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Spectrum Disorder: The Moderating Role of Emotion Regulation**



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Sleep Disturbance and Aggressive Behaviour among Children with Autism Spectrum Disorder: The Moderating Role of Emotion Regulation

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Abstract

Purpose: This study examines the relationship between sleep disturbance and aggressive behaviour among children with Autism Spectrum Disorder (ASD) in Pakistan, focusing on the moderating role of emotion regulation.

Methodology: A quantitative cross-sectional correlational design was employed using purposive sampling to recruit 260 children with ASD through their caregivers from autism centers, rehabilitation clinics, and special education institutions in Pakistan. Standardized instruments were used, including the Children's Sleep Habits Questionnaire (CSHQ), the Institute for Basic Research–Modified Overt Aggression Scale (IBR-MOAS), and the Emotion Regulation Checklist (ERC). Data were analyzed using SPSS Version 27 and Hayes' PROCESS Macro Version 4.2 (Model 1). Pearson correlation analysis and moderation analysis were conducted to examine the hypothesized relationships among study variables.

Findings: Results revealed that sleep disturbance was significantly and positively associated with aggressive behaviour, while sleep disturbance was significantly and negatively associated with emotion regulation. Emotion regulation also demonstrated a significant negative relationship with aggressive behaviour. Moderation analysis indicated that emotion regulation significantly weakened the positive relationship between sleep disturbance and aggressive behaviour. Specifically, the association between sleep disturbance and aggression was stronger among children with lower levels of emotion regulation and weaker among those with higher levels of emotion regulation, supporting the buffering role of emotion regulation.

Unique Contribution to Theory, Policy, and Practice: This study extends Gross's Process Model of Emotion Regulation (1998) by demonstrating that Emotion regulation buffers the association between sleep disturbances and aggressive behaviour among children with Autism Spectrum Disorder (ASD). The findings underscore the importance of integrating emotion regulation training with sleep management interventions in clinical, educational, and family settings. These results support the development of policies and interventions aimed at enhancing emotion regulation and psychological well-being among children with ASD in Pakistan.

Keywords: *Sleep Disturbance, Aggressive Behaviour, Emotion Regulation, Children with Autism*

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by persistent social communication deficits, limited interests, repetitive behaviours, and sensory processing abnormalities (Goncalves & Monteiro, 2023; Hirota & King, 2023). According to the World Health Organization, approximately one in every 100 children worldwide is diagnosed with ASD, making it one of the most prevalent developmental disorders among children (World Health Organization [WHO], 2023). Among these challenges, sleep disturbances and aggressive behaviour have emerged as significant concerns due to their detrimental effects on children's psychological functioning, social relationships, educational performance, and overall quality of life. Recent evidence suggests that sleep-related problems affect between 50% and 80% of children with ASD, a prevalence substantially higher than that observed in typically developing children (Cohen et al., 2014; Hirata et al., 2016).

Sleep disturbance is one of the most common co-occurring conditions among children with ASD and includes difficulties in initiating sleep, sustaining sleep, early morning awakening, irregular sleep-wake cycles, and poor sleep quality or high sleep disturbance. Research demonstrates that disrupted sleep adversely affects cognitive functioning, emotion stability, attention, and behavioural regulation (Mazurek & Sohl, 2016). Similarly, aggressive behaviour, comprising physical aggression, verbal aggression, self-injurious actions, and oppositional conduct, is often reported among children with autism and creates significant challenges for parents, teachers, and healthcare providers (Kanne & Mazurek, 2011). Previous studies have indicated a positive association between sleep problems and aggression, reflecting that insufficient or disturbed sleep may impair emotion control and elevates irritability, frustration, and behavioural outbursts (Adams et al., 2014; Reynolds et al., 2019).

