



The Effect of Moderate-Level FITT Training On Gross Motor Skills And Fine Motor Skills In Students With Disabilities

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ABSTRACT

Children with intellectual disabilities often experience delays in gross and fine motor development, which may limit functional independence and participation in daily activities. Structured physical training grounded in the FITT (Frequency, Intensity, Time, Type) principle is considered an effective approach to provide systematic neuromuscular stimulation. This study aimed to examine the effect of moderate-level FITT training on gross and fine motor skills in students with disabilities at SLB Swadaya Semarang. A quantitative pre-experimental one-group pretest-posttest design was employed involving 20 students (aged 7-9 years) selected through purposive sampling. The intervention was conducted twice weekly for six weeks at moderate intensity (60-70% HRmax; Borg 12-14). Gross motor skills were measured using the Test of Gross Motor Development (TGMD), while fine motor skills were assessed using the Nine-Hole Peg Test (NHPT). Data were analyzed using Shapiro-Wilk normality testing, Levene's homogeneity testing, and paired sample t-tests ($\alpha = 0.05$). The results showed a significant increase in gross motor scores from 10.40 to 24.30 ($p = 0.000$; 133.65% improvement; $d = 2.85$). Fine motor performance improved significantly, indicated by reduced NHPT completion time for the right hand (57.72 to 47.19 seconds; $p = 0.035$) and left hand (67.72 to 53.94 seconds; $p = 0.004$). In conclusion, moderate-level FITT training significantly enhances both gross and fine motor skills, supporting its implementation as an evidence-based intervention in adaptive physical education settings.

ARTICLE HISTORY

Received: 2026/02/13
Accepted: 2026/02/23
Published: 2026/02/26

KEYWORDS

FITT Training;
Gross Motor Skills;
Fine Motor Skills;
Intellectual Disability;
Adaptive Physical Education.

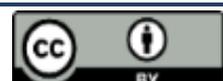
AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

Cites this Article : Gemilang, R.S.; Wibisana, M.I.N.; Pradifta, G.D. (2026). The Effect of Moderate-Level FITT Training On Gross Motor Skills And Fine Motor Skills In Students With Disabilities. **Competitor: Jurnal Pendidikan Kepeleatihan Olahraga**. 18 (1), p.1476-1486

INTRODUCTION

The development of gross and fine motor skills is a key foundation for a child's development, as it is directly related to the ability to engage in independent activities, social participation, and academic readiness. In children with disabilities, motor development is often delayed due to physical, intellectual, and sensory limitations, as well as accompanying behavioral disorders (Muhammad Awwad, 2015; Firdaus & Sidoarjo, 2019). Conceptually, motor development is the result of a complex interaction between biological factors, the environment, and systematic movement experiences.



However, empirically, children with special needs tend to have lower levels of physical fitness and coordination than typical children (Nuraini & Ilham, 2021; District & Yualita, 2022). Physical fitness itself includes cardiorespiratory components, muscle strength and endurance, flexibility, balance, coordination, agility, and body composition (Nuraini & Ilham, 2021). Low levels of regular physical activity in children with disabilities result in low functional capacity, which directly impacts motor skills (Irawan et al., 2022). This condition is exacerbated by limited inclusive educational facilities and the lack of structured exercise programs in special schools (Science & Sports, 2021). In addition to physical factors, psychosocial aspects also contribute to barriers to motor development. Social stigma, unsupportive parenting styles, and limited environmental support result in children with disabilities receiving insufficient movement stimulation (Agustini, 2017). Gross motor skills, such as running, jumping, throwing, and catching (Mulyana, 2017), and fine motor skills, such as finger-hand coordination in writing or drawing (Oleh et al., 2015), are important indicators of academic readiness and independence. Therefore, the main problem in this study lies in the lack of optimization of structured, scientifically based physical exercise programs to improve the motor skills of children with disabilities in special needs settings, particularly at the Swadaya Special Needs School in Semarang.

