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The Effect of the Combination of Perceptual Motor Approach and Obstacle Course Exercise on Dynamic Balance in Children with Autism Spectrum Disorder

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ABSTRACT

This study aimed to determine the effect of a combined Perceptual Motor Approach (PMA) and Obstacle Course Exercise (OCE) on dynamic balance in children with autism spectrum disorder (ASD). A pre-experimental study with a one-group pretest–posttest design was conducted at the Kids Care Child Development Clinic, Mataram, from October to December 2025. The population consisted of 35 children with ASD, from which 20 participants aged 4–12 years with dynamic balance impairment were selected using purposive sampling based on predefined inclusion and exclusion criteria. Dynamic balance was assessed using the Beam Balance Test before and after the intervention. The intervention was administered twice weekly for four weeks, with each session lasting 30–45 minutes and consisting of sensory-motor stimulation through PMA and functional movement challenges using OCE. Data normality was tested using the Shapiro–Wilk test, and the Wilcoxon signed-rank test was applied for inferential analysis. The results demonstrated a statistically significant improvement in dynamic balance following the intervention ($p < 0.001$), with a mean difference of 4.310 ± 1.180 between pretest and posttest scores. These findings indicate that the combination of PMA and OCE effectively enhances dynamic balance in children with ASD. The results support the integration of structured perceptual-motor and obstacle-based exercises into pediatric physiotherapy programs for children with ASD. Future studies are recommended to employ randomized controlled designs with larger sample sizes and longer follow-up periods to confirm and expand upon these findings.

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A. Conception and design of the study;
B. Acquisition of data;
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INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication, repetitive behaviors, and impaired sensorimotor integration, significantly impacting a child's motor function. In addition to communication and social interaction problems, children with ASD often exhibit motor

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deficits, including impaired eye-hand coordination, delayed postural control, and static and dynamic body imbalances. These impairments directly impact children's participation in physical activities, motor learning, and daily living (Fournier et al., 2015; Whyatt & Craig, 2018; Febriani et al., 2023).

Globally, the prevalence of ASD has shown a consistent upward trend over the past decade. The World Health Organization estimates that approximately 1 in 160 children worldwide are on the autism spectrum, with prevalence varying between countries influenced by diagnostic, social, and healthcare factors (WHO, 2023). In Indonesia, data from the Central Statistics Agency (BPS) shows that the number of children with autism continues to increase in line with population growth, with estimates reaching millions of children requiring special education and health services (BPS, 2021). Special education data also indicates a significant increase in the number of autistic students in special schools, and primary health care reports recorded thousands of cases of developmental disorders, including ASD, between 2020 and 2021 (Dwi Pratiwi et al., 2023).

At the regional level, West Nusa Tenggara Province, particularly West Lombok Regency, shows a year-on-year increase in the number of children with ASD. This situation emphasizes the urgency of developing contextual, effective, and easily implemented interventions for educators and therapists in the region. One of the dominant problems experienced by children with ASD in the region is dynamic balance disorders, characterised by unstable posture, difficulty maintaining a standing position, and an unsteady gait (Habibi, 2022).

Dynamic balance is the ability to maintain body stability while moving and changing positions, involving the integration of the vestibular, proprioceptive, visual, and neuromuscular systems. Dynamic balance impairments in children with ASD impact not only motor performance but also independence, self-confidence, and social engagement (Padafani et al., 2019; Westendorp et al., 2021). Therefore, interventions targeting dynamic balance improvement are urgently needed in development programs for children with ASD.

Various intervention approaches have been developed to improve the motor skills of children with ASD, ranging from occupational therapy and conventional balance training to structured physical activity-based approaches. Recent research shows that movement-based interventions that stimulate sensorimotor integration are more effective than mechanical and monotonous motor training (Bremer et al., 2016; Ruggeri et al., 2020).

One approach that has gained attention is the Perceptual Motor Approach (PMA), a training method that emphasizes the relationship between sensory perception and motor response. This approach trains postural control through multisensory stimulation, visual, auditory, tactile, and proprioceptive, thus supporting the maturation of the child's central nervous system and motor control. Empirical studies have shown that PMA can improve coordination, body orientation, and postural stability in children with special needs, including those with ASD (Pramita & Wahyudi, 2022; Cheldavi et al., 2014).

