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(IJEPC)**www.ijepec.com**ENHANCING MUSCULAR STRENGTH AND ENDURANCE
AMONG STUDENTS WITH PHYSICAL DISABILITIES
THROUGH A SEATED PHYSICAL ACTIVITY MODULE:
A QUASI-EXPERIMENTAL STUDY**Aisyah Zainudin¹, Eshelvana Elve Irin², Syuhadah Othman³, Mohamad Nizam Nazarudin^{4*}¹ Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia
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DOI: 10.35631/IJEPC.1061017**Abstract:**

Physical inactivity remains a critical challenge among students with physical disabilities, often resulting in reduced muscular strength, endurance, and functional independence. This study aimed to evaluate the effectiveness of a structured Seated Physical Activity (SPA) module in improving muscular fitness among students with physical disabilities within an inclusive education context. A quasi-experimental single-group pretest–posttest design was conducted with 22 students aged 13–17 years diagnosed with mild to moderate physical disabilities. Over eight weeks, participants completed two weekly SPA sessions comprising warm-up, seated resistance exercises, and cool-down phases. Three validated instruments, the Hand Grip Strength Test, 5-Repetition Sit-to-Stand Test, and 30-Second Chair Stand Test, were used to assess upper- and lower-body performance. Data were analysed using paired-sample t-tests and Cohen's *d* for effect size estimation. Significant improvements were observed in hand grip strength ($t = 5.48$, $p < .001$, $d = 1.17$), sit-to-stand endurance ($t = 6.12$, $p < .001$, $d = 1.30$), and chair stand repetitions ($t = 5.77$, $p < .001$, $d = 1.23$). These findings indicate large effect sizes and confirm the SPA module's effectiveness in enhancing both upper- and lower-limb performance. The SPA module demonstrates high validity (CVI = 0.92) and feasibility for school implementation. Its evidence-based design supports Motor Learning Theory, Physical Adaptation Theory, and Self-Determination

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Theory, enabling inclusive and low-cost physical education delivery for students with disabilities. This study offers one of the first empirical validations of a seated physical activity intervention in Malaysian special education, presenting a replicable model to promote inclusive, safe, and effective exercise participation in schools.

Keywords:

Seated Exercise, Adapted Physical Education, Muscular Endurance, Physical Disability, Inclusive Education, Motor Learning

Introduction

Physical fitness forms the cornerstone of health and well-being, serving as a foundation for functional independence and psychosocial development. For individuals with physical disabilities, however, opportunities to engage in structured physical activity are often restricted by physical, environmental, and systemic barriers (Martin Ginis et al., 2021; Shen et al., 2024). While mainstream physical education programs typically prioritize athletic performance, students with disabilities require adaptive, evidence-based models that emphasize inclusion, safety, and progression.

Within Malaysia's education system, the movement toward inclusive education has expanded access to academic learning for students with disabilities, but the physical domain remains underdeveloped. The Ministry of Education Malaysia (2019) highlights the need for accessible physical fitness programs tailored to functional abilities. Despite positive policy initiatives, participation in physical activity among students with special needs remains significantly lower compared to their peers, hindered by limited resources, a lack of trained instructors, and the absence of specialized programs (Rimmer et al., 2004; Wu et al., 2017).

Theoretical Foundation

This study draws upon multiple theoretical lenses that collectively frame adaptive physical activity. The motor learning theory (Schmidt & Lee, 2019) underscores how repetition and feedback facilitate skill acquisition. The physical adaptation theory (Sherrill, 2004) emphasizes the importance of modifying activity intensity, duration, and structure to match participants' functional capacities. The Self-Determination Theory (Deci & Ryan, 2000) and Bandura's Social Cognitive Theory (1986) both highlight autonomy, social interaction, and perceived competence as key motivators sustaining engagement. The Universal Design for Learning (CAST, 2018) provides a pedagogical foundation to ensure the program's accessibility for students with diverse physical capabilities.

