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Detraining Effects on Body Mass Index and Motor Performance in Boys with Down Syndrome: A One-Year Follow-Up Study

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A B S T R A C T

Down syndrome is one of the most common chromosomal disorders and is associated with multiple challenges in cognitive, motor, and physical development. The aim of the present study was to evaluate changes in body mass index (BMI) and perceptual–motor performance in boys with Down syndrome one year after completing a six-week program of aerobic and resistance exercises under conditions of detraining. This quasi-experimental study used a pretest–posttest–one-year follow-up design and was conducted on 30 boys with Down syndrome aged 7 to 14 years (BMI = 18.6367 ± 3.479). Participants were randomly assigned to three groups: aerobic training, resistance training, and control. After completing the six-week training program, all participants underwent a one-year detraining period and were re-evaluated at the end of this period. Data were analyzed using multivariate analysis of variance with repeated measures. The results showed a significant increase in BMI across all groups over the one-year period ($p < .001$). In addition, gross motor skills, fine motor skills, and upper-limb coordination, which had improved following the initial intervention, showed a marked decline during detraining. The degree of skill regression was less pronounced in the resistance training group compared to the aerobic training group; however, this difference was not sufficient to prevent performance decline over time. Overall, the findings indicated that the positive effects of short-term exercise interventions in children with Down syndrome do not persist without ongoing physical activity. These results underscore the importance of designing continuous, combined, and long-term rehabilitative exercise programs to prevent the deterioration of motor abilities and to maintain physical health indicators in this vulnerable population.

Keywords: *Down syndrome, upper-limb coordination, motor skills, aerobic training, resistance training*

1. Introduction

Down syndrome is the most common chromosomal disorder and is characterized by distinct neurodevelopmental and physical health challenges that affect growth, motor competence, and metabolic balance (Molinari et al., 2024; Robinson et al., 2024). Individuals with Down syndrome often present with hypotonia, ligamentous laxity, and delayed motor development, which influence their capacity to acquire and maintain functional movement patterns (González-Agüero et al., 2010). These factors not only compromise physical fitness but also predispose children to sedentary behaviors, elevated adiposity, and increased cardiometabolic risks (Esparza Ocampo et al., 2025; Moreau et al., 2021). For children and adolescents with Down syndrome, motor competence is strongly associated with broader developmental outcomes, including participation in physical activity, social inclusion, and independence in daily living (Koolwijk et al., 2024; Kyriakidou et al., 2024). Therefore, improving and sustaining motor performance and weight control in this vulnerable population is an essential public health and educational goal (Lei et al., 2025; Montalva-Valenzuela et al., 2025).

Exercise interventions, particularly aerobic and resistance training, have been shown to be safe and beneficial for individuals with Down syndrome when properly prescribed (Melo et al., 2022; Zolghadr et al., 2025). Evidence suggests that structured physical activity can improve cardiovascular health, muscular strength, balance, and overall body composition in this group (González-Agüero et al., 2010; Mendonca et al., 2011). Aerobic training enhances cardiorespiratory endurance and supports healthy weight regulation, while resistance training contributes to neuromuscular adaptations, bone health, and greater postural stability (Iglesias-Díaz et al., 2025; Post et al., 2022). Importantly, combined or multimodal programs—those integrating both aerobic and strength components—tend to produce superior outcomes for physical fitness and functional capacity compared to single-modality approaches (Mendonca et al., 2011; Montalva-Valenzuela et al., 2025). However, these gains are often dependent on long-term adherence to exercise, and their durability in the absence of continued training remains uncertain (Boer, 2018; Bosquet & Mujika, 2012).

The concept of **detraining**—the partial or complete loss of physiological and functional adaptations after the cessation of regular exercise—has become increasingly important in understanding the long-term health trajectory of children with Down syndrome (Bosquet & Mujika, 2012). While detraining effects are well documented in typically developing populations, fewer studies have explored their impact in children with intellectual disabilities. Available research suggests that motor competence, aerobic capacity, and metabolic indicators can regress relatively quickly after structured exercise programs stop (Boer, 2018; Kyriakidou et al., 2024). This regression may be more pronounced in individuals with Down syndrome because of their lower baseline fitness, hypotonia, and challenges in sustaining active lifestyles (Molinari et al., 2024; Moreau et al., 2021). Investigating how quickly and to what extent the benefits of exercise decline is crucial for designing long-term interventions and follow-up strategies (Zolghadr et al., 2025).