In addition to PMA, Obstacle Course Exercise (OCE) has developed as a form of functional training that challenges children to move through a series of structured obstacles. OCE is designed to provide vestibular and proprioceptive stimulation through activities such as jumping, crawling, rolling, throwing, and pushing. Research shows that

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obstacle course exercises can improve adaptive motor responses, self-control, and dynamic balance skills in children with ASD (Pan et al., 2017; Febriani et al., 2023).

While both approaches have been proven effective separately, the literature suggests that interventions that integrate perceptual-motor stimulation with functional activities based on movement challenges have greater potential to improve the quality of movement in children with ASD (Howells et al., 2018; Travers et al., 2022). However, the integrative implementation of these two approaches remains relatively limited in empirical studies, particularly in educational and therapeutic contexts in Indonesia.

Although several studies have reported the effectiveness of the Perceptual Motor Approach and Obstacle Course Exercise independently, several significant research gaps remain. First, most studies focus on improving general motor skills or static balance, while studies specifically measuring dynamic balance in children with ASD are limited (Whyatt & Craig, 2018; Westendorp et al., 2021).

Second, previous research has tended to be conducted in developed countries with adequate facilities and resources, so the generalizability of the results to developing contexts like Indonesia, particularly West Lombok, remains untested. Cultural and environmental factors, as well as limited resources, are contextual variables that have not been widely accommodated in previous intervention designs.

Third, few studies have systematically compared or combined the PMA approach with OCE to determine their effectiveness in improving dynamic balance in children with ASD. Most interventions are still partial, without exploring the synergy between perceptual stimulation and functional motor challenges.

Therefore, there is a need for research testing structured interventions based on the Perceptual Motor Approach through Obstacle Course Exercise as a holistic, applicable, and contextual training model for children with ASD.

Based on these research problems and gaps, this study aims to analyze the effect of the Perceptual Motor Approach intervention based on Obstacle Course Exercise on improving dynamic balance in children with Autism Spectrum Disorder. Specifically, this study evaluates changes in children's postural control and motor stability abilities after participating in a structured exercise program that integrates sensory stimulation and functional motor activities.

The novelty of this study lies in: (1) The conceptual and practical integration of the Perceptual Motor Approach and Obstacle Course Exercise as a single integrated intervention model for children with ASD, (2) The specific focus on dynamic balance, a crucial yet underexplored component in the ASD literature, (3) The local context of Indonesia, particularly West Lombok, provides empirical contributions to the development of interventions based on local needs and resources, and (4) The applicable implications for educators, therapists, and special education practitioners in designing effective, engaging, and easy-to-implement motor training programs.

Thus, this research is expected to enrich the scientific knowledge in the field of special education and motor therapy, while also providing evidence-based recommendations for improving the quality of services for children with Autism Spectrum Disorder.

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METHODS

Research Design

This study employed a pre-experimental one-group pretest–posttest design to examine the effect of a combined Perceptual Motor Approach (PMA) and Obstacle Course Exercise (OCE) intervention on dynamic balance in children with Autism Spectrum Disorder (ASD). This design enabled a within-subject comparison of dynamic balance performance before and after the intervention, allowing each participant to serve as their own control. Such an approach is widely used in preliminary and applied intervention research involving children with neurodevelopmental disorders, particularly when randomization and the inclusion of control groups are constrained by ethical, clinical, or logistical considerations (Portney & Watkins, 2015; Creswell & Creswell, 2018; Travers et al., 2022).

Pre-experimental designs are considered appropriate for exploratory investigations aiming to establish initial evidence of intervention effectiveness, especially in therapeutic and special education settings where withholding treatment may not be ethically justifiable (Whyatt & Craig, 2018; Westendorp et al., 2021). In the context of ASD, where individual variability is high and intervention responsiveness differs across children, a pretest–posttest framework provides meaningful insight into functional changes attributable to the intervention (Fournier et al., 2015; Ruggeri et al., 2020).

Research Setting and Participants

The study was conducted at the Kids Care Child Development Clinic, Mataram, from October to December 2025, a facility specializing in developmental therapy services for children with neurodevelopmental disorders. The study population consisted of 35 children with ASD who were actively receiving therapeutic services at the clinic during the study period.

A total of 20 children (boys and girls) aged 4–12 years were recruited as research participants using purposive sampling. This sampling technique was selected to ensure that participants met specific clinical and functional criteria relevant to the research objectives, a practice commonly adopted in ASD intervention studies (Bremer et al., 2016; Pan et al., 2017).

