.

Search strategy: The following keywords were used during the database searches: ("sensory processing" OR "sensory integration" OR "sensory processing disorder" OR "sensory integration disorder" OR "sensory reactivity" OR "sensory over-responsivity" OR "sensory under-responsivity" OR "sensory seeking" OR "sensory avoiding" OR "sensory sensitivity" OR "low registration") AND ("sleep" OR "sleep disorder" OR "sleep problems" OR "sleep disturbances" OR

"sleep patterns") AND ("autism spectrum disorder" OR "autism" OR "Asperger syndrome" OR "pervasive developmental disorder").

Inclusion criteria: The included studies had to meet the following inclusion criteria: (1) studies that included children with ASD aged 3-12 years as the primary population; (2) studies that focused on both SP/integration and sleep as outcome measures; (3) studies published between January 2012 and December 2022; (4) peer-reviewed articles; (5) articles available in full text; and (6) articles published in English.

Exclusion criteria: Studies were excluded if they were classified as Level 1A, Level 2A, or Level 3A evidence (systematic reviews and meta-analyses), Level 4 evidence (case reports and case series), or Level 5 evidence (expert opinions).

Critical appraisal: The McMaster critical review form for quantitative studies was used to evaluate the methodological quality of the included articles [17]. This form consists of 16 different items that assesses various aspects related to the methodological quality of the study, such as its purpose, literature review, study design, sample, outcomes, intervention, results, and conclusions. Each item is assigned a score of "one" if it meets the specified criteria and a score of "zero" if it does not. The categorisation of the study's methodological quality is determined by the overall score, which ranges from 0 to 16. Scores ranging from 0 to 8 are categorised as poor, while scores of 9 to 10 are considered fair. A score between 11 and 12 is deemed good, while a score of 13 to 14 is labeled as very good. Finally, a score ranging from 15 to 16 is classified as excellent [18].

Procedure

The main authors initially reviewed the titles and abstracts of the articles to assess whether they aligned with the predefined inclusion criteria. In cases where there were inconsistencies in opinions between the two authors regarding certain articles, or when articles did not meet the inclusion criteria, independent reviewers reassessed them to validate the decision to exclude them. After the full-text review, the risk of bias assessment of the included articles was performed using the McMaster critical review form for quantitative studies [Table/Fig-1] [19-27]. In instances of disagreements or inconsistencies between the authors' scores, all the authors reached a consensus on the final scores. This collaborative process ensured that the review was accurate and reliable.

RESULTS

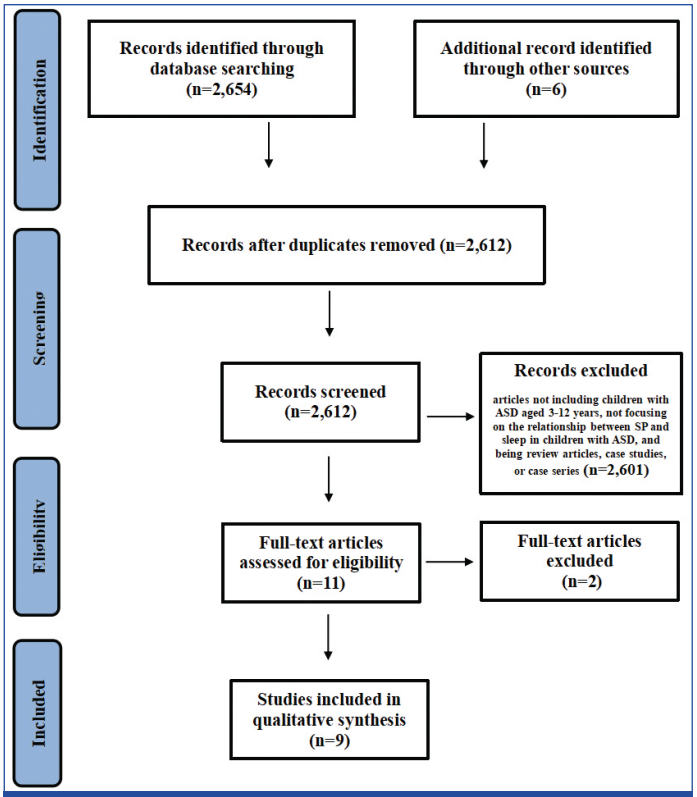
A comprehensive search of the literature, which included both electronic databases and manual searching, resulted in the identification of 2,660 articles (2,654 records from electronic databases and six records from manual searches). After removing 48 duplicates, 2,612 records were retained for title and abstract review. Among these, 2,601 articles were excluded for reasons such as not including children with ASD aged 3-12 years, not focusing on the relationship between SP and sleep in children with ASD, and comprising review articles, case studies, or case series. Consequently, 11 full-text articles were evaluated for eligibility, with nine studies meeting the inclusion criteria. Two studies were excluded after full-text review: one did not specify the diagnosis of the children included in the study, and the other did not utilise a specific measure to evaluate SP. The review process is visually represented in the PRISMA diagram [Table/Fig-2].