Anthropometric indicators, particularly body mass index (BMI), play a central role in evaluating physical health in children with Down syndrome. This population has an increased risk of obesity and metabolic disorders such as type 2 diabetes (Aslam et al., 2022; Esparza Ocampo et al., 2025). Metabolic vulnerability is influenced by altered endocrine profiles, reduced basal metabolic rate, and lower habitual physical activity (Molinari et al., 2024; Moreau et al., 2021). Even when normal weight is achieved, cardiometabolic risk factors remain elevated in some children with Down syndrome compared to their peers without the condition (Esparza Ocampo et al., 2025). Therefore, sustained physical activity is considered a key preventive measure to mitigate long-term health complications (Melo et al., 2022). Yet, little is known about the trajectory of BMI changes after relatively short but structured exercise programs once training stops (Boer, 2018; Bosquet & Mujika, 2012).

Motor development is another essential domain that requires long-term support. Gross motor skills such as walking, running, and jumping, as well as fine motor abilities like grasping and object manipulation, are often delayed or impaired in children with Down syndrome (González-Agüero et al., 2010; Silva et al., 2012). These delays limit opportunities for active play and participation in sports or physical education (Koolwijk et al., 2024). Evidence from structured programs shows that strength training improves postural control and movement efficiency (Iglesias-Díaz et al., 2025; Zolghadr et al., 2025), while aerobic training enhances endurance and coordination (Lei et al., 2025; Montalva-Valenzuela et al., 2025). Nevertheless, if these training effects are not maintained,

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skill regression can hinder participation in inclusive school activities and reduce overall quality of life (Bosquet & Mujika, 2012; Kyriakidou et al., 2024).

Emerging systematic reviews and meta-analyses have begun to consolidate knowledge on exercise and detraining in Down syndrome. For example, resistance training has been identified as a particularly valuable strategy for improving functional performance and preventing rapid deconditioning (Melo et al., 2022; Post et al., 2022). Aerobic programs also show benefits, especially when combined with strength elements to maximize neuromotor and metabolic outcomes (Montalva-Valenzuela et al., 2025; Zolghadr et al., 2025). However, heterogeneity in program duration, intensity, and follow-up assessments limits the generalizability of existing findings (Esparza Ocampo et al., 2025; Lei et al., 2025). Longitudinal studies exploring the sustainability of gains after program completion are still scarce (Boer, 2018; Bosquet & Mujika, 2012). This gap is critical because children with Down syndrome often rely on structured school-based or supervised programs and may lack family or community support to maintain physical activity independently (Molinari et al., 2024; Robinson et al., 2024).

From an ethical perspective, interventions targeting children with disabilities must adhere to rigorous research standards and prioritize participant safety. Conducting long-term exercise studies in vulnerable populations requires transparent informed consent and compliance with international ethical guidelines such as the Declaration of Helsinki (Ashcroft, 2008). Researchers must ensure that exercise prescriptions are individualized, safe, and feasible for participants with varying levels of ability (Melo et al., 2022; Silva et al., 2012). Safety considerations include joint stability, cardiovascular monitoring, and appropriate supervision during training sessions (Post et al., 2022). These standards are essential not only to protect participants but also to build confidence among caregivers and educators regarding the integration of physical activity programs into daily routines (Zolghadr et al., 2025).

Given the interplay between physical fitness, metabolic health, and functional autonomy, there is an urgent need to understand how quickly and to what extent benefits achieved from structured short-term exercise can fade if ongoing physical activity is not sustained (Boer, 2018; Bosquet & Mujika, 2012). Identifying which exercise modalities—resistance, aerobic, or combined—offer more lasting protection against detraining effects may guide practitioners in designing more durable interventions (Montalva-Valenzuela et al., 2025; Torabi & Khodarahmi, 2025). This knowledge can also inform inclusive physical education curricula and targeted support services in schools, helping to maintain motor competence and healthy body composition in children with Down syndrome (Koolwijk et al., 2024; Kyriakidou et al., 2024).

