



EFFECTIVENESS OF ADDING NEUROSENSOMOTOR REFLEX DEVELOPMENT AND SYNCHRONIZATION TO THE PERCEPTUAL MOTOR PROGRAM IN IMPROVING BALANCE IN CHILDREN WITH AUTISM SPECTRUM DISORDER

Ni Luh Putu Gita Karunia Saraswati^{1*}, Putu Mulya Kharismawan³, Govinda Vittala¹, Made Hendra Satria Nugraha², Indah Pramita¹, Anak Ayu Nyoman Trisna Narta Dewi²

¹Bachelor of Physiotherapy Study Program, Faculty of Medicine, Universitas Udayana, Jl. P.B. Sudirman, Dangin Puri Klod, Denpasar Barat, Denpasar, Bali 80232, Indonesia

²Physiotherapy Professional Education Study Program, Faculty of Medicine, Universitas Udayana, Jl. P.B. Sudirman, Dangin Puri Klod, Denpasar Barat, Denpasar, Bali 80232, Indonesia

³Yoga and Health Study Program, Faculty of Brahma Widya, Universitas Hindu Negeri I Gusti Bagus Sugriwa Denpasar, Jl. Kenyeri Gg. Sekar Kemuda No.1, Tonja, Denpasar Timur, Denpasar, Bali 80235, Indonesia

*gitakarunia@unud.ac.id

ABSTRACT

Children with Autism Spectrum Disorder (ASD) often show impaired sensorimotor integration, which disrupts both static and dynamic balance and limits how independently they manage daily activities. The Perceptual Motor Program (PMP) has been reported to enhance balance in this group, but evidence on whether pairing it with Neuro Sensory Motor Reflex Development and Synchronization (NSMRD&S) yields further benefit is lacking. The aim was to determine whether NSMRD&S given on top of PMP produces greater improvement in static and dynamic balance among children with ASD than PMP given by itself. Thirty children with ASD were allocated equally to an intervention group (NSMRD&S plus PMP, n=15) or a control group (PMP only, n=15) in a two-group pretest–posttest study. Both groups attended sessions three times weekly for four weeks. Static balance was assessed using the One Legged Stance Test and dynamic balance using the Beam Balance Test. The paired sample t-test examined changes within groups and the independent t-test compared the groups, at a significance level of $p < 0.05$. Static and dynamic balance both improved significantly in each group ($p = 0.001$). Static balance gains were larger in the intervention group than in controls (3.26 ± 1.66 vs. 2.93 ± 1.33 ; $p = 0.000$), and dynamic balance gains were considerably larger (1.35 ± 0.44 vs. 0.48 ± 0.30 ; $p = 0.000$). Adding NSMRD&S to PMP produced greater balance improvement, both static and dynamic, than PMP alone in children with ASD. The findings favor integrating sensorimotor-reflex techniques with perceptual-motor training when physiotherapists address balance problems in this population.

Keywords: autism spectrum disorder; balance; neuro sensory motor reflex development and synchronization; perceptual motor program; physiotherapy; postural control

How to cite (in APA style)

Saraswati, N. L. P. G. K., Kharismawan, P. M., Vittala, G., Nugraha, M. H. S., Pramita, I., & Dewi, A. A. N. T. N. (2026). Effectiveness of Adding Neurosensomotor Reflex Development and Synchronization to the Perceptual Motor Program in Improving Balance in Children with Autism Spectrum Disorder. *Indonesian Journal of Global Health Research*, 8(6), 1269–1276. <https://doi.org/10.37287/ijghr.v8i6.2192>.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent difficulties in social communication and interaction, alongside restricted, repetitive patterns of behavior, interests, or activity. In the DSM-5, ASD is grouped with the developmental disorders that disrupt a child's growth and development, its defining features being limited social and communication skills, repetitive behaviors, and narrowly focused interests. The first signs often become noticeable at about three years of age, when anticipated communication and social milestones have not emerged. The World Health Organization estimated that about one in 127 people around the world was autistic in 2021, and the Centers for Disease Control and Prevention in the United States, monitoring eight-year-olds, reported a prevalence of 1 in 31 in 2022. For Indonesia, population-based national estimates remain scarce, so the scale of the problem has largely been inferred from service data. Community health centers (puskesmas) reportedly handled at least 5,530 developmental disorder cases, including autism, during 2020–2021. These figures

highlight the urgency of earlier detection, evidence-based intervention, and stronger ASD services across Indonesia (Ramadhani, 2024).