Research Context and Rationale

Globally, adaptive exercise models such as yoga, resistance training, and movement-based play have shown promising effects on strength, coordination, and psychological well-being (Yuvaraj et al., 2024; Dimyati et al., 2022). In Malaysia, however, research focusing specifically on seated physical activity interventions remains scarce. Studies such as those by Liao et al. (2007) and Farías-Valenzuela et al. (2024) have demonstrated that seated exercise improves muscular endurance and flexibility among individuals with limited mobility, providing a safe and feasible alternative to traditional workouts.

The Seated Physical Activity (SPA) module developed in this study integrates these global insights into a culturally and contextually relevant framework for Malaysian special education classrooms. It is structured around three progressive phases warm-up, strength, and endurance requiring minimal space and equipment, thereby making it suitable for implementation within limited school resources.

Problem Statement and Research Gaps

Although international evidence supports the use of adaptive exercise, few local programs evaluate physiological outcomes, such as muscular strength and endurance, in school settings. Existing studies often focus on psychosocial or cognitive effects, neglecting the quantifiable physical gains achievable through structured seated exercise. Furthermore, most teachers in Malaysian special education programs lack formal training in adapted physical education (Wu et al., 2017), resulting in irregular program delivery and inconsistent assessment standards. Hence, this study was conducted to evaluate the effectiveness of a seated physical activity module designed specifically for students with physical disabilities. The intervention was expected to improve muscular strength and endurance, validated through standardized field tests (Farias-Valenzuela et al., 2024; Tsai et al., 2025).

Objectives:

1. To develop and implement a seated physical activity module tailored for students with physical disabilities.
2. To assess pre-intervention levels of muscular strength and endurance.
3. To evaluate post-intervention improvements in physical performance after the eight-week program.

Research Questions:

1. What are the key components and pedagogical features of the SPA module?
2. What are the baseline levels of muscular endurance and strength among students before intervention?
3. Does the SPA module produce significant improvements in muscular strength and endurance post-intervention?

Significance of the Study

This study contributes to three main domains:

1. Educational Practice: It offers an evidence-based, implementable model for teachers in special education to integrate adaptive physical activities safely within limited facilities.
2. Scientific Advancement: It validates seated activity as a viable mechanism for improving physical function in children with physical disabilities, filling a major empirical gap in Malaysian APA research.
3. Policy Development: Findings can inform the Ministry of Education's inclusive curriculum design and guide teacher training modules for adaptive physical education delivery.

Methodology

Research Design and Process

This study employed a quasi-experimental single-group pretest–posttest design, a design widely recommended for educational and rehabilitation settings involving students with special needs, where random assignment is both ethically and practically limited (Creswell & Creswell, 2018; López-de-la-Fuente et al., 2022). The overall research process was structured into three systematic phases to ensure methodological transparency and replication fidelity:

1. Phase 1 – Module Development

The Seated Physical Activity (SPA) module was designed based on a synthesis of adapted physical education frameworks (Sherrill, 2004; Wu et al., 2017) and validated instructional approaches emphasizing safety, repetition, and functional adaptability. The content was validated by a panel of five experts in adapted physical education, physiotherapy, and special education, using the Content Validation Index (CVI) procedure. Items with $CVI \geq 0.80$ were retained.

2. Phase 2 – Implementation (Intervention)

The validated module was implemented for eight weeks, with two sessions per week, each lasting 30–45 minutes. Each session followed a standardized three-phase sequence:

- a. Warm-up: rhythmic arm movements, neck rotations, and toe taps to elevate heart rate safely.
- b. Core training: seated bicep curls, leg extensions, shoulder presses, and torso rotations using light dumbbells or water bottles.
- c. Cool-down: breathing control, slow upper-limb stretches, and relaxation to reduce post-exercise tension.
- d. The progression followed the principles of motor learning and overload adaptation (Schmidt & Lee, 2019), with incremental increases in repetitions and duration every two weeks.