The present study builds on previous evidence from a six-week aerobic and resistance training intervention in boys with Down syndrome (Torabi & Khodarahmi, 2025). By conducting a one-year follow-up without structured training, this research seeks to evaluate how body mass index and perceptual–motor performance change after the cessation of supervised exercise. The findings aim to clarify the long-term sustainability of training effects, highlight the vulnerability of motor and metabolic adaptations to detraining, and provide evidence to inform the design of continuous, individualized, and safe physical activity programs for children with Down syndrome.

2. Methods and Materials

2.1. Study Design and Participants

This quasi-experimental study employed a posttest–one-year follow-up design. Pretest and posttest data were extracted from the initial research (six weeks of aerobic and resistance training) (Torabi & Khodarahmi, 2025), and follow-up data were collected one year after the end of the intervention, without any organized exercise program during that period. The statistical population included boys with Down syndrome aged 7 to 14 years in Tehran. In the first phase, 30 participants were randomly assigned into three groups: aerobic training, resistance training, and control (allocation ratio 1:1:1). The same participants were re-evaluated at the one-year follow-up.

Inclusion criteria were a confirmed diagnosis of Down syndrome, the ability to perform motor tests, and the absence of any medical condition limiting physical activity. Exclusion criteria included missing more than two training sessions during the initial phase or developing new medical problems during follow-up. Parents or legal guardians of the participants signed written informed consent after being informed of the study's objectives.

2.2. Training and Instruments

The intervention program in the two training groups lasted six weeks, with three sessions per week, each session lasting 60 minutes. The aerobic group performed activities

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such as light jogging, fartlek training, and rhythmic exercises, combined with 15 minutes of light resistance training. The resistance group performed light weight training, sit-ups, squats, push-ups, and stair climbing, supplemented with 15 minutes of aerobic exercise. The control group did not receive any intervention during this period. After completing the program, all participants entered a one-year detraining period and were invited back at the end for the same testing.

Height was measured with a standard seca 213 stadiometer with an accuracy of 0.1 cm, and weight was measured with a Seca 813 scale with an accuracy of 0.1 kg, both manufactured by seca gmbh & co. kg, Germany. Body mass index (BMI) was calculated. Perceptual–motor performance was assessed using standardized tests, including gross motor skills, fine motor skills, and upper-limb coordination.

2.3. Data Analysis

To assess the normality of the data distribution, the Kolmogorov–Smirnov test was applied. To simultaneously compare changes in multiple dependent variables across two time points (six weeks after training interventions and one-year follow-up), multivariate analysis of variance (MANOVA) with repeated measures was conducted. When significant main effects were found, Bonferroni post hoc tests were used to identify pairwise differences between time points. The significance level for all tests was set at $p < .05$.

3. Findings and Results

In this one-year follow-up study, changes in body mass index and perceptual–motor performance of boys with Down syndrome were evaluated one year after completing a six-week exercise intervention. To examine changes in anthropometric indicators and perceptual–motor performance in the three groups (aerobic training, resistance training, and control) at the posttest and one-year follow-up stages, MANOVA with repeated measures was employed. Results of the Kolmogorov–Smirnov test showed that the data distribution was normal. Additionally, Levene's test confirmed the assumption of homogeneity of variances for most variables ($p > .05$). Table 1 presents the changes in height, weight, BMI, fine and gross motor skills, and upper-limb coordination in the aerobic, resistance, and control groups at six weeks post-intervention and one-year follow-up.

Table 1

Descriptive Variables in Research Groups

Variable	Group	Post-Test Mean ± Std. Deviation	Follow-up Mean ± Std. Deviation
Weight (kg)	Aerobic	30.48 ± 8.42	36.130 ± 8.577
	Resistance	39.19 ± 15.03	46.730 ± 15.273
	Control	36.82 ± 8.56	44.090 ± 8.865
Height (cm)	Aerobic	129.30 ± 14.52	136.45 ± 14.04
	Resistance	141.05 ± 12.86	146.80 ± 11.44
	Control	139.15 ± 9.66	144.80 ± 9.87
BMI (kg/m²)	Aerobic	17.87 ± 2.42	19.27 ± 2.69
	Resistance	19.20 ± 4.93	21.39 ± 5.02
	Control	18.82 ± 2.78	21.08 ± 2.90
Gross Motor Skills	Aerobic	11.40 ± 5.60	7.60 ± 4.69
	Resistance	14.80 ± 3.58	11.80 ± 4.39
	Control	6.60 ± 3.71	7.50 ± 3.89
Fine Motor Skills	Aerobic	11.40 ± 7.45	5.10 ± 7.32
	Resistance	12.60 ± 4.97	9.90 ± 6.29
	Control	5.70 ± 5.45	5.30 ± 4.66
Upper Limb Coordination	Aerobic	2.30 ± 1.70	1.80 ± 2.04
	Resistance	3.30 ± 1.25	1.80 ± 0.63
	Control	1 ± 0.943	1.80 ± 1.03