Besides the defining social and communication characteristics, motor problems are widespread among children with ASD. A review indicated that 92.5% of included studies found significant motor impairment, estimated at about 50–88% of autistic children when assessed with standardized motor tests and/or functional questionnaires (Alhussain & Ibrahim, 2026). SPARK cohort data point the same way: about 88% of the children were at risk for motor difficulties, yet comparatively few had received physical therapy (Bhat, 2024). Motor impairment is highly prevalent in ASD and accompanies greater severity of functional, cognitive, social-communication, and behavioral problems; it should therefore be seen as a clinically significant concern instead of a minor comorbid feature (Bhat, 2021). These difficulties can take the form of weaker motor skills, postural control, balance, and coordination, any of which may reduce functional performance and participation (Kaur et al., 2024). Postural instability and weak balance control are described again and again in this population, and recent work indicates that these children find it harder than typically developing peers to maintain postural stability (Date et al., 2024).

Postural stability is the ability to hold or recover equilibrium by keeping the body's center of mass inside its base of support. As a core component of static and dynamic balance, it relies on sensory, motor, and biomechanical inputs working together. Effective postural control allows people to stay steady while moving and to complete functional tasks, daily living activities among them (Mani et al., 2021; Zhou & Qi, 2022). Impaired postural control and balance are consistently reported in autistic children, underscoring how much postural stability matters for functional movement and participation (Date et al., 2024). From a physiological viewpoint, balance depends on the integration of visual, vestibular, and proprioceptive information to produce appropriate neuromuscular responses and postural adjustments. In ASD this integration is often suboptimal, reflected in greater postural sway, difficulty maintaining a position, unsteadiness when standing, and decreased stability during movement. A recent systematic review and meta-analysis by Xu et al. identified weaker balance control among children and young people on the autism spectrum than in typically developing peers, most notably in sensory orientation and anticipatory postural adjustments (Xu et al., 2025). A cross-sectional study produced comparable findings (Abdel Ghafar et al., 2022a), in which autistic children showed deficits in sensory integration and in both static and dynamic balance. Such deficits can restrict mobility, play, social participation, and daily-life independence (Abdel Ghafar et al., 2022).

Targeted intervention is needed for balance deficits in autistic children, since postural stability forms the basis of more complex motor skills including walking, running, changing position, coordinating movements, exploring the environment, and participating in social activities. Physical exercise and sensorimotor-based programs are supported by the evidence for these aims. A meta-analysis found that diverse exercise-based interventions improved balance among children and adolescents on the spectrum, and a later meta-analysis restricted to randomized controlled trials (Li & Zhang, 2025a) confirmed that exercise yielded considerably greater balance improvement than control conditions (moderate-to-large effect, $SMD = 0.86$). Intervening on the sensorimotor system and postural control is therefore well justified when children with ASD have balance problems (Djordjević et al., 2022). This study adopted the Perceptual Motor Program (PMP) because it connects sensory perception to motor responses via structured movement tasks. A meta-analysis showed a large positive effect of exercise-based programs on balance among children and adolescents with ASD (Djordjević et al., 2022). A further study found that PMP gave significant improvements in static as well as dynamic balance in autistic children (Pramita & Wahyudi, 2022). More recently, perceptual motor training given three times weekly over four weeks reportedly improved dynamic balance significantly (Ansari et al., 2024). Together, these studies back PMP as a fitting intervention for balance problems in ASD.