3. Phase 3 – Evaluation

Pre- and post-tests were conducted to measure changes in muscular endurance and strength, analysed statistically for significance. Teacher feedback and field observations were also recorded to ensure program adherence and participant safety.

This process ensured methodological coherence across planning, implementation, and evaluation, consistent with the Physical Adaptation Theory (Sherrill, 2004) that underscores modification and repetition as drivers of performance improvement in adaptive contexts.

Participants

The study involved 22 students (13–17 years) from a special education school in Malaysia, representing mild-to-moderate physical disabilities such as cerebral palsy, spina bifida, and postural impairments. Participants were selected through purposive sampling, as recommended in small-scale research on inclusive education (Creswell & Creswell, 2018).

Inclusion criteria:

- a. Ability to sit independently for ≥ 15 minutes
- b. Capable of following simple instructions
- c. Free from cardiovascular or musculoskeletal contraindications
- d. Written parental consent and school approval

Exclusion criteria:

- a. Severe spasticity or uncontrolled seizures
- b. Participation in other physical therapy programs during the study

Instruments

The following instruments were selected to assess muscular endurance and strength, chosen for their feasibility, safety, and strong psychometric properties in adaptive contexts.

1. Hand Grip Strength Test

This test evaluates upper-body muscle strength, particularly forearm flexors, using a calibrated Jamar digital dynamometer. Participants performed two trials per hand, and the best score (in kilograms) was recorded. The test has been widely validated for use in children and youth, demonstrating high test–retest reliability ($r = .95$) and inter-rater reliability (ICC = .98) (Mayorga-Vega et al., 2015).

2. Repetition Sit-to-Stand (5R-STs) Test

Measures lower-body endurance and functional mobility. Participants rose from a 45-cm chair as quickly as possible five times without arm support. Time (in seconds) was recorded using a stopwatch. Tsai et al. (2025) confirmed strong criterion validity ($r = 0.87$) with leg press performance and test–retest reliability (ICC = 0.96) for individuals with limited mobility.

3. Second Chair Stand Test

Assesses lower-body muscular endurance by counting the number of full stands completed in 30 seconds. The test is highly suitable for seated or low-mobility populations, with established validity ($r = .84$) and reliability ($r = .94$) (Fariás-Valenzuela et al., 2024).

All instruments were administered by trained physical education teachers familiar with adaptive testing protocols. The testing environment was quiet, safe, and monitored by a physiotherapist to ensure comfort and prevent injury.

The Seated Physical Activity (SPA) Module

The SPA module was created to enhance muscular strength and endurance through accessible seated exercises adapted for classroom implementation. It emphasizes progressive overload, rhythmic sequencing, and inclusivity for students with physical disabilities. The module consisted of three main session components: warm-up, core exercise, and cool-down, which were conducted twice a week for eight weeks.

Table 1. Framework of the Seated Physical Activity (SPA) Module

Session Phase	Duration	Activity Description	Intended Outcomes
Warm-Up	5–10 min	Neck rotations, shoulder rolls, seated toe taps	Gradual heart rate increase, joint flexibility
Core Exercise	20–25 min	Seated shoulder press, bicep curls with water bottles, leg extensions, trunk twists	Strengthening of upper and lower limb muscles, and endurance building
Cool-Down	5 min	Controlled breathing, arm stretches, and slow trunk flexion	Muscle relaxation and recovery

The SPA module adheres to the motor learning principles of repetition, feedback, and task progression (Schmidt & Lee, 2019), aligning with Sherrill's (2004) Physical Adaptation Theory. This ensures that each movement can be adjusted to accommodate individual functional capacity.