In the past decade, adaptive physical education has emerged as a strategic approach to improving the psychomotor function of children with special needs (Surabaya, 2019). Empirical studies have shown that controlled-intensity physical activity interventions can improve coordination, balance, and muscle strength in children with intellectual and sensory impairments (Isna et al., 2023). The FITT (Frequency, Intensity, Time, Type) principle has been widely used in fitness training planning because it provides a systematic framework for determining exercise frequency, intensity level, duration, and activity type (Isna et al., 2023). Conceptually, the FITT approach allows for personalized exercise programs tailored to individual characteristics, including those in the disability population. Scopus-indexed studies have shown that moderate-intensity exercise effectively improves balance and coordination without putting excessive stress on the musculoskeletal system (District & Yualita, 2022). International research also reports that a moderate aerobic exercise program 3-5 times per week can improve cardiorespiratory capacity and neuromotor function in children with cerebral palsy and intellectual disabilities. Furthermore, adaptive physical activity contributes to increased self-efficacy and emotional regulation (Islam & Sunan, 2021). In the context of fine motor skills, exercises involving visual-motor coordination have been shown to improve hand movement precision and object control (Oleh et al., 2015). Several SINTA and Scopus studies over the past 10 years have also confirmed a significant relationship between physical fitness and motor performance in a population of schoolchildren with special needs (Nur & Mulyana, 2017; Firdaus & Sidoarjo, 2019). However, most research still focuses on improving fitness or only one aspect of motor skills (gross or fine), without integrating both into a systematic, FITT-based exercise model with measurable moderate intensity.

Although various studies have shown that moderate-intensity physical activity has a positive impact on the motor development of children with disabilities, several

significant research gaps remain. First, most previous studies have focused on typical child populations or only on specific types of disabilities, thus limiting generalizability to special needs populations. Second, the implementation of the FITT principle in the context of adaptive physical education has not been extensively tested experimentally using a controlled pretest-posttest design in special needs schools in Indonesia. Third, few studies have simultaneously measured the impact of moderate-intensity FITT-based training on two motor domains (gross and fine motor skills) as a comprehensive indicator of psychomotor development. However, neurophysiologically, improvements in cardiorespiratory fitness and muscle strength are correlated with sensorimotor integration and fine motor coordination. Fourth, the local context of SLB Swadaya Semarang has not been scientifically documented in national or international literature, necessitating evidence-based research to provide an applicable and replicable intervention model. Therefore, there is an urgent need to conduct experimental research that tests the effectiveness of moderate-level FITT training in simultaneously improving gross and fine motor skills in students with disabilities.

This study aims to empirically analyze the effect of moderate-intensity FITT-based training on improving gross and fine motor skills in students with disabilities at the Swadaya Special Needs School in Semarang. Specifically, this study examines changes in motor skills before and after the intervention using a quantitative approach with an experimental design. The novelty of this study lies in the following aspects: (1) Integration of two motor domains (gross and fine) in a single moderate-intensity FITT intervention model, (2) Structured implementation of FITT principles in the context of adaptive physical education in special needs schools in Indonesia, (3) Evidence-based approach for the disability population, considering physical, psychological, and social characteristics, and (4) Empirical contribution to the development of a safe, effective, and applicable adaptive fitness training model for special needs schools.

Theoretically, this study strengthens the concept that systematically designed moderate intensity physical exercise can optimize neuromotor integration by increasing cardiorespiratory capacity, muscle strength, and sensorimotor coordination. Practically, the research results are expected to form the basis for developing FITT-based adaptive physical education programs in special needs schools. Thus, this research not only contributes to the development of adaptive physical education science, but also provides an applicable solution to improve the quality of life and independence of children with disabilities through measurable and scientifically based exercise interventions.

METHODS

This study employed a quantitative approach using a quasi-experimental one-group pretest-posttest design to examine the effect of moderate-level exercise based on the FITT (Frequency, Intensity, Time, Type) principle on gross and fine motor skills in students with disabilities. The quasi-experimental design was selected because it allows the evaluation of motor skill changes before and after intervention within the same group, which is considered appropriate in adaptive education settings where

randomization is ethically and practically limited (Isna et al., 2023; Nuraini & Ilham, 2021). This design has been widely used in intervention studies involving children with special needs to determine causal effects of structured physical activity programs (District & Yualita, 2022; Firdaus & Sidoarjo, 2019).