Balance problems in ASD reflect more than motor performance alone; they also involve sensory integration, postural readiness, and automatic execution of motor responses. A sensorimotor-reflex-based approach, namely Neuro Senso Motor Reflex Development and Synchronization (NSMRD&S), is therefore pertinent. Exercise aimed at sensory-motor integration has been reported to significantly boost motor performance in autistic children (Xing & Wu, 2025). Melillo et al. likewise raised the possibility that retained primitive reflexes are linked to motor function and coordination in ASD, while noting that evidence for reflex-based interventions is still developing (Melillo et al., 2022). Balance impairment in ASD is thus frequent and functionally consequential, and treatment should target sensorimotor integration and postural control as well as motor output. PMP has established benefits for balance in this group, but little is known about its effect when combined with a sensorimotor-reflex approach like NSMRD&S. This study therefore set out to test whether adding NSMRD&S to PMP improves static and dynamic balance in autistic children more than PMP alone.

METHOD

A pretest–posttest design with two groups was used to evaluate how adding NSMRD&S to PMP affects balance in children with ASD. Children in the intervention group received both NSMRD&S and PMP; those in the control group received PMP only. Data were gathered at private child development clinics in Denpasar and Badung from July to September 2025. The target population was children with a medical diagnosis of ASD, drawn from the accessible population of children undergoing therapy at the study sites. Purposive sampling was used, and eligible children were enrolled until the required sample size was reached. Inclusion required parental consent, the ability to follow simple instructions and respond to objects and sounds, and a calm state (no tantrum). Children with congenital comorbidities, pain and/or neurological signs, lower-limb dysfunction, or recent corrective deformity surgery were excluded. Dropout was defined as missing two successive therapy sessions, being injured during the study, or clinical deterioration during the intervention. Applying the sample size calculation and these criteria, 30 children took part and were divided into two groups of 15.

NSMRD&S and PMP were the independent variables; the children's static and dynamic balance scores were the dependent variables. Static balance was measured using the One Legged Stance Test and dynamic balance using the Beam Balance Test. Assessment took place twice per child, before the intervention (pre-test) and following completion of all sessions (post-test). Treatment was given three times weekly for four weeks in both groups. Children in the intervention group received NSMRD&S plus PMP, and those in the control group PMP alone. NSMRD&S is a physiotherapy technique that rests on stimulating somatic sensation and establishing basic movement patterns so that children can relearn sensory perception, integration, and association. Stimulation was delivered mainly through touch, aiming to raise body awareness and help the central nervous system process incoming sensory information. PMP sessions were held in a large, flat, comfortable room with mats, a balance beam, and sensorimotor play equipment. Each session involved standing on a level surface, swinging one leg forward and backward for 10 seconds per leg, jumping in different directions, and tandem walking or walking along a balance beam (2.5 m long, 7 cm wide, 10 cm high). All activities were repeated 10 times, with sessions lasting about 30 minutes and two physiotherapists supervising each one. SPSS was used for analysis, and participant characteristics were described descriptively. Normality was assessed with the Shapiro–Wilk test and variance homogeneity with Levene's test; both assumptions were satisfied, so parametric tests were applied. The paired sample t-test evaluated changes in static and dynamic balance from pre- to post-intervention within each group, and the independent t-test compared the groups. Significance was defined as $p < 0.05$.

RESULT

A total of 30 children with ASD (15 per group) were included in the analysis. Mean age was 6.20 ± 2.30 years for the intervention group and 5.26 ± 1.66 years for the control group, while mean

duration of therapy was 1.60 ± 0.50 and 1.66 ± 0.48 years, respectively. Both sexes were represented fairly evenly: 8 boys (53.3%) and 7 girls (46.7%) in the intervention group, and 7 boys (46.7%) and 8 girls (53.3%) in the control group. Baseline static balance was 9.26 ± 1.48 in the intervention group and 8.60 ± 1.72 in the control group; baseline dynamic balance was 2.64 ± 0.40 and 3.02 ± 0.36 , respectively.