According to Gross (1998), emotion regulation refers to the processes through which individuals monitor, evaluate, and modify their emotion responses to achieve adaptive functioning. Sleep plays a critical role in maintaining emotion regulation capacities by supporting neural processes involved in impulse control, emotion processing, and executive functioning (Palmer & Alfano, 2017). Children who experience chronic sleep disturbances often reflect reduced emotion regulation abilities, making them more prone to anger, frustration, and aggressive reactions when exposed to environmental stressors. Within the autism population, deficits in emotion regulation are particularly pronounced due to inherent challenges in recognizing, understanding, and managing emotion (Mazefsky et al., 2013). Consequently, emotion regulation may act as a protective factor that buffers the negative impact of sleep disturbances on aggressive behaviour.

Despite growing international evidence regarding sleep problems and behavioural difficulties in ASD, significant research gaps remain. Most existing studies have been conducted in North America, Europe, and other high-income countries, limiting the generalizability of findings to developing nations with different sociocultural and healthcare contexts (Mazurek et al.,

2019). Furthermore, previous investigations have primarily focused on direct associations between sleep disturbances and behavioural outcomes, while the moderating role of emotion regulation has received comparatively limited empirical attention.

To date, very few Pakistani studies have examined sleep disturbances among children with autism, and research exploring the interplay between sleep, emotion regulation, and aggressive behaviour is virtually absent. Therefore, findings from Western populations cannot be assumed to apply directly to Pakistani children because cultural norms regarding parenting practices, emotion expression, family structure, and healthcare access may influence these relationships. Investigating these variables within the Pakistani context will contribute culturally relevant evidence that can guide assessment, intervention, and policy development.

Based on the identified gaps, the present study seeks to examine the relationship between sleep disturbance and aggressive behaviour among children with autism while investigating the moderating role of emotion regulation. The problem addressed by this study is the limited understanding of how emotion regulatory capacities influence the behavioural consequences of sleep difficulties in children with ASD, particularly within Pakistan. Understanding this relationship is essential because aggressive behaviours can significantly impair social adaptation, educational participation, and family functioning. The findings are expected to contribute to the existing literature by extending Emotion Regulation Theory to autism research, identifying potential protective factors against aggression, and providing evidence for clinicians, educators, and caregivers.

Hypothesis

H1: Emotion regulation moderates the relationship between sleep disturbance and aggressive behaviour among children with autism, such that the positive association between sleep disturbance and aggressive behaviour is weaker among children with higher levels of emotion regulation than among those with lower levels of emotion regulation.

Methodology

Research Design

The present study employed a quantitative, cross-sectional correlational research design to investigate the relationship between sleep disturbance and aggressive behaviour among children with Autism Spectrum Disorder (ASD), while examining the moderating role of emotion regulation. A correlational design was appropriate because it enables the assessment of naturally occurring relationships among variables without manipulating any conditions.

Sampling Technique and Participants

A purposive sampling technique was used to recruit participants from special education centres, autism rehabilitation clinics, developmental assessment centres, and inclusive educational

institutions in Karachi, Lahore, Faisalabad, Hyderabad, Islamabad, and Rawalpindi, Pakistan. Purposive sampling was considered appropriate because the study required participants who met specific inclusion criteria, namely children with a formal diagnosis of Autism Spectrum Disorder (ASD).

Inclusion Criteria

- Children aged 6–16 years.
- Clinical diagnosis of Autism Spectrum Disorder.
- Parent available to complete questionnaires.
- Parent must be at least matric or O level qualified.
- Ability of parent to understand English.

Exclusion Criteria

- Children with severe neurological disorders unrelated to ASD (e.g., traumatic brain injury).
- Children with severe intellectual disability preventing reliable behavioural assessment.
- Caregivers who do not provide informed consent.