Validity and Reliability of the SPA Module

The module's content validity was established using the Content Validity Index (CVI) based on expert evaluation. The experts rated each component (exercise sequence, safety protocol, progression structure, and instruction clarity) on a four-point relevance scale. Items with CVI < 0.80 were revised or removed, ensuring high content fidelity (López-de-la-Fuente et al., 2022). For reliability, a pilot test was conducted with five students (not included in the main sample) over a two-week period to assess the consistency and clarity of instruction. The Cronbach's alpha coefficient of .89 indicated strong internal reliability of the module's procedural and instructional consistency. Observational checklists were also used to evaluate the fidelity of implementation.

Data Collection Procedure

1. Pre-Test (Week 1): Baseline measures for hand grip, 5R-STs, and 30-s chair stand were recorded.
2. Intervention (Weeks 2–9): Participants attended 16 structured SPA sessions conducted twice weekly. Attendance, participation, and perceived exertion were monitored.
3. Post-Test (Week 10): The same instruments were re-administered under identical conditions.
4. Data Verification: The researcher and physical education teacher jointly reviewed and confirmed data entries for accuracy.

The intervention sessions were conducted in the school's multipurpose hall to ensure accessibility. Exercises utilised simple equipment, such as chairs, resistance bands, and small dumbbells, which were consistent with the school's facilities.

Data Analysis

Data were analysed using IBM SPSS Statistics version 27. Descriptive statistics (mean, standard deviation) summarized participant performance. Paired-sample t-tests evaluated differences between pre- and post-test scores for each dependent variable. Normality was checked using the Shapiro–Wilk test, confirming all distributions within an acceptable range ($p > .05$). Statistical significance was established at $\alpha = .05$.

Ethical Considerations

Ethical compliance was a central priority throughout the study. Approval was obtained from the university's Research Ethics Committee. Parents or guardians provided informed consent after receiving detailed written information on the research purpose, activities, potential benefits, and minimal risks. Students gave verbal assent before participation. Confidentiality was maintained through the use of coded identifiers, and all data were stored securely with restricted access. The exercises were conducted under supervision, ensuring physical safety, and participants were allowed to withdraw at any time without penalty. These procedures align with ethical standards outlined in the Declaration of Helsinki (2013) and the Malaysian Code of Responsible Conduct in Research (2021).

Results and Findings

RO 1 / RQ 1 – Module Validation and Expert Review

Five experts in adapted physical education and physiotherapy rated the SPA module on content relevance, clarity, and feasibility using a four-point scale. The Content Validity Index (CVI) in Table 2 averaged 0.92, exceeding the 0.80 threshold for excellent content validity (López-de-la-Fuente et al., 2022). Inter-rater agreement was 94%.

Table 2. Expert Validation of SPA Module

Validation Dimension	Mean Rating (1–4)	CVI Interpretation
Relevance of content to the target group	3.8	0.95 Excellent
Clarity of instructions	3.6	0.90 High
Feasibility in the school context	3.7	0.92 Excellent
Safety and adaptability	3.8	0.91 Excellent
Average CVI	–	0.92 Excellent

RO 2 / RQ 2 – Baseline Strength and Endurance

Based on Table 3, before the eight-week intervention, participants (N = 22) displayed low-to-moderate baseline performance, consistent with previous literature on youths with mild to moderate motor impairments (Wu et al., 2017).

Table 3. Baseline Physical Performance Scores

Test Instrument	Mean (M)	SD	Reference Benchmark*	Performance Level
Hand Grip Strength (kg)	11.52	2.34	< 15 kg = Low Strength	Low
5-Repetition Sit-to-Stand (s)	23.67	4.85	> 20 s = Low Endurance	Low
30-Second Chair Stand (reps)	7.36	1.88	< 10 reps = Low Endurance	Low

*Benchmarks derived from Farías-Valenzuela et al. (2024) and Mayorga-Vega et al. (2015).

The pre-test findings confirmed the need for structured seated training to improve both upper- and lower-body capacity, aligning with prior adaptive-fitness research (Liao et al., 2007; Pan & McNamara, 2022).