Table 1.
Subject Characteristics

Characteristic	Mean $\pm$ SD Group 1 (Intervention)	Mean $\pm$ SD Group 2 (Control)
Age (years)	6.20 ± 2.30	5.26 ± 1.66
Duration of Therapy (years)	1.60 ± 0.50	1.66 ± 0.48
Static Balance (Pre-Test)	9.26 ± 1.48	8.60 ± 1.72
Dynamic Balance (Pre-Test)	2.64 ± 0.40	3.02 ± 0.36

Table 2.
Distribution of Subjects by Sex

Sex	Group 1 Frequency	Group 1 %	Group 2 Frequency	Group 2 %
Male	8	53.3	7	46.7
Female	7	46.7	8	53.3

Table 3.
Normality and Homogeneity Test Results

Time Point	Balance	Grp 1 Statistic	P	Grp 2 Statistic	p	Homogeneity p
Pre-Intervention	Static	0.923	0.217	0.922	0.203	0.380
	Dynamic	0.886	0.059	0.910	0.136	0.634
Post-Intervention	Static	0.955	0.606	0.896	0.082	0.142
	Dynamic	0.884	0.054	0.886	0.059	0.383

For every variable in both groups, the Shapiro–Wilk test gave $p > 0.05$ before and after the intervention. In the intervention group, static balance had $p = 0.217$ at baseline and 0.606 afterwards, while dynamic balance had $p = 0.059$ and 0.054. Corresponding control group values were $p = 0.203$ and 0.082 for static balance, and $p = 0.136$ and 0.059 for dynamic balance. Levene's test showed homogeneous variances between the groups ($p = 0.380$ for static and 0.634 for dynamic balance at baseline; $p = 0.142$ and 0.383 post-intervention). Parametric testing assumptions were thus fulfilled.

Table 4.
Pre- and Post-Intervention Balance Scores by Group (Paired Sample t-Test)

Group	Pre-Test Static	Pre-Test Dynamic	Post-Test Static	Post-Test Dynamic	p-value (Static/Dynamic)
Group 1 (Intervention)	9.26 ± 1.48	2.64 ± 0.40	12.53 ± 1.35	4.00 ± 0.47	0.0001 / 0.0001
Group 2 (Control)	8.60 ± 1.72	3.02 ± 0.36	11.33 ± 0.91	3.51 ± 0.33	0.0001 / 0.0001

Mean static balance in the NSMRD&S plus PMP group rose from 9.26 ± 1.48 to 12.53 ± 1.35 , and mean dynamic balance climbed from 2.64 ± 0.40 to 4.00 ± 0.47 . In the control group receiving PMP only, static balance increased from 8.60 ± 1.72 to 11.33 ± 0.91 and dynamic balance from 3.02 ± 0.36 to 3.51 ± 0.33 . According to the paired sample t-test, both balance components improved significantly in both groups (all $p = 0.001$; $p < 0.05$).

Table 5.
Between-Group Comparisons (Independent t-Test)

Time Point	Balance	Group	N	Mean $\pm$ SD	p-value
Pre-Intervention	Static	Group 1	15	9.26 ± 1.48	0.266
		Group 2	15	8.60 ± 1.72	
	Dynamic	Group 1	15	2.64 ± 0.40	0.013
		Group 2	15	3.02 ± 0.36	
Post-Intervention	Static	Group 1	15	12.53 ± 1.35	0.025
		Group 2	15	11.33 ± 0.91	
	Dynamic	Group 1	15	4.00 ± 0.47	0.003
		Group 2	15	3.51 ± 0.33	
Change Score	Static	Group 1	15	3.26 ± 1.66	0.000
		Group 2	15	2.93 ± 1.33	
	Dynamic	Group 1	15	1.35 ± 0.44	0.000
		Group 2	15	0.48 ± 0.30	