Sample Characteristics

A total of 260 children with Autism Spectrum Disorder (ASD) were included in the study, and their caregivers completed the questionnaires on their behalf, with no missing data reported. The mean age of the children was 11.84 years ($SD = 3.39$), with the highest proportion being 15 years ($n = 62$, 23.8%). Male children constituted 60.0% ($n = 156$), whereas female children comprised 40.0% ($n = 104$) of the sample. Most participants resided in Lahore ($n = 139$, 53.5%), followed by Faisalabad ($n = 53$, 20.4%), Karachi ($n = 27$, 10.4%), Islamabad ($n = 25$, 9.6%), Hyderabad ($n = 10$, 3.8%), and Rawalpindi ($n = 6$, 2.3%). The majority of children were receiving medication for ASD-related symptoms ($n = 171$, 65.8%), while 89 (34.2%) were not. Most participants belonged to nuclear families ($n = 152$, 58.5%), whereas 108 (41.5%) belonged to joint families. The questionnaires were completed by fathers ($n = 91$, 35.0%), mothers ($n = 85$, 32.7%), and guardians ($n = 84$, 32.3%). The caregivers had a mean age of 45.59 years ($SD = 8.43$). Regarding educational qualifications, 85 (32.7%) caregivers had completed Matric/O-Level, 65 (25.0%) had Intermediate education, 57 (21.9%) held a Bachelor's degree, 25 (9.6%) had a Master's degree, and 28 (10.8%) possessed a PhD.

Children's Sleep Habits Questionnaire (CSHQ)

Sleep disturbance was assessed using the Children's Sleep Habits Questionnaire (CSHQ; Owens et al., 2000). The CSHQ is a widely used parent-report measure designed to evaluate sleep behaviours in school-aged children. The scale consists of 33 items rated on a 3-point Likert scale ranging from 1 (Rarely) to 3 (Usually). It measures bedtime resistance, sleep onset delay, sleep

duration, sleep anxiety, night wakings, parasomnias, sleep-disordered breathing, and daytime sleepiness. Higher scores indicate greater sleep disturbance. The original instrument demonstrated good internal consistency (Cronbach's $\alpha = .78$) (Owens et al., 2000). The internal consistency of the scale in the present study was excellent, with a Cronbach's $\alpha = .89$.

Institute for Basic Research–Modified Overt Aggression Scale (IBR-MOAS)

Aggressive behaviour was assessed using the Institute for Basic Research–Modified Overt Aggression Scale (IBR-MOAS). The scale consists of 20 items rated on a 4-point Likert scale ranging from 0 (Never) to 3 (Often). It assesses verbal aggression, aggression against self, aggression against others, and aggression against property. Higher scores indicate greater aggressive behaviour. The instrument demonstrated good internal consistency (Cronbach's $\alpha = .86$) (Cohen et al., 2010). The scale demonstrated good internal consistency in the present study (Cronbach's $\alpha = 0.84$).

Emotion Regulation Checklist (ERC)

Emotion regulation was measured using the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997). The ERC consists of 24 items rated on a 4-point Likert scale ranging from 1 (Never) to 4 (Almost Always). The instrument assesses children's ability to regulate emotion responses and manage emotion experiences appropriately. Higher scores on the emotion regulation dimension indicate better emotion regulatory capacity. The original instrument demonstrated excellent internal consistency (Cronbach's $\alpha = .83$) (Shields & Cicchetti, 1997). The scale demonstrated good internal consistency in the present study (Cronbach's $\alpha = .85$).

Procedure

Caregivers of eligible children with Autism Spectrum Disorder (ASD) were approached and informed about the purpose, objectives, and voluntary nature of the study. Written informed consent was obtained from all participants before data collection, and they were assured that their responses would remain confidential and be used solely for research purposes. Participants completed the demographic information sheet, the Children's Sleep Habits Questionnaire (CSHQ), the Institute for Basic Research–Modified Overt Aggression Scale (IBR-MOAS), and the Emotion Regulation Checklist (ERC), either in paper-and-pencil format or through a secure online platform. Completion of the survey package required approximately 20–25 minutes. Following data screening and coding, statistical analyses were conducted using IBM SPSS Statistics Version 27 and PROCESS Macro Version 4.2 (Hayes, 2022). Descriptive statistics, reliability analyses, Pearson correlation analyses, and moderation analysis were performed to test the study hypotheses.