RO 3 / RQ 3 – Effectiveness of the SPA Module

Paired-sample t-tests revealed significant improvements across all measures following the intervention, as shown in Table 4.

Table 4. Pre- and Post-Intervention Comparison (n = 22)

Measure	Pre-Test M ± SD	Post-Test M ± SD	M t (df = 21)	p	Cohen's d	% Improvement
Hand Grip Strength (kg)	11.52 ± 2.34	15.27 ± 2.67	5.48	< .001	1.17	+32.6 %
5R-STs (s)	23.67 ± 4.85	17.41 ± 3.29	6.12	< .001	1.30	−26.4 % (faster)
Chair Stand (reps)	7.36 ± 1.88	10.82 ± 2.15	5.77	< .001	1.23	+47.0 %

Effect-size interpretation followed Cohen (1988): $d > 0.80$ = large. Thus, all improvements were of large magnitude.

Interpretation of Findings

1. Muscular Strength Improvement

The 32.6 % increase in hand-grip force corroborates earlier findings that resistance-based seated training enhances upper-limb activation and neuromuscular efficiency (Mayorga-Vega et al., 2015; Farías-Valenzuela et al., 2024). Repeated overload and motor-learning feedback within the SPA module likely facilitated motor-unit recruitment and coordination (Schmidt & Lee, 2019).

2. Endurance Enhancement

Participants' mean 5R-STs time improved by 26 %, consistent with Liao et al. (2007) who found eight-week seated programs significantly increased lower-limb endurance. Reduced completion times indicate better muscle oxygenation and metabolic adaptation from progressive training sessions. The 47 % increase in chair-stand repetitions confirms that seated multi-joint movements can replicate the effects of standing exercises on muscular endurance (Sherrill, 2004; Wu et al., 2017).

3. Functional and Pedagogical Implications

Improved scores across all tests translate to greater functional independence in daily tasks (e.g., transfers, postural stability). The data affirm that the SPA module successfully bridges physical and educational outcomes by providing inclusive, low-risk movement opportunities within classrooms (Pan & McNamara, 2022). Moreover, consistent progress throughout the eight weeks supports the principles

Physical Adaptation Theory and Self-Determination Theory, where gradual challenges and perceived competence enhance motivation and participation (Deci & Ryan, 2000; Sherrill, 2004). The Summary of findings is in Table 5.

Table 5. Summary of Findings

Research Objective	Key Result	Interpretation
RO 1 – Develop and validate SPA module	CVI = 0.92; expert agreement	high Module content is valid and implementable in school settings
RO 2 – Determine baseline levels	Low initial strength and endurance	Confirms the need for targeted adaptive intervention
RO 3 – Evaluate effectiveness	All $p < .001$; large $d > 0.80$	The SPA module significantly improves muscular strength and endurance

Overall, the findings validate the SPA module as an effective and inclusive approach for students with physical disabilities, supporting prior research that structured adaptive exercise enhances functional capacity and social engagement (Fariás-Valenzuela et al., 2024; Wu et al., 2017; Martin Ginis et al., 2021). These results provide a quantitative foundation for policy integration under Malaysia's inclusive education agenda (Ministry of Education Malaysia, 2019).

Discussion

The findings from this study demonstrated that the Seated Physical Activity (SPA) module produced significant improvements in both muscular strength and endurance among students with physical disabilities. These results affirm the theoretical and empirical foundations underpinning adaptive physical education, particularly within inclusive school contexts (Sherrill, 2004; Wu et al., 2017). The observed 32.6% increase in hand-grip strength and 47% improvement in lower-body endurance align closely with previous studies, which have shown that seated and resistance-based interventions effectively stimulate neuromuscular activation and promote functional adaptations (Fariás-Valenzuela et al., 2024; Mayorga-Vega et al., 2015). Repeated engagement with progressive overload and consistent feedback during the eight-week program likely enhanced motor-unit recruitment and coordination, as supported by the Motor Learning Theory (Schmidt & Lee, 2019). This theory emphasizes that structured repetition and feedback not only refine skill performance but also strengthen cognitive-motor integration, leading to more efficient muscle activation patterns.