Baseline comparison by independent t-test showed no significant group difference in static balance ($p = 0.266$) but a significant one in dynamic balance ($p = 0.013$). Following the intervention, significant group differences emerged for static balance ($p = 0.025$) and dynamic balance ($p = 0.003$). Mean change in static balance was 3.26 ± 1.66 for the intervention group against 2.93 ± 1.33 for controls, and mean change in dynamic balance was 1.35 ± 0.44 against 0.48 ± 0.30 , respectively. Gains in both static and dynamic balance were thus larger in the intervention group than in controls. Overall, balance (static and dynamic) improved in both groups after the intervention, though gains were consistently greater for children receiving NSMRD&S with PMP than for those receiving PMP only.

DISCUSSION

Both static and dynamic balance improved significantly in each group after treatment. Children who received NSMRD&S in addition to PMP, however, showed larger gains on each balance measure than recipients of PMP only. These findings imply that combining sensorimotor-reflex preparation with task-oriented motor training may offer additional therapeutic benefit for children with ASD and balance impairment. In clinical terms, the intervention group's static balance improved by 3.26 points (9.26 to 12.53) and the control group's by 2.93 points (8.60 to 11.33). The difference was more marked for dynamic balance: the intervention group gained 1.35 points (2.64 to 4.00), whereas the control group gained just 0.48 points (3.02 to 3.51). This bigger improvement in dynamic balance may be clinically important, as dynamic balance supports everyday functional tasks such as walking, climbing stairs, playing on playgrounds, and shifting between positions. Adding NSMRD&S to PMP may therefore bring an additional advantage.

Therapeutic Mechanisms of the Perceptual Motor Program

That the control group improved suggests PMP alone may be enough to enhance balance in children with ASD. Over four weeks, PMP comprised repeated tasks, namely standing on a stable surface, swinging one leg, jumping in several directions, and tandem walking or walking on a balance beam. These tasks tax the postural control system, as they require visual, vestibular, and somatosensory inputs to be integrated with coordinated movement. Earlier studies associated postural control problems in ASD with atypical sensory processing and poor balance, and demonstrated that exercise-based programs benefit balance in this group (Date et al., 2024; Djordjević et al., 2022; Ferreiro-Pérez et al., 2024). These sensorimotor processes may function atypically in children with ASD. Recent studies indicate unusual use and integration of visual, vestibular, and somatosensory inputs during postural control, which may partly explain the lower postural stability observed in this population (Date et al., 2024; Ferreiro-Pérez et al., 2024). Repetitive perceptual-motor training such as PMP could therefore be an appropriate way to challenge these processes, because it gradually requires children to merge sensory inputs while performing tasks that demand balance. With repeated practice, children may become better at spotting errors, adapting to sensory input, and fine-tuning postural responses, potentially leading in time to more efficient and stable postural control (Ferreiro-Pérez et al., 2024). These results are in line with previous work showing that perceptual-motor interventions can be effective for autistic children. An earlier study found improvements of 36.18% in static balance and 124.59% in dynamic balance after a perceptual-motor program (Pramita & Wahyudi, 2022). Recent studies also report that exercise-based interventions lead to significant balance gains in children and adolescents on the autism spectrum, which underlines the value of structured motor activity for building postural control (Date et al., 2024; Djordjević et al., 2022). In a Grade 1 ASD sample from the Denpasar Autism Service Center, a perceptual motor approach worked better than specific balance training for dynamic balance, and motor training provided three times weekly over four weeks yielded significant dynamic balance improvements. Taken together, the evidence suggests that perceptual-motor training not only teaches children motor skills but also taxes the sensory and postural control processes that balance relies on (Ansari et al., 2024; Li & Zhang, 2025).

