

Effect of Perceptual Motor Program Combined with Obstacle Course Exercise on Dynamic Balance in Children with Autism Spectrum Disorders

An-nissa Istifarra Koestya Devi¹, Alinda Nur Ramadhani^{2*}, Dita Mirawati³, Nugraheni Agustyaningsih⁴

^{1,2,3}Program Studi DIV Fisioterapi, Fakultas Ilmu Kesehatan, Universitas ‘Aisyiyah Surakarta, Indonesia

⁴Yayasan Pembinaan Anak Cacat (YPAC) Surakarta, Indonesia

Email: alinda.ramadhani@aiska-university.ac.id

Submitted : 2026-03-17; Accepted : 2026-05-29; Published : 2026-06-01

ABSTRACT

Introduction: Disorders of the neuromuscular system in children with autism cause motor deficits which cause children with autism to be unable to move. This is caused by a decrease in postural tone. Disturbed postural tone in children with autism will also cause coordination disorders and abnormal movement patterns. Apart from that, improper postural control in children with autism will cause changes in balance and balance disorders. For this reason, researchers provide Perceptual Motor Program and Obstacle Course Exercise interventions in conditions of Autism Spectrum Disorder. To analyze the effect of Perceptual Motor Program and Obstacle Course Exercise on dynamic balance in children with Autism Spectrum Disorder. **Methods:** This research is quantitative research with a quasi-experimental research with a one group pre and posttest without control group. The subjects were 25 autism children with balance impairment. Dynamic balance measurements using Pediatric Balance Scale (PBS). **Results:** Based on the Wilcoxon Test, the significance value is <0.001 ($p<0.05$), mean that Perceptual Motor Program and Obstacle Course Exercise can improve dynamic balance. **Conclusion:** There is an effect of the combination of Perceptual Motor Program and Obstacle Course Exercise on improving dynamic balance function of children with Autism Spectrum Disorder.

Keywords: *Autism Spectrum Disorder; Dynamic balance; Obstacle Course Exercise; Perceptual Motor Program; Pediatric Balance Scale (PBS)*

ISSN 2722 – 9610
 E –ISSN 2722 - 9629

INTRODUCTION

Neuromuscular system disorders in children with autism causes motor deficits that cause autistic children to become unable to move. This is caused by a decrease postural tone. Postural tone which disturbs the child autism it will also cause impaired coordination, abnormal movement patterns. Apart from that, there is inappropriate postural control in children autism will cause change balance and disturbance balance (Febriani *et al.*, 2023).

Limited social and communicative abilities in autistic children, but also have motor abnormalities, such as poor timing and balance coordination. Impaired gross motor skills hinder participation with peers. Balance control is interesting from a cognitive science perspective,

because it involves complex interactions between information processing, motor planning, and the timing and sequencing of muscle movements (Stins & Emck, 2018)

Autism spectrum disorders (ASD) is a neurodevelopmental disorder characterized by a lack of social communication, limited interests and repetitive behavior (Hodges *et al.*, 2020). According to the Special School Statistics Data Center, the number of autistic students in Indonesia in 2018-2019 was 11,558 autistic students (Kemendikbud, 2019). This prevalence increased in 2020-2021 to 1,778 students with autism. The number of students with special needs in Indonesia in 2019-2020 was 144,102 students. This figure increased in 2020-2021 to 144,621 students with special needs in Indonesia



(Kemendikbud, 2021). There has been an increase in the prevalence of children with ASD in Surakarta. Studies show that ASD prevalence at Alamanda Autism Special School AGCA Center and Autism Harmony Special School has increased over the past three years (Indiyana et al., 2021).

Sensory and motor deficits are consistently reported in children with ASD. Sensory abnormalities are often the earliest identifiable clinical features and are correlated with severity of the social communication deficiency (Rosca et al., 2022). Approximately, 80-90% children with ASD shows motor disorders that caused difficulties in carrying out daily activities. One of the motor disorders in autism children is balance disorders (Xu et al., 2025; Pramita et al, 2022).

Studies show that exercise or training program has a positive impact on development, motor, sensory, balance and executive function in children with ASD. Intervention programs aimed to improving balance in ASD such as taekwondo, aquatic exercise, combine training of balance, strength and jumping training, yoga, videogame training and psychomotor training (Ansari et al., 2020; Djordjevi et al., 2022; Li & Zhang, 2025). However, most previous studies focused on single-modality interventions and primarily examined general motor outcomes rather than specifically targeting dynamic balance through integrated perceptual-sensory-motor training.