Ethical Considerations

The study adhered to the Ethical Principles of Psychologists and Code of Conduct established by the American Psychological Association (APA, 2017). Ethical approval was obtained from the relevant Institutional Review Board (IRB) before data collection commenced.

Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without penalty. Written informed consent was obtained from all caregivers prior to participation. Participants were informed about the purpose, procedures, potential benefits, and minimal risks associated with the study. Confidentiality and anonymity were maintained by assigning identification codes instead of recording participants' names. All data were stored securely and were accessible only to the researcher and supervisory team. No physical, psychological, social, or financial harm was anticipated or reported as a result of participation. The findings were reported in aggregate form to ensure that individual participants could not be identified. Participants were also provided with the researcher's contact information should they require additional information regarding the study.

Results

Table 1: Correlation among Study Variables (N = 260)

Variables	1	2	3
1.Sleep Disturbance	-	-.46***	.76***
2. Emotion Regulation		-	-.66***
3.Aggressive Behaviour			-

Note. *** $p < .001$

Pearson correlation analysis showed that sleep disturbance was significantly and negatively associated with emotion regulation ($r = -.46, p < .001$) and significantly and positively associated with aggressive behaviour ($r = .76, p < .001$). Emotion regulation was also significantly and negatively correlated with aggressive behaviour ($r = -.66, p < .001$).

Table 2: Moderation Analysis (N = 260)

Predictors	<i>B</i>	<i>SE</i>	<i>t</i>	<i>P</i>	<i>LLCI</i>	<i>ULCI</i>
Constant	13.45	4.96	2.71	.007	3.67	23.22
SD	.54	.07	7.22	<.001	.39	.69
ER	-.05	.13	-.38	.70	-.31	.21
SD X ER	-.004	.002	-2.24	.02	-.009	-.0006

Note. $**p < .01$, $***p < .001$, SD = Sleep Disturbance, ER = Emotion Regulation, B = Unstandardized Beta, SE = Standard Error, LLCI = Lower Limit Confidence Interval, ULCI = Upper Limit Confidence Interval, $R^2 = .71$, $F = 217.63$, $p < .001$; for the interaction term (SD X ER): $\Delta R^2 = 0.005$, $F = 5.04$, $p = .02$

The moderation analysis indicated that the overall model was significant, explaining 71% of the variance in aggressive behaviour ($R^2 = .71$, $F = 217.63$, $p < .001$). Sleep disturbance significantly and positively predicted aggressive behaviour ($B = .54$, $p < .001$). Although the direct effect of emotion regulation was not significant ($B = -.05$, $p = .70$), the interaction between sleep disturbance and emotion regulation was significant ($B = -.004$, $p = .02$), supporting that emotion regulation significantly moderated the relationship between sleep disturbance and aggressive behaviour.

Discussion

The present study examined the moderating role of emotion regulation in the relationship between sleep disturbance and aggressive behaviour among children with Autism Spectrum Disorder (ASD) in Pakistan. The findings supported the proposed hypothesis, demonstrating that emotion regulation significantly buffered the positive association between sleep disturbance and aggressive behaviour. Specifically, children with poorer emotion regulation exhibited a stronger relationship between sleep disturbances and aggressive behaviour, whereas this association was considerably weaker among children with better emotion regulation abilities. These findings highlight emotion regulation as an important protective factor that may reduce the adverse behavioural consequences of inadequate sleep in children with ASD.

The findings of the moderation analysis are consistent with Gross's (1998) Process Model of Emotion Regulation, which suggests that individuals who effectively regulate their emotion are better able to manage emotion responses to stressful situations. Sleep disturbances negatively affect executive functioning, emotion processing, and impulse control, thereby increasing emotion reactivity and behavioural dysregulation (Palmer & Alfano, 2017). Children with autism frequently experience deficits in recognizing and regulating emotion (Cai & Samson, 2025; Mazefsky et al., 2013), making them particularly vulnerable to aggressive outbursts when sleep quality is compromised or sleep disturbance is too high. The present findings therefore extend emotion regulation theory by demonstrating its buffering role within the Pakistani cultural context.