Added Value of NSMRD&S: Sensorimotor Priming and Postural Readiness

The stronger results in the intervention group support the hypothesis that NSMRD&S adds clinically meaningful benefit to PMP. In this study NSMRD&S was a physiotherapy approach centered on somatosensory stimulation, delivered mainly through touch and combined with systematic training in basic movement patterns, to help children relearn sensory perception, integration, and association. NSMRD&S could therefore act as sensorimotor priming, readying the child for the harder motor learning tasks in PMP. Neurophysiologically, tactile input contributes to body representation and somatosensory processing, and both matter for postural coordination. Atypical sensory processing in ASD has been associated with altered body awareness and postural control. Structured tactile stimulation delivered before motor practice may heighten children's awareness of sensory information and improve how they use it during the PMP tasks that follow, which could support more effective postural responses. Nevertheless, these mechanisms are speculative and need cautious interpretation, since sensory processing and neurophysiological change were not directly measured here. NSMRD&S's emphasis on developing and synchronizing basic reflex patterns is also theoretically plausible given recent literature on primitive reflexes and motor development in ASD. Melillo et al. (2022) put forward that persistent primitive reflexes might contribute to motor difficulties in autism spectrum disorders, and stressed the need for more research on intervention effects. Reflex-oriented elements of NSMRD&S might thus establish a neuromotor foundation for later voluntary motor practice; whether altered primitive reflex integration directly accounts for improved balance, however, remains unproven. Other sensorimotor interventions offer further support for this interpretation. Ben Hassen et al. (2023) reported that psychomotor rehabilitation enhanced postural control in children with ASD across varying visual conditions, implying that structured sensorimotor activity may alter how sensory information is used in postural tasks. In addition, a systematic review concluded that a range of postural control interventions can improve balance-related outcomes in autistic children, though heterogeneity in protocols and outcome measures means results must be interpreted with care (Date et al., 2024).

The added benefit of NSMRD&S found here is consistent with the wider literature on sensorimotor and motor interventions in ASD. Xing and Wu (2025) concluded from a systematic review that motor skill and physical activity programs can enhance motor development in children with ASD, supporting interventions that pair sensory-motor experience with active movement. Ben Hassen et al. (2023) also reported better postural control following nine weeks of psychomotor rehabilitation in this population. In sum, these studies suggest that interventions integrating several sensorimotor components may improve postural control and balance in autistic children (Ben Hassen et al., 2023; Xing & Wu, 2025). The idea of multimodal sensory enrichment may explain this relationship. Stimulating multiple sensory channels simultaneously, in a graded and structured manner, can give children repeated opportunities to connect sensory input with motor responses. In the present study, the NSMRD&S–PMP combination may have achieved this by coupling sensory-focused preparation (NSMRD&S) with task-oriented motor practice (PMP). Together these complementary components may have improved sensorimotor integration and task performance beyond what PMP achieved alone. The underlying neural mechanisms nonetheless remain speculative, because neural adaptation and sensory reweighting were not measured directly. This combined approach also appears well matched to the developmental level of young children with ASD. NSMRD&S and PMP share a sensorimotor, play-based delivery format that fits intervention principles favoring active involvement and meaningful motor experiences. Such a format may have boosted participation and adherence, enabling children in the intervention group to receive the intended therapeutic dose.

Interpretation of the Baseline Dynamic Balance Difference

One notable finding was the significant difference in baseline dynamic balance between groups ($p = 0.013$): the control group began slightly higher (3.02 ± 0.36) than the intervention group (2.64 ± 0.40). This should be borne in mind when reading the post-intervention results. Even though controls started with better dynamic balance, the intervention group ended up improving far more,

with a mean change of 1.35 ± 0.44 compared with 0.48 ± 0.30 in the control group ($p = 0.000$). The pattern suggests a possible advantage of combining NSMRD&S with PMP, yet the unequal starting point must be considered when interpreting the between-group difference. Stratifying allocation by baseline balance scores in future randomized controlled trials would produce more comparable groups at the start and thus stronger evidence. Statistical adjustment for baseline values, for instance through analysis of covariance, could also help account for initial differences in balance performance.