The inclusion criteria were: a formal diagnosis of Autism Spectrum Disorder confirmed by a qualified clinician, observable dynamic balance impairment documented in clinical records or therapist assessments, the ability to follow simple verbal or visual instructions, and written informed consent obtained from parents or legal guardians.

The exclusion criteria included: severe motor impairments that prevented safe participation in balance-related activities, uncontrolled epilepsy or other neurological conditions posing safety risks, significant visual or auditory impairments that could interfere with task execution, and acute medical conditions during the intervention period.

Participants who attended fewer than 80% of intervention sessions or withdrew voluntarily were classified as dropouts and excluded from the final analysis. These criteria were applied to maintain internal validity and ensure adequate exposure to the intervention dosage, consistent with prior intervention research involving children with ASD (Cheldavi et al., 2014; Howells et al., 2018).

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Intervention Procedure

The intervention consisted of a combined Perceptual Motor Approach and Obstacle Course Exercise program, delivered twice per week for four consecutive weeks, resulting in a total of eight sessions. Each session lasted approximately 30–45 minutes, aligning with recommended durations for motor-based interventions in children with ASD to optimize engagement and minimize fatigue (Bremer et al., 2016; Travers et al., 2022).

The Perceptual Motor Approach component emphasized multisensory stimulation and perceptual–motor integration, targeting visual, vestibular, proprioceptive, tactile, and auditory systems. Activities included body orientation tasks, spatial awareness exercises, weight-shifting movements, and coordinated limb actions designed to enhance postural control and sensorimotor integration (Cheldavi et al., 2014; Pramita & Wahyudi, 2022).

The Obstacle Course Exercise component involved structured movement challenges arranged in a progressive sequence, such as walking along balance beams, stepping over obstacles, jumping, crawling, rolling, and pushing objects. These tasks were designed to stimulate dynamic balance through functional movement patterns while promoting motor planning, self-regulation, and adaptive responses to environmental demands (Pan et al., 2017; Febriani et al., 2023).

Both components were integrated within each session, with task difficulty adjusted individually based on the child's functional ability and tolerance. Standardized equipment and consistent task sequences were used to ensure procedural fidelity and replicability across sessions.

Instrumentation and Data Collection

Dynamic balance was the primary outcome variable in this study and was operationally defined as the ability to maintain postural stability while performing locomotor movements. Dynamic balance was assessed using the Beam Balance Test, a widely used and clinically accepted measure of balance performance in children, including those with developmental disorders (Westendorp et al., 2011; Padafani et al., 2019).

In this test, participants were instructed to walk along a 150 cm balance beam with standardized width, while performance time and qualitative execution were recorded using a stopwatch and standardized scoring criteria. The test has demonstrated acceptable reliability and sensitivity in detecting changes in dynamic balance following intervention (Habibi, 2022). Measurements were conducted twice: Pretest, before the commencement of the intervention, and Posttest, immediately after completion of the four-week intervention program. To minimize measurement bias, assessments were conducted under identical conditions and supervised by trained personnel familiar with pediatric balance testing procedures.

Data Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including mean, standard deviation, minimum, and maximum values, were calculated to summarize participant characteristics and balance performance.

Data normality was assessed using the Shapiro–Wilk test, which is recommended for small sample sizes in clinical research (Ghasemi & Zahediasl, 2012). As the data did not meet normality assumptions, differences between pretest and posttest dynamic

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balance scores were analyzed using the Wilcoxon signed-rank test, a non-parametric alternative suitable for paired data (Field, 2018).

A p-value < 0.05 was considered statistically significant. Effect magnitude was interpreted based on changes in median scores and distribution patterns, providing practical insight into intervention effectiveness beyond statistical significance alone.

RESULTS AND DISCUSSION

Result

Table 1.
Frequency distribution of subject characteristics

Subject Characteristics	n	%
Gender		
Male	13	65,0
Female	7	35,0
Total	**20**	**100,0**
Age		
a. 4-6 years	13	65,0
b. 7-9 years	5	25,0
c. 10-12 years	2	10,0
Total	**20**	**100,0**

Table 1 shows the frequency distribution of the characteristics of the research subjects based on gender and age group. Based on gender, most of the subjects were male, namely 13 children (65.0%), while the number of female subjects was 7 children (35.0%). Based on age group, most subjects were in the 4–6 years age range, namely 13 children (65.0%), followed by the 7–9 years age group, namely 5 children (25.0%), and the 10–12 years age group, namely 2 children (10.0%). This distribution indicates that most of the research subjects were in the early-to-early school age, which is a crucial phase in the motor and balance development of children with autism spectrum disorder.