The results also align with previous empirical evidence indicating that sleep disturbances are associated with greater behavioural difficulties among children with ASD (Adams et al., 2014; Mazurek & Sohl, 2016; Reynolds et al., 2019). Poor sleep has consistently been linked with increased irritability, frustration, emotion instability, and externalising behaviours. The current study further contributes to the literature by identifying emotion regulation as an important mechanism that weakens this relationship. These findings are also consistent with previous studies demonstrating that better emotion regulation predicts fewer aggressive behaviours among children with autism despite experiencing environmental or physiological stressors (Mazefsky et al., 2013).

Within the Pakistani context, these findings carry particular significance. Families raising children with autism often encounter limited access to specialized behavioural interventions, shortages of trained mental health professionals, and societal misconceptions regarding neurodevelopmental disorders. Consequently, sleep-related difficulties and aggressive behaviours may remain inadequately recognised or managed. Moreover, collectivistic family structures common in Pakistan may expose caregivers to considerable psychological and caregiving burden when children display persistent aggression. Improving children's emotion regulation skills may therefore not only reduce aggressive behaviour but also improve family functioning, parental well-being, and children's adjustment within educational and community settings.

Conclusion

The present study concludes that emotion regulation serves as a significant protective factor in the relationship between sleep disturbance and aggressive behaviour among children with Autism Spectrum Disorder. While sleep disturbances contribute to increased aggressive behaviour, effective emotion regulation substantially weakens this relationship. These findings emphasize that interventions addressing emotion regulation alongside sleep management may be particularly effective in reducing behavioural difficulties among children with autism. The study also contributes culturally relevant evidence to the limited Pakistani literature on autism by highlighting the importance of psychological and behavioural protective factors in promoting adaptive functioning among children with ASD.

Limitations and Recommendations

Several limitations should be considered when interpreting the findings. First, the cross-sectional design precludes causal inferences among sleep disturbance, emotion regulation, and aggressive behaviour. Second, purposive sampling limits the generalizability of the findings to the broader population of children with autism in Pakistan. Third, reliance on caregiver-reported questionnaires may have introduced reporting bias. Finally, important factors such as autism severity, sensory sensitivities, anxiety, parenting stress, and medication use were not examined. Future research should employ longitudinal designs, probability sampling, multi-informant assessments, and objective sleep measures to strengthen the evidence.

Theoretical and Practical Implications

The findings provide theoretical support for Gross's (1998) Process Model of Emotion Regulation by extending its application to children with Autism Spectrum Disorder in Pakistan. The study highlights that emotion regulation acts as a protective factor that buffers the behavioural consequences of sleep disturbances, contributing to a better understanding of behavioural regulation in neurodevelopmental disorders. Additionally, the findings provide culturally relevant evidence for the limited Pakistani autism literature and encourage future research on protective psychological factors.

Practically, the findings suggest that clinicians, psychologists, speech therapists, occupational therapists, and special education professionals should assess sleep disturbances and emotion regulation difficulties when designing interventions for children with autism. Parent training programs should incorporate strategies to enhance emotion regulation and promote healthy sleep routines. Schools and autism rehabilitation centres should implement evidence-based social-emotion learning interventions to strengthen self-regulation skills. Policymakers should also support autism services, caregiver education, and community awareness programs to improve early identification and management of behavioural difficulties among children with ASD in Pakistan.