Limitations and Future Research Directions

This study has certain limitations. First, the sample was small (15 per group), which lowers statistical power and restricts generalizability; a larger multicenter randomized controlled trial would yield firmer evidence on the clinical efficacy of NSMRD&S as an add-on to PMP for children with ASD. Second, using purposive rather than random sampling may have created selection bias, as participants were recruited from particular clinics in Denpasar and Badung and may not represent the wider ASD population in Indonesia or other cultural settings. Third, the absence of follow-up assessment means the durability of treatment effects is unknown; future studies should include follow-ups at one, three, and six months to determine whether balance improvements are retained. Fourth, NSMRD&S was only described conceptually in this study and lacks a standardized, widely published protocol, making replication difficult. Subsequent work should develop and operationalize a formal NSMRD&S protocol and examine its inter-rater reliability so comparative studies become feasible. Fifth, sensory processing and sensorimotor integration were not objectively assessed, so how NSMRD&S achieves its effects cannot be explained here. Including neurophysiological measures in future research, for example electroencephalography (EEG) coherence, force-plate stabilometry, or sensory organization tests, would deepen understanding of the underlying mechanisms. Last, the significant baseline difference in dynamic balance is a key methodological issue: the intervention group improved more despite starting lower, but it cannot be fully excluded that this imbalance influenced the amount of change. Notwithstanding these limitations, the study adds to the growing body of evidence on multimodal sensorimotor interventions for balance impairment in autistic children and gives a first foundation for further work on the clinical value of NSMRD&S.

CONCLUSION

PMP and NSMRD&S each improved static and dynamic balance in children with autism spectrum disorder. The strongest results, however, were seen when the two were combined, because the combination addressed reflexive motor control as well as planned voluntary movement. NSMRD&S appeared to enhance sensorimotor readiness, body awareness, and automatic postural responses, which magnified the benefits of PMP alone. These findings support using sensorimotor-reflex-based approaches together with perceptual-motor training in the physiotherapy management of balance impairments in children with ASD.

REFERENCES

- Abdel Ghafar, M. A., Abdelraouf, O. R., Abdelgalil, A. A., Seyam, M. K., Radwan, R. E., & El-Bagalaty, A. E. (2022b). Quantitative Assessment of Sensory Integration and Balance in Children with Autism Spectrum Disorders: Cross-Sectional Study. *Children*, 9(3), 353. <https://doi.org/10.3390/children9030353>
- Alhussain, J. M., & Ibrahim, A. I. (2026). Assessment of Motor Performance in Children with Autism Spectrum Disorder: The Relationship Between Clinical Characteristics and Intelligence—An Exploratory Cross-Sectional Study. *Medicina*, 62(1), 145. <https://doi.org/10.3390/medicina62010145>
- Ansari, N. V., Hariandja, A. M. A., & Pambudi, R. A. (2024). Pengaruh Perceptual Motor Training Terhadap Keseimbangan Dinamis Pada Anak Autism Spectrum Disorder. *Jurnal Fisioterapi Dan Kesehatan Indonesia*, 4(02), 356–362. <https://doi.org/10.59946/Jfki.2024.378>