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Table 2

Results of repeated measures MANOVA for study variables (post-test and follow-up)

Variable	Effect	df	F	p	Partial η²
BMI	Time	1	4.219	0.045	0.072
	Group	2	1.249	0.295	0.044
	Group × Time	2	0.077	0.926	0.003
Fine Motor Skills	Time	1	3.924	0.053	0.068
	Group	2	4.407	0.017	0.140
	Group × Time	2	1.178	0.316	0.042
Gross Motor Skills	Time	1	3.039	0.078	0.053
	Group	2	10.390	0.000	0.278
	Group × Time	2	1.656	0.200	0.058
Upper Limb Coordination	Time	1	1.309	0.258	0.024
	Group	2	3.627	0.033	0.118
	Group × Time	2	3.627	0.033	0.118

The results of the repeated measures multivariate analysis of variance (MANOVA) showed that during the one-year follow-up, body mass index (BMI) increased in all groups: in the aerobic group from 17.87 ± 2.42 to 19.27 ± 2.69, in the resistance group from 19.20 ± 4.93 to 21.39 ± 5.02, and in the control group from 18.82 ± 2.78 to 21.08 ± 2.90. The main effect of time for BMI was significant ($F = 4.219$, $p = .045$, $\eta^2 = 0.072$), while the effects of group ($p = .295$) and group × time interaction ($p = .926$) were not significant (Figure 1).

In the domain of motor performance, the results indicated that for fine motor skills, the mean in the aerobic group decreased from 11.40 ± 7.45 to 5.10 ± 7.32, in the resistance group from 12.60 ± 4.97 to 9.90 ± 6.29, and in the control group from 5.70 ± 5.45 to 5.30 ± 4.66. The main effect of group was significant ($F = 4.407$, $p = .017$, $\eta^2 = 0.140$), and the effect of time approached significance ($F = 3.924$, $p = .053$, $\eta^2 = 0.068$), while the group × time interaction was not significant ($p = .316$) (Figure 2).

For gross motor skills, the mean in the aerobic group changed from 11.40 ± 5.60 to 7.60 ± 4.69, in the resistance group from 14.80 ± 3.58 to 11.80 ± 4.39, and in the control group from 6.60 ± 3.71 to 7.50 ± 3.89. The main effect of group was significant ($F = 10.390$, $p < .001$, $\eta^2 = 0.278$); however, the effects of time ($p = .078$) and group × time interaction ($p = .200$) were not significant (Figure 3).

Finally, for upper-limb coordination, the mean in the aerobic group changed from 2.30 ± 1.70 to 1.80 ± 2.04, in the resistance group from 3.30 ± 1.25 to 1.80 ± 0.63, and in the control group from 1 ± 0.943 to 1.80 ± 1.03. These results showed that the main effect of group ($F = 3.627$, $p = .033$, $\eta^2 = 0.118$) and the group × time interaction ($F = 3.627$, $p = .033$, $\eta^2 = 0.118$) were significant, but the main effect of time alone was not ($p = .258$) (Figure 4).