The participants consisted of 20 students (12 males, 8 females) from SLB Swadaya Semarang with mild to moderate disabilities. Purposive sampling was applied based on the following inclusion criteria: (1) diagnosed mild–moderate disability, (2) ability to follow simple motor instructions with assistance, and (3) written parental consent. Such criteria align with adaptive physical education research standards to ensure safety and intervention feasibility (Islam & Sunan, 2021). The sample size is consistent with small-group experimental designs frequently reported in adaptive motor intervention studies over the past decade.

The intervention program was structured according to the FITT principle at moderate intensity (Borg Scale 12–14; 60–70% HRmax), consistent with international physical activity recommendations for children with disabilities (World Health Organization, 2020; Nur & Mulyana, 2017). Moderate intensity is considered safe and effective in improving neuromuscular coordination, balance, and functional motor control without excessive physiological strain (Isna et al., 2023).

The program was conducted twice weekly for six weeks, with each session lasting 35 minutes. Gross motor activities included ladder drills, zig-zag running, hurdle jumps, balance walking, and ring toss coordination, targeting locomotor and manipulative skills. Fine motor activities involved bead stringing, peg manipulation, pyramid stacking, and line tracing exercises to stimulate hand–eye coordination and finger dexterity. These activities were selected based on empirical findings indicating that combined locomotor and manual dexterity training enhances overall sensorimotor integration (Oleh et al., 2015; District & Yualita, 2022).

Motor skills were measured using standardized and validated instruments. Gross motor skills were assessed using the Test of Gross Motor Development (TGMD), which evaluates locomotor and object-control skills. Fine motor skills were measured using the Nine-Hole Peg Test (NHPT), a widely used tool for assessing manual dexterity and fine motor coordination. Both instruments have demonstrated strong validity and reliability in pediatric and disability populations ($r > 0.80$ in previous studies). In this study, inter-rater reliability reached $r = 0.89$, indicating high scoring consistency.

Data normality was tested using the Shapiro–Wilk test. Differences between pretest and posttest scores were analyzed using paired sample t-tests at a 0.05 significance level. Effect size (Cohen’s d) was calculated to determine the magnitude of the intervention effect, following recommendations from contemporary experimental motor research (Nuraini & Ilham, 2021).

All procedures complied with ethical standards in accordance with the Declaration of Helsinki (World Medical Association, 2013). Ethical approval was obtained from the Research Ethics Committee of UPGRIS University. Written informed consent was secured from parents or guardians prior to participation.

Table 1.
 Moderate-Level FITT-Based Motor Skills Intervention Program

Week	Frequency	Intensity	Gross Motor Activities	Fine Motor Activities	Time	Primary Objective
1	2x/week	Moderate (Borg 12-14)	Zig-zag run, balance walk, ladder drill, ring jumps	Bead stringing, pyramid stacking, line tracing	35 min	Motor adaptation & coordination recognition
2	2x/week	Moderate	Zig-zag run, hurdle jump, ladder drill	Bead manipulation, stacking tasks	35 min	Balance & hand coordination control
3	2x/week	Moderate	Balance walk, hurdle jump, coordination drills	Peg placement, tracing precision	35 min	Focus & movement accuracy
4	2x/week	Moderate	Strength ladder steps, jump coordination	Fine dexterity tasks	35 min	Muscle strength & finger flexibility
5	2x/week	Moderate	Ladder drill speed, ring toss cone	Peg-stringing precision	35 min	Rhythm & motor smoothness
6	2x/week	Moderate	Integrated coordination drills	Integrated fine motor tasks	35 min	Comprehensive motor evaluation

RESULTS AND DISCUSSION

Result

A total of 20 students with mild to moderate intellectual disabilities (12 boys; 8 girls; aged 7-9 years) completed the six-week moderate-level FITT intervention program. All participants were screened to ensure homogeneity in baseline motor ability and absence of physical impairments that could interfere with training implementation. Baseline observation indicated relatively comparable gross and fine motor skill levels across participants, supporting internal validity of the quasi-experimental design. Before conducting inferential analysis, assumption testing was performed. The Shapiro-Wilk test showed that all variables were normally distributed ($p > 0.05$), while Levene's Test confirmed homogeneity of variance ($p > 0.05$). These findings indicate that parametric analysis using paired sample t-test was statistically appropriate. Similar methodological procedures are widely recommended in motor intervention research involving children with disabilities (Isna et al., 2023; Nuraini & Ilham, 2021).