Nine articles that met the predefined criteria were included in the systematic review. The authors, year of publication, aims and objectives, study design, sample characteristics, assessments used to measure sensory processing and sleep, and findings were extracted from the included articles. Among the nine studies, two utilised a longitudinal design [19,20], two were case-control studies [21,22], and the remaining five adopted a cross-sectional design [23-27]. Throughout the studies, male participants outnumbered female participants. Several confounding factors were described in the included studies; however, only some of these factors showed a significant relationship with sleep difficulties. Caregiver education and socio-economic status significantly correlated with sleep difficulties in children with ASD [20,21,25]. Except for one study, which found a significant correlation between IQ and sleep difficulty scores in individuals with Asperger's Syndrome, the remaining studies concluded that the relationship between IQ and sleep difficulties was statistically insignificant [26]. Only one study concluded that older children experienced more sleep problems and were prescribed medications for the same [20]. No other statistically significant findings were established regarding gender, developmental complications, race, siblings, and schooling. The nine studies are summarised in [Table/Fig-3].

All nine studies were critically appraised using the McMaster critical review form for quantitative studies. All the studies yielded

S. no.	Items	Manelis-Baram L et al., (2022) [19]	Jamioł-Milc D (2021) [23]	Tzischinsky O et al., (2018) [24]	Wang GF et al., (2019) [21]	Tyagi V et al., (2019) [25]	Mazurek MO et al., (2019) [20]	Hollway JA et al., (2013) [26]	Mazurek MO and Petroski GF (2015) [27]	Kosaka T et al., (2021) [22]
1	Purpose	1	1	1	1	1	1	1	1	1
2	Literature review	1	1	1	1	1	1	1	1	1
3	Study design	1	1	1	1	1	1	1	1	1
4	No biases present	0	0	0	0	0	0	0	0	0
5	Sample described	1	1	1	1	1	1	1	1	1
6	Sample size justification	0	0	0	0	1	0	0	0	0
7	Informed consent	1	1	1	1	1	1	0	1	1
8	Validity of outcome measures	1	0	1	1	1	1	1	1	1
9	Reliability of outcome measures	1	0	1	1	1	1	1	1	1
10	Intervention	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	Statistical reporting of results	1	1	1	1	1	1	1	1	1
12	Appropriate statistical analysis	1	1	1	1	1	1	1	1	1
13	Clinical importance	1	1	1	1	1	1	1	1	1
14	Conclusions	1	1	1	1	1	1	1	1	1
15	Clinical implications	1	1	1	1	1	1	1	1	1
16	Study limitations	1	1	1	1	1	1	1	1	1
Total score		13 Very Good	11 Good	13 Very Good	13 Very Good	14 Very Good	13 Very Good	12 Good	13 Very Good	13 Very Good

[Table/Fig-1]: Critical appraisal of included studies- McMaster critical review form for quantitative studies [19-27].



[Table/Fig-2]: PRISMA flow diagram.

a score between 11 and 14, indicating "very good" and "good" methodological quality. The critical appraisal is summarised in [Table/Fig-1] [19-26].