Figure 1

Changes in BMI for Boys with Down Syndrome

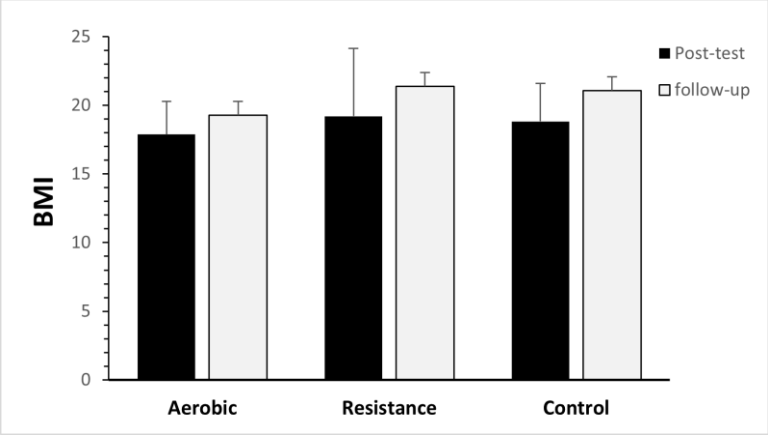

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Figure 2

Changes in Fine Motor Skills for Boys with Down Syndrome

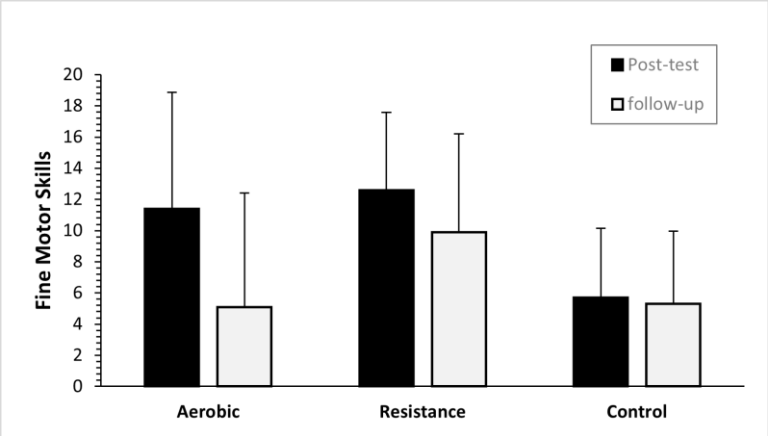


Figure 3

Changes in Gross Motor Skills for Boys with Down Syndrome

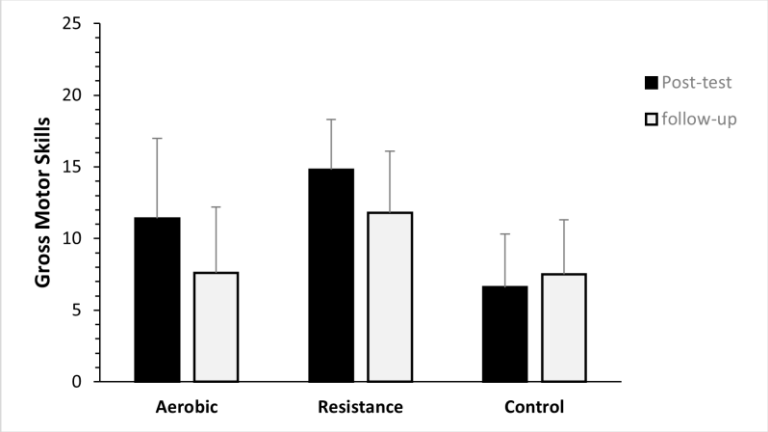
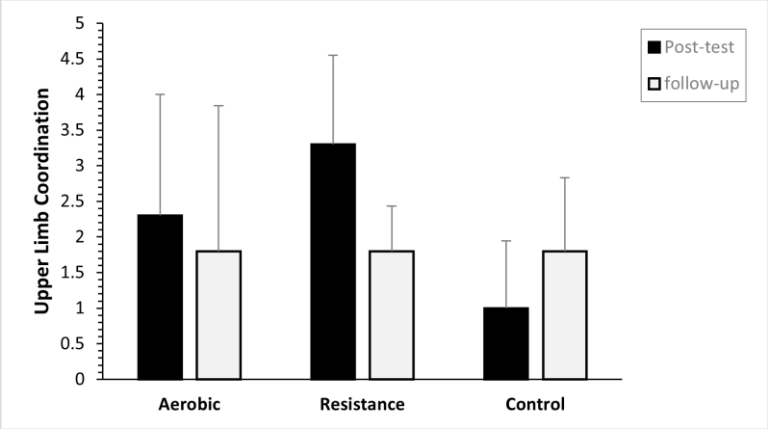


Figure 4

Changes in Upper Limb Coordination for Boys with Down Syndrome



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4. Discussion and Conclusion