From a pedagogical perspective, the SPA module demonstrated that inclusive and adaptive exercise can be successfully integrated into classroom settings without requiring specialized facilities or equipment. The program's seated format, rhythmic pacing, and gradual progression reflect the practical application of Physical Adaptation Theory, which advocates tailoring movement tasks to individual physical capabilities to ensure equitable participation (Sherrill, 2004). The low-risk and space-efficient design enabled students with limited mobility to engage in safe and meaningful physical activity, addressing long-standing challenges of accessibility and exclusion in special education settings (Wu et al., 2017; Pan & McNamara, 2022).

Moreover, the consistent improvement trends observed across all physical indicators support the motivational framework of Self-Determination Theory (Deci & Ryan, 2000). As students perceived competence and autonomy through achievable exercise goals, their intrinsic motivation likely increased, sustaining participation and effort. This finding aligns with the research of Martin Ginis et al. (2021), who emphasized that autonomy-supportive environments enhance engagement and well-being among individuals with disabilities. By fostering feelings of control and success, the SPA module not only improved physical outcomes but also strengthened students' self-efficacy and social interaction, two core objectives in adaptive physical education.

In the context of these findings, Malaysia's Inclusive Education Policy Framework (Ministry of Education Malaysia, 2019) is also reinforced, advocating for equitable access to physical and recreational learning. However, previous research has highlighted that implementation remains inconsistent, largely due to a shortage of adapted resources and trained personnel (Wu et al., 2017). The success of this SPA intervention thus provides an actionable model for

policymakers and educators to adopt low-cost, scalable approaches that align with national inclusive education goals.

In sum, the present study demonstrates that structured seated physical activity is not merely compensatory but transformative. It contributes to improved functional independence, psychological well-being, and classroom participation. These outcomes support the argument that adapted physical activity should be integrated into school curricula as a core component of holistic development for students with disabilities. Future studies could extend this work by comparing different disability categories or integrating technology-based feedback systems for real-time performance monitoring.

Conclusion and Practical Implications

This study provides compelling evidence that the Seated Physical Activity (SPA) module effectively enhances muscular strength and endurance among students with physical disabilities. The integration of evidence-based movement patterns, progressive overload principles, and adaptive teaching methods led to significant physiological and functional improvements after just eight weeks. These outcomes support the theoretical foundations of Motor Learning Theory (Schmidt & Lee, 2019) and Physical Adaptation Theory (Sherrill, 2004), demonstrating that even in seated or low-mobility conditions, the human body is capable of meaningful adaptation through consistent, structured engagement.

From a pedagogical perspective, this research highlights the feasibility of incorporating inclusive physical activity into the special education classroom setting. The SPA module, requiring minimal equipment and space, can be easily adopted by teachers to complement the Malaysian Inclusive Education Policy Framework (Ministry of Education Malaysia, 2019). The module's design also reflects the motivational principles of Self-Determination Theory (Deci & Ryan, 2000), which emphasizes the importance of task mastery, autonomy, and enjoyment in fostering intrinsic engagement and long-term behavioral adherence.

Practically, educators and policymakers should view adapted physical activity not as supplementary but as essential to the holistic development of students with disabilities. Teachers can incorporate the SPA module into their daily routines, integrating 20–30 minutes sessions to improve not only physical capacity but also attention, emotional regulation, and classroom participation. Moreover, teacher training institutions should incorporate adaptive exercise pedagogy into their professional development programs to ensure that educators possess the competencies to modify activities for varying functional needs. In conclusion, the SPA module offers a sustainable, inclusive, and empirically validated framework for improving the health and quality of life of students with physical disabilities. It bridges the existing gap between policy and practice, representing a practical pathway toward achieving a more equitable and empowering educational environment for all learners.

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