Measurement of Sleep and SP

In five studies, sleep was measured using the Child Sleep Habit Questionnaire [19,20,24,26,27]. The remaining four studies assessed sleep using the Athens Insomnia Scale [23], the Chinese Sleep Habit Questionnaire [21], the Sleep Disturbance Scale for Children [25], and the Japanese Sleep Questionnaire for Preschoolers and Actigraph [22]. In four studies, SP was measured using Short Sensory Profile [20,21,26,27], and Sensory Profile [19,22,24,25]. Only one study assessed sensory processing using observation of child's behaviour during tactile stimulation tasks [23].

Characterising the Relation between Sleep and SP in ASD

The literature suggests that a positive relationship exists between sleep and SP in children with ASD. All studies revealed a statistically significant correlation between sleep and SP scores, except for one study [23], which indicated a higher occurrence of tactile under-responsivity among children with insomnia; however, this association did not reach statistical significance.

The impact of SP on social participation in children with ASD is discussed further through two different lenses: sensory threshold and sensory system.

Author (Year)	Aim	Study design and sample characteristics	Assessments	Findings
Manelis-Baram L et al., (2022) [19]	Investigated the longitudinal relation between sleep disturbances and sensory sensitivities.	**Study design:** Longitudinal design **Sample:** • Convenience sampling. • N=103 • The study included children who had been diagnosed with ASD, with an initial age of 3 years. • Every child met the criteria for ASD as described in DSM-5, which was corroborated by evaluations from both a physician and a developmental psychologist.	• Child Sleep Habit Questionnaire (CSHQ) • Sensory Profile-2	• A significant Pearson correlation was observed between the sleep and sensory quadrants: sensory sensitivity, sensation avoiding, low registration, and sensation seeking. • In the partial correlation analysis, it was found that only sensory sensitivities exhibited a substantial and consistent correlation with sleep disturbance scores when accounting for the influence of other sensory quadrants. • Notably, a significant and negative correlation was identified between total sleep duration and sensory sensitivity, sensation avoiding, and sensation seeking, though this correlation was not observed with low registration. Among all sensory quadrants, sensory sensitivity scores demonstrated the strongest correlations with sleep duration. • An important finding was the significant positive correlation between changes in sleep disturbance scores and changes in sensory sensitivity, sensation avoiding, and sensory registration scores. However, no such correlation was observed with sensation-seeking scores. • Notably, in the partial correlation analysis that controlled for other sensory quadrants, changes in sleep disturbances were particularly linked to changes in sensory sensitivities, with no notable correlation with changes in sensory avoiding, sensory registration, or sensory seeking.
Jamioł-Milc D et al., (2021) [23]	The study aimed to explore the relationship between difficulties in modulating tactile stimuli and the presence of insomnia in individuals with ASD.	**Study design:** Cross-sectional design. **Sample:** • A total of 27 children who had been diagnosed with ASD participated, with an average age of 6.8 years (±2.9 years). • The diagnosis was verified by a child psychiatrist based on the ICD-10 criteria.	• Tactile processing was not assessed using any standardised tests; instead, the diagnosis of tactile modulation disorder was made based on observing children's behaviour during tactile stimulation. • Athens insomnia scale.	• Children with insomnia tend to exhibit a greater occurrence of tactile under-responsivity, although the relationship was not statistically significant.
Tzischinsky O et al., (2018) [24]	To examine the relationship between sleep disturbances and sensory sensitivities.	**Study design:** Cross-sectional design **Sample:** • 69 children with ASD aged 3-7 years and 62 age-matched typically developing children were included. • Every child fulfilled the criteria for ASD outlined in DSM-5, which was verified by both a physician and a developmental psychologist.	• Sensory Profile • Children's sleep Habits Questionnaire	• Pearson's and Spearman's correlation analyses, it was determined that a noteworthy negative correlation exists between touch and oral sensitivity scores and the total CSHQ scores among children with autism. However, the remaining sensory modalities did not exhibit statistical significance. • Hypersensitivity and hyposensitivity in the touch domain showed significant correlations with sleep disruptions in ASD children.