Obstacle Course Exercise (OCE) is a part of sensory therapy that involves physical activity to manage the sensory system. It is applied to train children's ability to move body parts, such as jumping, rolling, pushing and throwing to increase dynamic balance (Febriani et al., 2023). Perceptual Motor Program (PMP) and Hydrotherapy improving balance and coordination in children with Autism Spectrum Disorder by practicing the process of achieving functional skills and abilities using sensory input, sensory integration, motor interpretation, movement activity and feedback (Arifadhi & Susanti, 2019). Other study also found that Perceptual Motor Program increase balance in children with Autism Spectrum Disorder (Pramita et al., 2022).

Despite these promising findings, evidence regarding the combined application of Perceptual Motor Program and Obstacle Course Exercise remains limited, particularly in Indonesian clinical settings. In addition, few studies have explored how the integration of perceptual-motor stimulation and obstacle-based sensory training may provide complementary mechanisms for improving dynamic balance in children with ASD. Therefore, the present study aimed to investigate the effect of combining PMP and OCE on dynamic balance in children with ASD, thereby addressing an important gap in physiotherapy-based intervention research.

METHODS

This research was carried out at the Surakarta Foundation for the Development of Disabled Children (YPAC) and was carried out in April – Juni 2024. Quasi-experimental method with one group pretest and posttest design involving ASD children. Subjects are selected using Fixed Disease Sampling techniques. The inclusion criteria: 1) Children with a medical diagnosis of ASD aged 5-10 years old; 2) ASD children with balance disorders based on a Pediatric Balance Scale (PBS) <56 point. The exclusion criteria are the subject who cannot stand or use a walking aid. Drop Out criteria are subject that did not participate in the exercise or drawn from the research. Total 25 children with ASD who met the inclusion and exclusion criteria participated in this study. Balance measurements were performed using PBS before and after the intervention program. Combination of Perceptual Motor Program and Obstacle Course Exercise were given 2x per week for 4 weeks.

Perceptual Motor Program (PMP) is a training method to stimulate children's motor perception skills by performing 5 exercises: walking on a footbridge, throwing and catching the ball in a kneeling position, throwing and catching the ball in a standing position on a chair/stool, standing on a boshu ball and standing on a balance board, with 2 treatments a week for 4 weeks.



of Universitas 'Aisyiyah Surakarta, with ethical number 191/VI/AUEC/2024.



Figure 1. Perceptual motor program-walking on a footbridge.

Obstacle course Exercise (OCE) which is part of sensory integration therapy which involves physical activity to process the sensory system by providing input to the vestibular, proprioceptive, auditory and tactile sensors. Three exercises were carried out in the form of walking on the floor according to the footprints, walking with a raffia rope in a zigzag shape and walking over obstacles such as cones with a training dose of 2x a week for 4 weeks.



Figure 2. Obstacle course exercise-walking over cones

The Wilcoxon test was used to analyze the effect of the intervention, with a significance value of $p < 0,05$; CI 95%. If p -value $< 0,05$ indicates that the combination of Perceptual Motor Program and Obstacle Course Exercise has an effect on improving balance in children with ASD.

Research ethics principles were applied by enforcing subject data confidentiality and obtaining informed consent from the children's parents. This research was declared ethically sound by the Health Research Ethics Committee

RESULTS

Characteristics of research respondents include: age and gender. A description of the characteristics of research respondents is presented in table 1. Based on table 1, the research results showed that the majority were 16 respondents aged 5-7 years (64%) and it was found that the majority of respondents were male, 21 respondents (84%).

Table 1. Characteristics of Respondents

Respondent Characteristics	n	%	
Age	5-7 years	16	64
	8-10 years	9	36
Gender	Male	21	84
	Female	4	16
Total		25	100

The results of the normality test using Shapiro-Wilk showed a p value of 0.006 ($p < 0.05$), which means that the data is not normally distributed.

Table 2. Wilcoxon test

Wilcoxon Test	PBS Pre Score - PBS Post Score
<i>p-value</i>	< 0.001

Results of Wilcoxon test show a significant value of $p < 0,001$ ($p < 0,05$). It can be concluded that there is an influence on giving the combination of Perceptual Motor Program and Obstacle Course Exercise to improve dynamic balance in children with ASD.

DISCUSSION

During the period between 5 and 8 years of age, regardless of severity, autistic traits can be assessed reliably and quantitatively in the general population. However, we found possible differences in sex-specific pattern of mental development in autistic traits in children with higher levels of autistic trait preschool and elementary school ages (Haraguchi et al., 2019).