The purpose of this study was to examine the long-term sustainability of improvements in body mass index (BMI) and perceptual–motor performance in boys with Down syndrome following a six-week program of aerobic and resistance training, evaluated after one year of detraining. The results demonstrated a significant increase in BMI across all groups over the follow-up period, alongside a decline in gross and fine motor skills and upper-limb coordination. These findings indicate that the positive adaptations gained from a short-term exercise intervention are not fully maintained in the absence of continued structured activity, aligning with the broader concept of detraining as described in sports science (Bosquet & Mujika, 2012). Importantly, the resistance training group showed a relatively smaller decline in motor performance compared to the aerobic group, suggesting that neuromuscular adaptations may be more resilient than cardiorespiratory gains, although they too diminished over time.

The increase in BMI observed in the aerobic, resistance, and control groups after one year of inactivity highlights the metabolic vulnerability of children with Down syndrome. Several factors likely contributed to this weight gain, including reduced energy expenditure, hypotonia, and lower baseline physical activity levels (Molinari et al., 2024; Moreau et al., 2021). Similar trends have been reported in longitudinal studies, where children with Down syndrome showed a tendency toward increased adiposity when physical activity was not maintained (Aslam et al., 2022; Esparza Ocampo et al., 2025). Even individuals who initially achieved healthy BMI values remained at higher cardiometabolic risk compared to typically developing peers (Esparza Ocampo et al., 2025), emphasizing the need for ongoing activity to maintain metabolic health. The present findings reinforce the conclusion that short-term interventions, while beneficial in the immediate term, cannot substitute for long-term exercise habits in controlling body composition (Boer, 2018).

With regard to motor performance, the observed decline in gross and fine motor skills after detraining is consistent with previous evidence demonstrating the rapid reversibility of neuromotor adaptations in children with intellectual disabilities (Bosquet & Mujika, 2012; Kyriakidou et al., 2024). Studies on swimming performance and overall movement competence in individuals with intellectual disability have shown that even brief training breaks can lead to decreased coordination, reduced strength, and poorer performance outcomes (Koolwijk et al., 2024; Kyriakidou et al., 2024). The motor skill regression seen in the present study may be related to both physiological and behavioral factors. Physiologically, reductions in neural drive, muscle mass, and movement efficiency occur when activity ceases (Iglesias-Díaz et al., 2025; Montalva-Valenzuela et al., 2025). Behaviorally, children with Down syndrome often face barriers to independent physical activity, such as limited opportunities for inclusive play and reduced parental confidence in managing exercise safely (Melo et al., 2022; Robinson et al., 2024).

Interestingly, the resistance training group experienced a smaller but still notable decline in perceptual–motor skills compared to the aerobic group. This pattern aligns with reports that strength training induces structural and neural adaptations that may persist longer than those achieved through aerobic training alone (Iglesias-Díaz et al., 2025; Post et al., 2022). Resistance training promotes improvements in muscular strength, joint stability, and postural control, which are essential for maintaining motor function (Melo et al., 2022; Zolghadr et al., 2025). Additionally, resistance exercise has been shown to reduce hypotonia and enhance proprioceptive feedback, potentially sustaining motor performance for longer periods (Lei et al., 2025). However, the continued decline despite these benefits confirms that even strength-induced adaptations require ongoing stimulus to be preserved (Boer, 2018; Bosquet & Mujika, 2012).

The partial maintenance of motor competence in the resistance group also has implications for educational and therapeutic programming. Strength-based activities might be easier to integrate into daily routines and school-based interventions than continuous aerobic sessions, especially for children with lower endurance (Melo et al., 2022). Strength-oriented play, functional tasks, and adapted physical education may help delay detraining effects (Iglesias-Díaz et al., 2025; Zolghadr et al., 2025). Nonetheless, our findings suggest that no single modality alone can fully prevent regression; instead, sustained multimodal programs seem necessary (Mendonca et al., 2011; Montalva-Valenzuela et al., 2025).