- Ben Hassen, I., Abid, R., Ben Waer, F., Masmoudi, L., Sahli, S., Driss, T., & Hammouda, O. (2023). Intervention Based on Psychomotor Rehabilitation in Children with Autism Spectrum Disorder ASD: Effect on Postural Control and Sensory Integration. *Children*, 10(9), 1480. <https://doi.org/10.3390/children10091480>
- Bhat, A. N. (2021). Motor Impairment Increases in Children With Autism Spectrum Disorder as a Function of Social Communication, Cognitive and Functional Impairment, Repetitive Behavior Severity, and Comorbid Diagnoses: A <scp>SPARK</scp> Study Report. *Autism Research*, 14(1), 202–219. <https://doi.org/10.1002/aur.2453>
- Bhat, A. N. (2024). Fewer children with autism spectrum disorder with motor challenges receive physical and recreational therapies compared to standard therapies: A SPARK data set analysis. *Autism*, 28(5), 1161–1174. <https://doi.org/10.1177/13623613231193196>
- Date, S., Munn, E., & Frey, G. C. (2024). Postural balance control interventions in autism spectrum disorder (ASD): A systematic review. *Gait & Posture*, 109, 170–182. <https://doi.org/10.1016/j.gaitpost.2024.01.034>
- Djordjević, M., Memisevic, H., Potic, S., & Djuric, U. (2022). Exercise-Based Interventions Aimed at Improving Balance in Children with Autism Spectrum Disorder: A Meta-Analysis. *Perceptual and Motor Skills*, 129(1), 90–119. <https://doi.org/10.1177/00315125211060231>
- Ferreiro-Pérez, M., Abuín-Porras, V., Martín-Casas, P., & Ortiz-Gutiérrez, R. M. (2024). Postural Control and Sensory Processing in Preschool Children with Autistic Spectrum Disorder: A Cross-Sectional Study. *Children*, 11(3), 303. <https://doi.org/10.3390/children11030303>
- Kaur, M., Gochyyev, P., & Tiwari, D. (2024). Use of standardized motor assessments in children with autism spectrum disorder: A meta-analysis and systematic review. *Research in Autism Spectrum Disorders*, 110, 102298. <https://doi.org/10.1016/j.rasd.2023.102298>
- Li, H., & Zhang, R. (2025a). The effect of exercise intervention on balance and executive function in children with autism spectrum disorder: a meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, 17(1). <https://doi.org/10.1186/s13102-025-01142-1>
- Li, H., & Zhang, R. (2025b). The effect of exercise intervention on balance and executive function in children with autism spectrum disorder: a meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, 17(1), 80. <https://doi.org/10.1186/s13102-025-01142-1>
- Mani, H., Miyagishima, S., Kozuka, N., Inoue, T., Hasegawa, N., & Asaka, T. (2021). Development of the Relationships Among Dynamic Balance Control, Inter-limb Coordination, and Torso Coordination During Gait in Children Aged 3–10 Years. *Frontiers in Human Neuroscience*, 15. <https://doi.org/10.3389/fnhum.2021.740509>
- Melillo, R., Leisman, G., Machado, C., Machado-Ferrer, Y., Chinchilla-Acosta, M., Kamgang, S., Melillo, T., & Carmeli, E. (2022). Retained Primitive Reflexes and Potential for Intervention in Autistic Spectrum Disorders. *Frontiers in Neurology*, 13. <https://doi.org/10.3389/fneur.2022.922322>
- Pramita, I., & Wahyudi, A. T. (2022). Pengaruh perceptual motor program terhadap keseimbangan pada anak autism spectrum disorder (asd). *Jurnal Pendidikan Kesehatan Rekreasi*, 8(2), 336–343.
- Ramadhani, T. (2024). Sistem Pakar Mendeteksi Penyakit Autis Pada Anak Dengan Metode LDA Pada Desa Sambirejo. *Jurnal Rekayasa Sistem (JUREKSI)*, 2(1), 193–207.
- Xing, Y., & Wu, X. (2025). Effects of Motor Skills and Physical Activity Interventions on Motor Development in Children with Autism Spectrum Disorder: A Systematic Review. *Healthcare*, 13(5), 489. <https://doi.org/10.3390/healthcare13050489>
- Xu, W., Li, N., & Qi, J. (2025). Balance Control in Children and Youth with Autism Spectrum Disorder: A Systematic Review and Meta-Analysis. *Alpha Psychiatry*, 26(3). <https://doi.org/10.31083/AP42869>
- Zhou, Y., & Qi, J. (2022). Effectiveness of Interventions on Improving Balance in Children and Adolescents With Hearing Impairment: A Systematic Review. *Frontiers in Physiology*, 13. <https://doi.org/10.3389/fphys.2022.876974>