Wang GF et al., (2019) [21]	To explore the links between atypical SP, disturbances in sleep, difficulties in emotional and behavioural aspects, and mealtime behaviours among Chinese preschoolers who have been diagnosed with ASD.	**Study design:** Case-control design **Sample:** • 81 children diagnosed with ASD aged 3-6 years, along with 153 typically developing children of the same age range for comparison. • All children with ASD were evaluated by paediatric psychologists using Childhood Autism Rating Scale.	• Short Sensory Profile • Chinese Sleep Habits Questionnaire	• The outcomes of Pearson's correlation analysis revealed a substantial negative correlation among children with ASD, indicating that tactile sensitivity, movement sensitivity, under-responsive/seeks sensation, and low energy/ weak attributes exhibit a significant relationship with the overall Short Sensory Profile scores in relation to the total scores on the CSHQ. • The relation between SP deficits and sleep difficulties was apparent, particularly among ASD children who demonstrated hypo- and hypersensitivity profiles, notably within the tactile domain.
Tyagi V et al., (2019) [25]	The aim was to investigate the link between sleep problems and co-existing factors such as adaptive and maladaptive behaviours, sensory behaviour, developmental function, and the severity of autism.	**Study design:** Cross-sectional study **Sample:** • The study encompassed a total of 73 children diagnosed with ASD and an additional 146 typically developing children for comparison. • Age- 3-12 years.	• Sensory Profile-2 • Sleep Disturbance Scale for Children (SDSC)	There was a critical association between sleep disruption and heightened sensory seeking, increased sensory sensitivity, as well as touch and movement processing.
Mazurek MO and Petroski GF (2019) [20]	The aim was to examine the long-term relationships between sleep disruptions and concurrent symptoms in children diagnosed with ASD.	**Study design:** Longitudinal design **Sample:** • The study involved 437 children diagnosed with ASD, aged from 2 to 10 years.	• Short Sensory Profile • Children's Sleep Habits Questionnaire	• The research found a correlation between sleep patterns and sensory over-responsivity in children aged 2 to 10 years with ASD. • The study also indicated that sensory over-responsivity serves as a predictive factor for sleep issues in young children, extending longitudinally.
Hollway JA et al., (2013) [26]	The aim was to explore potential indicators in the realms of cognition, behaviour, emotion, and physiology that could be linked to sleep difficulties in children with ASD.	**Study design:** Cross-sectional design **Sample:** • A total of 1,583 children diagnosed with ASD, aged 2-17 years. • Every child fulfilled the criteria for ASD outlined in DSM-IV.	• Short Sensory Profile • Children's Sleep Habits Questionnaire	• Reduced scores in the taste/smell sensitivity domain of the Short Sensory Profile were linked to heightened levels of sleep anxiety. • Children experiencing under-responsiveness, sensory seeking, and auditory filtering difficulties encountered greater difficulties with sleep.
Mazurek MO and Petroski GF (2015) [27]	To investigate the correlation between sensory over-responsivity, anxiety, and sleep issues in children diagnosed with ASD.	**Study design:** Cross-sectional design **Sample:** • The study involved 347 children diagnosed with ASD, aged 2 to 17.6 years.	• Short Sensory Profile • Children's sleep Habits Questionnaire	• Pearson's correlation analysis results indicated a noteworthy connection between sensory over-responsivity and each CSHQ subscale, including resistance to bedtime, sleep-onset delay, sleep hours, anxiety related to sleep, and night wakings. • In the multivariate path models involving older children (aged 6-18 years), sensory over-responsivity exhibited significant associations with resistance in bedtime, sleep-onset delay, shorter sleep time, and anxiety related to sleep; however, it did not show a significant association with night wakings. • Conversely, within the multivariate path models concerning younger children (aged 2-5 years), sensory over-responsivity displayed significant associations with sleep-onset delay, sleep hours, and night waking, whereas there were no significant associations with resistance in bedtime and anxiety related to sleep.
Kosaka T et al., (2021) [22]	To establish a validated relationship between sensory traits and sleep patterns in children diagnosed with ASD through the utilisation of an actigraph.	**Study design:** Case-control design **Sample:** • The study comprised 20 children diagnosed with ASD (aged 3-6 years), along with 20 typically developing children of the same age range for comparison. • The diagnosis of ASD in children was established by two paediatric neurologists in accordance with the DSM-5 criteria.	• Japanese version of Sensory Profile • Japanese Sleep Questionnaire for Preschoolers • Actigraph	• Spearman's correlation analysis uncovered a notable positive correlation between the frequency of activities per minute during sleep and a heightened susceptibility to vestibular (p-value=0.046) and oral (p-value=0.006) sensory stimuli. • Through multiple regression analysis, it was determined that there exists a significant link between the frequency of activities per minute during sleep and an increased sensitivity to vestibular sensory stimuli characterised by a low threshold.