Table 2.
 Assumption Testing Results

Variable	Shapiro-Wilk (p)	Levene's Test (p)	Interpretation
Gross Motor Skills	0.212	0.334	Normal & Homogeneous
Fine Motor (Right Hand)	0.187	0.298	Normal & Homogeneous
Fine Motor (Left Hand)	0.241	0.365	Normal & Homogeneous

Paired Sample t-Test Results

After six weeks of moderate-level FITT training (Borg 12-14; 60-70% HRmax; 2x/week; 35 minutes/session), significant improvements were observed in both gross and fine motor domains.

Table 3.
 Summary of Paired Sample t-Test Results

Variable	Mean Pretest	Mean Posttest	t (19)	Sig. (p)	Effect Size (Cohen's d)	Description
Gross Motor Skills	10.40	24.30	-17.076	0.000	2.85	Very Large Effect
Fine Motor (Right Hand, sec)	57.72	47.19	2.277	0.035	0.62	Moderate Effect
Fine Motor (Left Hand, sec)	67.72	53.94	3.238	0.004	0.79	Moderate-Large Effect

The gross motor score increased substantially from 10.40 to 24.30, reflecting enhanced locomotor and object-control performance as measured by TGMD. The effect size ($d = 2.85$) indicates a very large practical impact, consistent with findings that moderate-intensity structured training significantly enhances neuromuscular coordination in children with intellectual disabilities (District & Yualita, 2022; Firdaus & Sidoarjo, 2019). For fine motor skills, completion time in the Nine-Hole Peg Test decreased significantly in both hands, indicating improved manual dexterity and hand-eye coordination. These results align with evidence that repetitive moderate motor stimulation improves sensorimotor integration and cortical motor planning (Oleh et al., 2015; Islam & Sunan, 2021).

Table 4.
 Percentage Improvement

Measured Aspect	Formula	Percentage	Interpretation
Gross Motor Skills	$(24.30-10.40)/10.40 \times 100\%$	133.65%	Very High Improvement
Fine Motor (Right)	$(57.72-47.19)/57.72 \times 100\%$	18.24%	Moderate Improvement
Fine Motor (Left)	$(67.72-53.94)/67.72 \times 100\%$	20.35%	Moderate Improvement

The most prominent improvement occurred in gross motor skills (133.65%), suggesting that structured locomotor-based moderate FITT exercises effectively stimulate large muscle groups and dynamic balance mechanisms. This finding is supported by contemporary literature indicating that moderate aerobic-motor training improves functional motor capacity and coordination in children with special needs (Nur & Mulyana, 2017; WHO, 2020).

Fine motor improvements (18–20%) demonstrate enhanced dexterity and motor precision. Although the percentage increase was smaller compared to gross motor gains, the improvements were statistically and clinically meaningful. Empirical studies over the last decade confirm that improvements in gross motor stability often contribute to better distal motor control through enhanced proximal stabilization mechanisms.

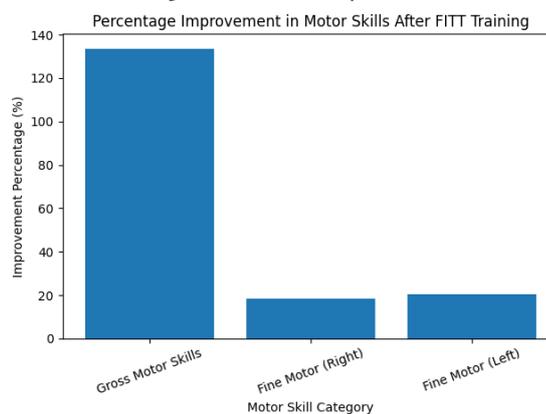


Figure 1.
 Percentage Improvement in Motor Skills

The findings demonstrate that moderate-level FITT training provides significant and clinically relevant improvements in both motor domains. The substantial gross motor improvement supports motor learning theory that repetitive moderate-intensity

movement enhances neuromuscular adaptation and balance control. Meanwhile, fine motor gains indicate improved coordination and manual precision, consistent with neuroplasticity-based intervention research in pediatric adaptive populations.