References

- Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA school-age forms and profiles*. University of Vermont, Research Center for Children, Youth, and Families.
- Adams, H. L., Matson, J. L., Cervantes, P. E., & Goldin, R. L. (2014). The relationship between autism symptom severity and sleep problems: Should bidirectionality be considered? *Research in Autism Spectrum Disorders*, 8(3), 193–199. <https://doi.org/10.1016/j.rasd.2013.11.008>
- American Psychological Association. (2017). *Ethical principles of psychologists and code of conduct*. American Psychological Association.
- Cai, R. Y., & Samson, A. C. (2025). A non-systematic overview review of self-focused emotion regulation in autistic individuals through the lens of the extended process model. *Autism*, 29(5), 1118-1128.
- Cohen, S., Conduit, R., Lockley, S. W., Rajaratnam, S. M. W., & Cornish, K. M. (2014). The relationship between sleep and behavior in autism spectrum disorder (ASD): A review. *Journal of Neurodevelopmental Disorders*, 6(1), 44. <https://doi.org/10.1186/1866-1955-6-44>
- Goncalves, A. M., & Monteiro, P. (2023). Autism Spectrum Disorder and auditory sensory alterations: a systematic review on the integrity of cognitive and neuronal functions related to auditory processing. *Journal of neural transmission*, 130(3), 325-408.
- Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, 2(3), 271–299. <https://doi.org/10.1037/1089-2680.2.3.271>
- Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). Guilford Press.
- Hirata, I., Mohri, I., Kato-Nishimura, K., Tachibana, M., Kuwada, A., Kagitani-Shimono, K., ... & Taniike, M. (2016). Sleep problems are more frequent and associated with problematic

- behaviors in preschoolers with autism spectrum disorder. *Research in Developmental Disabilities*, 49-50, 86–99. <https://doi.org/10.1016/j.ridd.2015.11.002>
- Hirota, T., & King, B. H. (2023). Autism spectrum disorder: a review. *Jama*, 329(2), 157-168.
- Kanne, S. M., & Mazurek, M. O. (2011). Aggression in children and adolescents with ASD: Prevalence and risk factors. *Journal of Autism and Developmental Disorders*, 41(7), 926–937. <https://doi.org/10.1007/s10803-010-1118-4>
- Mazefsky, C. A., Borue, X., Day, T. N., & Minshew, N. J. (2013). Emotion regulation patterns in adolescents with high-functioning autism spectrum disorder: Comparison to typically developing adolescents and association with psychiatric symptoms. *Autism Research*, 7(3), 344–354. <https://doi.org/10.1002/aur.1366>
- Mazurek, M. O., & Sohl, K. (2016). Sleep and behavioral problems in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46(6), 1906–1915. <https://doi.org/10.1007/s10803-016-2723-7>
- Mazurek, M. O., Dovgan, K., Neumeyer, A. M., & Malow, B. A. (2019). Course and predictors of sleep and co-occurring problems in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 49(5), 2101–2115. <https://doi.org/10.1007/s10803-019-03883-x>
- Owens, J. A., Spirito, A., & McGuinn, M. (2000). The Children's Sleep Habits Questionnaire (CSHQ): Psychometric properties of a survey instrument for school-aged children. *Sleep*, 23(8), 1043–1051. <https://doi.org/10.1093/sleep/23.8.1d>
- Palmer, C. A., & Alfano, C. A. (2017). Sleep and emotion regulation: An organizing, integrative review. *Sleep Medicine Reviews*, 31, 6–16. <https://doi.org/10.1016/j.smrv.2015.12.006>
- Reynolds, A. M., Soke, G. N., Sabourin, K. R., Hepburn, S., Katz, T., Wiggins, L. D., ... & Levy, S. E. (2019). Sleep problems in children with autism spectrum disorder and their relationship to maladaptive behavior and caregiver stress. *BMC Pediatrics*, 19(1), 414. <https://doi.org/10.1186/s12887-019-1798-4>
- Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology*, 33(6), 906–916. <https://doi.org/10.1037/0012-1649.33.6.906>
- World Health Organization. (2023). Autism. <https://www.who.int/news-room/fact-sheets/detail/autism>



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