[Table/Fig-3]: Synthesis of studies examining Sensory Processing (SP) and sleep in children with ASD [19-27].
ASD:Autism spectrum disorder;DSM:Diagnostic and statistical manual of mental disorders;ICD:International classification of diseases

In the study conducted by Kosaka T et al., a noteworthy and positive connection was found between the frequency of activities per minute during sleep and increased sensitivity to vestibular and oral sensory stimuli [22]. Mazurek MO et al., concluded that sensory over-responsivity is an essential predictor of sleep [20]. Mazurek MO and Petroski GF found that sensory over-responsivity was linked to delays in sleep onset, resistance at bedtime, shorter sleep duration, and increased sleep-related anxiety in older children with ASD [27]. Moreover, in younger children with autism, sensory over-responsivity correlated with sleep onset delays, reduced sleep duration, and increased occurrences of night-time awakenings. Manelis-Baram L et al., concluded that the sensory sensitivities quadrant showed a significant correlation with sleep disturbances when controlling for other sensory quadrants such as sensory avoiding, sensory seeking, and sensory registration [19]. Tzischinsky O et al., also found a significant correlation between tactile and oral sensitivity and sleep [24]. However, both hypersensitivity and hyposensitivity scores in the touch domain correlated significantly with sleep scores. Wang GF et al., concluded that tactile sensitivity, movement sensitivity, sensory under-responsiveness, low energy, and overall scores from the Short Sensory Profile correlated with sleep scores [21]. Tyagi V et al., found that sensory seeking and sensory sensitivity in the tactile and movement domains correlated with sleep disruptions [25]. Hollway JA et al., revealed a specific relationship between lower scores of taste/smell sensitivity and increased sleep anxiety. Additionally, sensory under-responsiveness, sensory seeking behaviors, and challenges with auditory filtering were connected to greater difficulty in maintaining sleep [26].

The studies included in the systematic review rely on reports from parents or caregivers to evaluate SP and sleep. These reports can introduce bias due to subjective perceptions and potential inaccuracies in reporting the child's SP behaviour and sleep patterns.

DISCUSSION

The transition from day to night is accompanied by several environmental changes that pose challenges for falling asleep and maintaining sleep throughout the night in children with ASD who have sensory processing difficulties. Bedtime settling involves a variety of preparatory tasks, such as alterations in light and sound input, exposure to bedding, and changes in posture. These factors might provoke anxiety and hyperarousal, thereby affecting the ability to sleep. A variety of sleep disruptions are present in children with autism, including problems such as insomnia, resistance to bedtime, delays in sleep onset, changes in sleep duration, night awakenings, and increased sleep-related anxiety. Additionally, SP differences reported in children with ASD include a wide range of problems, such as sensory sensitivities, sensory over-responsivity, sensory under-responsivity, and sensory-seeking behaviours. Sensory hypersensitivity is considered one of the potential factors contributing to a hyperarousal state, which leads to sleep difficulties in children with ASD [28]. Children who possess increased sensitivity to sensory stimuli might exhibit a greater awareness of various sensations, potentially resulting in difficulties with sleep [27]. Conversely, children who have an under-responsive reaction to sensory stimuli might fail to perceive the environmental sensory inputs that regulate the sleep/wake cycle, consequently leading to disruptions in their sleep patterns [29]. Children characterised by increased sensory-seeking behaviour might not only exhibit hyperactivity but also become overly focused on seeking sensory experiences, causing them to miss sleep cues [27].