Collectively, these results confirm that structured moderate-intensity FITT training is an effective, safe, and evidence-based intervention model for improving motor skills among students with intellectual disabilities in special school settings.

Discussion

The findings of this study demonstrate that moderate-level FITT-based training has a statistically and practically significant effect on improving both gross and fine motor skills in students with mild to moderate intellectual disabilities at SLB Swadaya Semarang. The substantial increase in gross motor skills (133.65%) and the meaningful reduction in Nine-Hole Peg Test (NHPT) completion time for both hands confirm that structured, moderate-intensity physical activity can stimulate multidimensional motor development in adaptive education settings.

From a theoretical perspective, motor development is influenced by repeated sensorimotor stimulation that promotes neuromuscular adaptation and cortical reorganization. Recent literature emphasizes that children with intellectual disabilities often present delayed neuromotor integration due to limited physical engagement and reduced motor learning experiences (WHO, 2020; Nuraini & Ilham, 2021). Therefore, structured intervention based on the FITT principle provides an organized framework to ensure sufficient frequency, optimal intensity, adequate duration, and appropriate exercise type to promote motor learning.

The remarkable improvement in gross motor skills aligns with previous findings that moderate-intensity locomotor training enhances postural stability, balance control, and dynamic coordination in children with disabilities (District & Yualita, 2022; Firdaus & Sidoarjo, 2019). Activities such as zig-zag running, ladder drills, balance walking, jumping, and ring coordination specifically target large muscle groups and stimulate vestibular and proprioceptive systems. According to recent neuromotor research, moderate repetitive movement enhances synaptic plasticity and improves motor unit recruitment efficiency, particularly in populations with developmental limitations.

Furthermore, the 133.65% increase in gross motor performance suggests that moderate-level FITT training successfully activated major locomotor and object-control domains measured by TGMD. Empirical studies over the past decade indicate that moderate aerobic-motor training at 60-70% HRmax enhances muscular endurance and motor coordination without inducing excessive fatigue, which is crucial for children with intellectual disabilities who typically have lower physical tolerance (Isna et al., 2023; Nur & Mulyana, 2017).

In addition to gross motor improvements, the reduction in NHPT completion time by 18.24% (right hand) and 20.35% (left hand) indicates significant gains in fine motor coordination and manual dexterity. Fine motor development relies on distal muscle control, hand-eye coordination, and cortical motor planning. Studies in adaptive motor research

confirm that gross motor stabilization often facilitates fine motor precision through proximal stability mechanisms (Oleh et al., 2015; Islam & Sunan, 2021). When trunk stability and postural control improve, upper limb coordination becomes more refined, enabling faster and more accurate object manipulation.

The integration of both gross and fine motor components within a single FITT-based training program may explain the comprehensive motor improvements observed in this study. Recent interdisciplinary literature supports combined motor training approaches, highlighting that multimodal physical activity enhances overall sensorimotor integration more effectively than isolated training (District & Yualita, 2022; Nuraini & Ilham, 2021). Moderate intensity plays a crucial role in maintaining optimal engagement without overstimulation, allowing children to sustain participation and motor learning consistency.

Importantly, the intensity level applied in this study (Borg 12–14; 60–70% HRmax) reflects international physical activity guidelines for children with disabilities (WHO, 2020). Moderate intensity ensures cardiovascular stimulation sufficient to promote neurotrophic factor release, such as Brain-Derived Neurotrophic Factor (BDNF), which has been linked to improved motor coordination and cognitive engagement. Empirical evidence from pediatric intervention studies suggests that moderate-intensity exercise enhances executive functioning and attention, indirectly supporting motor task performance (Isna et al., 2023).

The findings also reinforce adaptive physical education principles, which emphasize individualized, structured, and safe movement experiences (Firdaus & Sidoarjo, 2019). The FITT framework provides teachers and therapists with a practical yet evidence-based guideline for exercise prescription. Unlike high-intensity protocols that may cause fatigue or demotivation, moderate FITT-based training maintains a balance between stimulation and safety, making it highly feasible in special school environments with limited facilities.