Table 2.
Data Normality Test

Saphiro-Wilk	n	%
Dynamic balance before intervention	20	0,006
Dynamic balance after intervention	20	0,805

Table 2 shows the results of the normality test using the Shapiro–Wilk, which obtained a significance value for the dynamic balance variable before the intervention of α = 0.006, which indicates that the data is not normally distributed because the significance value is less than 0.05. Meanwhile, for the dynamic balance variable after the intervention, a significance value of α = 0.805, which indicates that the data is normally distributed because the significance value is greater than 0.05. Thus, it can be concluded that the distribution of dynamic balance data before and after the intervention is not normally distributed, so it does not meet the requirements for parametric statistical tests. Therefore, further statistical analysis uses a non-parametric statistical test in the form of the Wilcoxon test.

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Table 3.
The Effect of PMA and OCE on dynamic balance in children with autism spectrum disorder

Saphiro-Wilk	n	mean	SD	p-value
Dynamic balance before intervention	20	9,477	1,713	<0,001*
Dynamic balance after intervention	20	5,167	0,940	
Difference before and after	20	4,310	1,180	

Table 3 shows the results of the analysis using the Wilcoxon test, which revealed a significant difference between the dynamic balance scores before the intervention (pre-test) and after the intervention (post-test). The average dynamic balance score in the pre-test was 9.477 ± 1.713, while in the post-test it increased to 5.167 ± 0.940. The difference between the pre-test and post-test scores indicated an average change of 4.310 ± 1.180.

The significance value obtained was $p < 0.001$, indicating that the combination of the Perceptual Motor Approach and Obstacle Course Exercise had a significant effect on improving dynamic balance in children with autism spectrum disorder.

Discussion

The present study investigated the effect of a combined Perceptual Motor Approach (PMA) and Obstacle Course Exercise (OCE) intervention on dynamic balance in children with Autism Spectrum Disorder (ASD). The results demonstrated a statistically significant improvement in dynamic balance following the intervention, as indicated by the Wilcoxon signed-rank test ($p < 0.001$). Specifically, the mean dynamic balance score decreased from 9.477 ± 1.713 at pretest to 5.167 ± 0.940 at posttest, with an average difference of 4.310 ± 1.180. These findings provide strong empirical evidence that the integration of PMA and OCE is effective in enhancing dynamic balance abilities in children with ASD.

From a neurodevelopmental perspective, children with ASD frequently exhibit impairments in postural control, motor coordination, and balance due to atypical sensory processing and neuromuscular integration. Previous studies have consistently reported that deficits in vestibular, proprioceptive, and visual systems contribute to unstable gait patterns, poor balance responses, and reduced participation in physical activities among children with ASD (Fournier et al., 2015; Whyatt & Craig, 2018; Westendorp et al., 2021). The significant improvement observed in this study suggests that dynamic balance in children with ASD is not a fixed limitation but rather a modifiable motor ability when appropriate, targeted interventions are applied.

The effectiveness of the combined PMA and OCE intervention can be understood through the lens of sensorimotor integration theory. PMA emphasizes the enhancement of perceptual input processing and its translation into coordinated motor output by stimulating visual, vestibular, tactile, and proprioceptive systems. Improved sensory integration supports better body awareness, spatial orientation, and postural alignment, which are fundamental prerequisites for maintaining balance during movement (Cheldavi et al., 2014; Pramita & Wahyudi, 2022). Meta-analytic evidence further supports that perceptual–motor programs significantly improve balance-related sensory functions, including vestibular and proprioceptive sensitivity, in children with ASD (Fatimah & Nesi, 2022).

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Meanwhile, OCE provides a functional and ecologically valid movement context that challenges children to apply perceptual–motor skills in dynamic, goal-directed situations. Obstacle-based activities require continuous postural adjustments, anticipatory balance control, and adaptive motor planning in response to changing environmental demands. Prior research has demonstrated that obstacle course–based exercises effectively improve dynamic balance, motor coordination, and movement confidence in children with ASD (Pan et al., 2017; Febriani et al., 2023). The findings of the present study align closely with these results, reinforcing the role of functional movement challenges in improving balance performance.