Research has documented distinct variations across specific sensory domains, such as tactile under-responsivity, however the established relationship is not significant [23]; touch and oral sensitivity; tactile and movement sensitivity [21,25]; taste and smell sensitivity [26]; and low thresholds for vestibular and oral sensitivity [22]. Previous studies have suggested the relationship between touch sensitivity to be associated with altered levels of GABA (Gamma-aminobutyric acid) [30]. These neurophysiological alterations may indicate difficulties in initiating and maintaining sleep among children with ASD. The vestibular nuclei are linked to the suprachiasmatic hypothalamic nucleus through the intergeniculate lateral region. This nucleus is responsible for regulating biological rhythmicity and controlling the transition between sleep and wake cycles [31-33]. Reduced sleep can influence somatosensory perception in the orofacial region. Additionally, sleep bruxism (teeth grinding) has been found to be associated with daytime fatigue and sleepiness [34]. The proposed mechanisms that connect diminished visual processing with sleep difficulties include inadequate establishment of the circadian rhythm influenced by light cues and a decrease in responsiveness to visual stimuli [27].

Measures used to assess sleep outcomes in children with ASD predominantly rely on subjective or parent-reported assessments rather than objective measures. Only one study utilised actigraphy [22] as an additional sleep measure, along with a Japanese sleep questionnaire for preschoolers. To effectively detect sleep disruptions, in-depth research is required that utilises objective techniques such as actigraphy, polysomnography, and videosomnography [35]. Similarly, the most common measures used to assess SP are parent-rated tools, including the Sensory Profile [36], Sensory Profile 2 [37], and Short Sensory Profile [36]. While these assessments demonstrate relatively promising reliability and validity, their application across different contexts and populations should be approached cautiously, as they were developed and standardised on the US population.

Only one study was conducted on the Indian population [25]. This study highlights the influence of developmental, cultural, and lifestyle factors on children's sleep behaviours and patterns. Existing literature indicates a greater prevalence of sleep issues among individuals with ASD in the Indian context, ranging from 75 to 95% [38], compared to the Western context, where the range was 40 to 80% [39-42]. Since bedtime behaviours and practices, settings, sleeping arrangements, and sleep patterns differ across contexts, healthcare professionals need to carefully assess this relationship. Further research should investigate in-depth how sleep patterns affect the sleep of children with ASD.

While the impact of SP on sleep in children with ASD is diverse and multifaceted, the significance of this relationship cannot be overlooked. Inadequate sleep patterns may lead to lower intellectual functioning and adaptive skills, poor performance in daily living skills, and increased communication deficits in children with ASD [43]. This systematic review underscores the need for more intensive research in the domain of sleep and SP in ASD.

The limitations of this systematic review include the restricted use of only four databases. Additionally, due to the vast array of terminologies in the domains of SP and sleep in ASD, some studies might be missed that fall within the scope of the review. Lastly, the search was limited to studies published in English.

CONCLUSION(S)

This systematic review concludes that the impact of SP difficulties on sleep is evident. However, the types of sleep problems and the sensory systems affected are diverse and inconsistent. Given the multidimensional and context-dependent nature of this relationship, further research is necessary, encompassing both quantitative and qualitative analyses. The research should not only explored the relationship between SP and sleep but also examined the influence of additional factors such as parental co-sleeping, the effects of schooling and academics, screen time exposure, and daytime sleeping.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jun 04, 2024
- Manual Googling: Jul 19, 2024
- iThenticate Software: Jul 23, 2024 (8%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 29, 2024**
Date of Peer Review: **Jul 04, 2024**
Date of Acceptance: **Jul 26, 2024**
Date of Publishing: **Sep 01, 2024**