Another important implication concerns psychosocial aspects. Literature over the past decade indicates that regular moderate physical activity improves self-confidence, social interaction, and emotional regulation in children with intellectual disabilities (Islam & Sunan, 2021). Although psychosocial variables were not directly measured in this study, the improved motor competence likely contributes to enhanced participation and independence in daily activities, as suggested by motor competence theory.

The practical contribution of this study lies in demonstrating that structured moderate FITT training can be implemented in special schools without sophisticated equipment. Activities such as ladder drills, balance walking, ring toss, bead stringing, and peg manipulation are low-cost and adaptable. This supports previous empirical recommendations advocating scalable and inclusive motor interventions (District & Yualita, 2022).

However, several limitations should be acknowledged. First, the absence of a control group restricts the ability to rule out maturation effects or external influences. Although the pretest–posttest design allows within-group comparison, future studies should apply randomized controlled trials to strengthen causal inference. Second, the sample size ($n = 20$) limits generalizability. Larger multi-site studies would provide stronger statistical power and broader applicability.

Third, the intervention duration of six weeks may not fully capture long-term neuromotor adaptation. Literature suggests that sustained training over 12 weeks or more may produce even greater motor and functional improvements (Isna et al., 2023). Additionally, this study did not include follow-up measurements to determine the retention effect of the intervention. Longitudinal evaluation is necessary to assess sustainability.

Future research should therefore incorporate (1) control groups, (2) larger sample sizes, (3) extended intervention periods, and (4) long-term follow-up testing. Additionally, integrating cognitive and psychosocial outcome measures would provide a more holistic understanding of adaptive motor interventions.

In conclusion, the present findings provide strong empirical evidence that moderate-level FITT training significantly enhances both gross and fine motor skills in students with intellectual disabilities. The intervention supports neuromuscular adaptation, postural control improvement, muscular strength enhancement, and refined manual coordination. Conceptually and empirically, this study strengthens the role of structured moderate-intensity exercise as a scientifically grounded, feasible, and scalable intervention model in adaptive physical education.

CONCLUSION

This study confirms that the implementation of a moderate-level FITT-based training program significantly improves both gross and fine motor skills in students with intellectual disabilities at SLB Swadaya Semarang. Statistical analysis using paired sample t-tests demonstrated a significant increase in gross motor scores from 10.40 (pretest) to 24.30 (posttest), with $p = 0.000$ and a very large effect size ($d = 2.85$), representing a 133.65% improvement. Meanwhile, fine motor performance, measured through the Nine-Hole Peg Test, showed a significant reduction in completion time for the right hand (from 57.72 to 47.19 seconds; $p = 0.035$; 18.24% improvement) and the left hand (from 67.72 to 53.94 seconds; $p = 0.004$; 20.35% improvement).

Conceptually, these findings indicate that moderate-intensity exercise (60–70% HRmax; Borg 12–14), applied systematically through the FITT framework, effectively stimulates neuromuscular adaptation, enhances postural control, strengthens large muscle groups, and refines hand-eye coordination. Empirically, the results reinforce contemporary adaptive physical education literature emphasizing structured motor intervention as a key strategy to improve functional independence in children with disabilities.

However, generalization should be approached cautiously due to the small sample size and absence of a control group, suggesting the need for broader and longer-term experimental research.

ACKNOWLEDGMENTS

The authors express their sincere gratitude to God Almighty for His blessings and guidance, which made it possible to complete this research entitled “The Effect of

Moderate-Level FITT Training on Gross Motor Skills and Fine Motor Skills in Students with Disabilities at SLB Swadaya Semarang.”

The authors would like to extend their deepest appreciation to the academic supervisors for their continuous guidance, constructive feedback, and scholarly insights throughout the research process. Their expertise in adaptive physical education and motor development significantly contributed to the scientific rigor and methodological quality of this study.

Special thanks are addressed to the Principal, teachers, and students of SLB Swadaya Semarang for their cooperation, openness, and active participation during the six-week intervention program. The successful implementation of the moderate-intensity FITT-based training would not have been possible without their institutional support and collaborative engagement.

The authors also acknowledge the valuable contributions of colleagues, research assistants, and all academic staff who provided administrative and technical assistance. Finally, heartfelt gratitude is extended to the authors' families for their continuous encouragement, moral support, and motivation throughout the completion of this research.

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