Importantly, this study extends existing literature by demonstrating that the synergistic combination of PMA and OCE yields substantial improvements in dynamic balance. While previous studies have examined PMA and OCE separately, few have explored their integration as a unified intervention model. Research by Pramita and Wahyudi (2022) reported improvements of 36.18% in static balance and 124.59% in dynamic balance following a perceptual motor program, whereas Febriani et al. (2023) highlighted the effectiveness of obstacle course training in enhancing balance control. The current findings suggest that combining these approaches may create more optimal neuromotor conditions than either intervention implemented in isolation, supporting the argument that multimodal interventions are particularly beneficial for children with ASD (Howells et al., 2018; Travers et al., 2022).

The magnitude of improvement observed in this study is also consistent with prior empirical evidence demonstrating that balance training and structured physical activity programs can significantly modify motor performance in children with ASD. Djordjević et al. (2022), in a meta-analysis of physical activity interventions, concluded that balance skills in children with ASD are highly responsive to systematic training. Similarly, Ardiasari et al. (2020) reported a 109.5% improvement in balance performance following straight-line walking exercises in children with ASD. These findings collectively support the notion that balance impairments in ASD are amenable to intervention through repetitive, task-specific, and progressively challenging motor activities.

Beyond physiological mechanisms, motivational and cognitive factors likely played a crucial role in the success of the intervention. The PMA–OCE program was delivered in a playful, game-based format with gradual progression, which is particularly relevant for children with ASD who often experience difficulties in sustaining attention and responding to abstract verbal instructions. Game-like obstacle activities promote intrinsic motivation, enjoyment, and active engagement, which are essential components of effective motor learning (Bremer et al., 2016; Ruggeri et al., 2020). Increased engagement enhances practice quality, repetition, and task focus, thereby facilitating more efficient neural adaptation and motor skill acquisition.

Furthermore, the use of obstacle courses encourages active problem-solving and anticipatory control, requiring children to plan movements, adjust body position, and respond to sensory feedback in real time. These cognitive–motor demands are critical for improving dynamic balance, as balance control is not purely mechanical but involves

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continuous interaction between sensory perception, cognition, and motor execution (Shumway-Cook & Woollacott, 2017). The integration of PMA and OCE therefore addresses balance from a holistic perspective, targeting both underlying sensory deficits and functional movement application.

From a practical standpoint, the findings of this study have important implications for clinical and educational practice. The PMA–OCE intervention is relatively low-cost, adaptable, and feasible to implement in therapy clinics, special schools, and community-based programs. The structured yet flexible nature of the program allows practitioners to tailor task difficulty to individual child abilities, which is critical given the heterogeneity of ASD (Lord et al., 2020). Moreover, the positive outcomes observed in a local Indonesian clinical setting contribute valuable context-specific evidence, addressing the limited representation of developing regions in ASD intervention research.

Nevertheless, this study should be interpreted in light of certain limitations. The use of a one-group pretest–posttest design without a control group limits causal inference, as improvements may partly reflect maturation or external influences. The relatively small sample size also constrains generalizability. Future studies employing randomized controlled or quasi-experimental designs with larger samples and longer follow-up periods are recommended to strengthen the evidence base and examine the sustainability of balance improvements over time.

Overall, the present findings underscore that a combined Perceptual Motor Approach and Obstacle Course Exercise intervention is an effective strategy for improving dynamic balance in children with Autism Spectrum Disorder. By integrating sensory stimulation, motor control training, and functional movement challenges within an engaging and child-centred framework, this approach offers a promising model for enhancing motor competence and functional independence in children with ASD.

CONCLUSION

This study demonstrates that the combination of the Perceptual Motor Approach (PMA) and Obstacle Course Exercise (OCE) has a significant effect on improving dynamic balance in children with autism spectrum disorder treated at the Kids Care Child Development Clinic, Mataram. The findings indicate a meaningful improvement in dynamic balance performance following the intervention, as reflected by changes between pretest and posttest measurements. These results confirm that structured perceptual–motor stimulation combined with functional movement challenges can effectively address balance deficits commonly observed in children with ASD.

From a clinical and scientific perspective, this research contributes to the growing body of evidence supporting integrative sensorimotor-based interventions in pediatric physiotherapy for ASD. The observed improvement in dynamic balance suggests that PMA and OCE facilitate better sensory integration, postural control, and motor adaptation during movement. Although the findings are promising, the results should be interpreted with caution due to the pre-experimental design, absence of a control group,

relatively small sample size, and limited intervention duration. These factors may restrict the generalizability of the findings to broader ASD populations.

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