According to the ICD (International Classification of Diseases), autism in children is a disease that develops with symptoms before the child reaches the age of 3 years. Symptoms of autism are delayed speech development,



stereotyped language or irregular (repetitive) speech as well as being unable to play imaginatively, being unable to meet face to face, being unable to establish good relationships with peers, having repeated motor movement abnormalities, showing inconsistent emotions. normal and limited preoccupation with abnormal behavior (Alfinna et al., 2019)

Results also showed that boys are 2.875 times more likely to experience autism than girls. Autism is more dominant in male children, this is due to the occurrence of certain genetic processes which then lead to dominance so that males experience autism, including the causative gene attached to the X chromosome (X-linked disorders) and imprinting genes (Pangestu & Fibriana, 2017) in (Pratiwi et al., 2023).

Children with autism spectrum disorders (ASD) not only experience communication and social difficulties, but also have poor balance and motor control abilities, which often affect daily activities. Balance and effective motor control depend on the integration of somatosensory, visual, and vestibular input (Oster & Zhou, 2022).

The present study demonstrated that the combination of Perceptual Motor Program (PMP) and Obstacle Course Exercise (OCE) significantly improved dynamic balance in children with ASD, as indicated by the significant increase in Pediatric Balance Scale (PBS) scores after the intervention ($p < 0.001$). These findings support previous evidence that exercise-based interventions can positively influence postural control and motor performance in children with ASD (Djordjevi et al., 2022; Li & Zhang, 2025). However, the current study extends previous findings by demonstrating that combining perceptual-motor training with obstacle-based sensory integration activities may provide additional benefits for dynamic balance improvement.

Perceptual Motor Program which stimulates many components of balance, including sensory processing mechanisms, adaptation, muscle strength, postural control, visual, as well as vestibular. Each exercise given does not only stimulate one component, but stimulates all components that affect balance, such as the visual organs. Practice throwing and

catching the ball in position kneeling able to stimulate visual, proprioceptive and postural control. To achieve this function, cooperation between the sensory and motor systems is required which will influence balance function. Standing activity above balance ball combined with games will provide stimulation to the visual, tactile system and also the work of the body's supporting muscles, so that this can provide stimulation to the balance control system (Pramita et al, 2022).

Physiotherapy management in cases of autistic disorder using the Perceptual Motor Program method has been proven to be effective in increasing concentration, improving balance sensory abilities (vestibular), improving visual sensory abilities, and improving proprioceptive sensory abilities in autistic disorder (Fatimah & Nesi, 2022)

Obstacle course exercise enhanced dynamic balance through repetitive multisensory movement activities such as jumping, rolling, pushing, throwing and so on, which can improve dynamic balance. Changes in the center of gravity that are disturbed when carrying out these activities are unbalanced, causing external loads when walking and carrying out movements with joints to increase awareness and control neuromuscular hip, knee and ankle muscles. Which involves physical activity to manage the sensory system by providing input to sensory-vestibular, proprioceptive, auditory dan tactile well as motor stimulation of muscles and joints with good self-control through therapy sensory integration (Febriani et al., 2023).

Neural mechanisms involving abnormal touch sensitivity in ASD. Because tactile stimulation is part of somatosensory and depends on the subcortical and cortical areas of the brain. The researchers focused on possible brain region differences between ASD and TD. Alterations in sensory processing have become an important feature in the clinical picture of ASD. As reviewed above, sensory dysregulation spans multiple modalities (vision, hearing, touch, smell, taste) and appears early in the development of ASD (Balasco et al., 2020).

Another important contribution of this study is its relevance to physiotherapy practice.



The combination of PMP and OCE can be considered as a practical, low-cost, and easily implemented intervention strategy in pediatric physiotherapy settings, schools, and community-based rehabilitation programs. The exercises use relatively simple equipment and can be adapted according to the child's functional abilities. Clinically, improvement in dynamic balance may contribute to better mobility, safer ambulation, enhanced participation in play activities, and greater independence in daily activities among children with ASD. Therefore, this intervention may support not only motor development but also broader functional participation and quality of life.

In general, the research results indicate that the combination of the Perceptual Motor Program and Obstacle Course Exercise significantly improves balance function in children with ASD. These results provide new evidence-based support for intervention programs that can be implemented to improve balance and support the development of children with ASD. However, this study has several limitations. The results of this study are limited by the lack of a control group to compare the effects of the intervention. Future studies are recommended to use randomized controlled trial design with larger sample sizes, longer follow-up periods, and additional functional outcome measures to further evaluate the long-term effectiveness of combined PMP and OCE interventions in children with ASD.

CONCLUSION

The combination of a perceptual motor program and obstacle course exercise significantly improved balance in children with ASD ($p < 0.001$). The results of this study can be used as an evidence-based practice physiotherapy that is practical, feasible, and clinically applicable for improving functional balance in children with ASD.

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