Ethical and safety considerations are critical when designing such interventions. Exercise prescriptions for children with Down syndrome must be individualized, ensuring safety while targeting key motor deficits (Melo et al., 2022; Silva et al., 2012). The present study adhered to the Declaration of Helsinki, reflecting the need for robust

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ethical frameworks in research involving vulnerable populations (Ashcroft, 2008). Previous studies have emphasized that caregivers and educators are more likely to support long-term programs when safety and adaptability are clearly demonstrated (Robinson et al., 2024; Zolghadr et al., 2025). These factors become particularly important when planning sustainable activity beyond the structured research setting, where professional supervision may be limited.

Moreover, the findings highlight the educational role of schools in sustaining motor competence and preventing obesity among children with Down syndrome. Schools provide a consistent environment for adapted physical education and inclusive play opportunities (Koolwijk et al., 2024). Integrating resistance and aerobic elements into the curriculum may help maintain physical gains acquired through initial training (Montalva-Valenzuela et al., 2025; Torabi & Khodarahmi, 2025). Teachers and therapists can also use regular fitness assessments to identify early signs of detraining, allowing for timely intervention. In this context, collaboration between families, educators, and healthcare providers is essential to ensure continuity of physical activity (Iglesias-Díaz et al., 2025; Melo et al., 2022).

From a metabolic health perspective, our findings strengthen the evidence that BMI control requires long-term strategies rather than isolated interventions (Aslam et al., 2022; Moreau et al., 2021). The increase in BMI across all groups suggests that even short-term exercise may not offset the combined effects of genetic predisposition, reduced basal metabolism, and sedentary behavior (Esparza Ocampo et al., 2025; Molinari et al., 2024). Interventions should therefore include structured activity beyond the initial period and incorporate nutritional education, behavioral strategies, and family involvement to support sustained weight management (Melo et al., 2022).

Another important aspect is the psychological and motivational dimension. Children with Down syndrome often benefit from social support and structured routines to maintain engagement in physical activity (Robinson et al., 2024). When structured programs end, motivation may decline, and families may lack the knowledge or resources to maintain activity levels (Melo et al., 2022). Evidence suggests that supervised and enjoyable activities, including play-based resistance and rhythmic aerobic exercise, can improve adherence and reduce attrition (Iglesias-Díaz et al., 2025; Silva et al., 2012). Future approaches might incorporate digital tools or home-based adaptations to support long-term activity engagement (Montalva-Valenzuela et al., 2025).

Collectively, these findings underscore that detraining effects in children with Down syndrome are significant, impacting both weight status and motor competence. While resistance training appears somewhat more protective, it is insufficient by itself to preserve the functional and metabolic benefits gained from short-term exercise. Our data support the call for continuous, varied, and well-structured physical activity programs, implemented in safe and ethically guided ways, to support the long-term health and functional independence of this population (Montalva-Valenzuela et al., 2025; Zolghadr et al., 2025).

This study, while adding important insights into detraining in children with Down syndrome, has several limitations. First, the sample size was relatively small, limiting statistical power and the generalizability of findings. Larger, multi-center trials would allow for more robust subgroup analyses, including the effects of age, baseline motor competence, and comorbidities. Second, physical activity outside the intervention and follow-up period was not strictly monitored. Unstructured or sporadic activity could have influenced the rate of regression, particularly in the resistance group. Third, although BMI is widely used to track body composition, it may not accurately reflect fat distribution or lean mass changes; future studies should include more precise measurements such as dual-energy X-ray absorptiometry or bioelectrical impedance. Additionally, psychosocial and environmental factors, including family support and access to physical activity resources, were not systematically assessed but likely contributed to long-term outcomes.

Future research should examine strategies to minimize detraining by exploring the optimal duration, intensity, and frequency of follow-up or maintenance exercise programs in children with Down syndrome. Studies comparing fully combined aerobic–resistance protocols with sequential or hybrid formats could provide deeper insight into sustaining adaptations. Longitudinal studies with extended follow-ups beyond one year would clarify the trajectory of decline and help determine the critical time windows for booster interventions. Investigating individualized exercise prescriptions based on baseline motor competence, fitness level, and metabolic status may also enhance personalization and long-term adherence. Additionally, research should consider integrating technological support, such as wearable activity trackers and interactive home-based training platforms, to help families sustain activity without direct professional supervision.

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Practitioners designing physical activity programs for children with Down syndrome should consider long-term sustainability from the outset. Initial structured training should transition into maintenance phases that include periodic follow-up sessions, parental guidance, and school-based support to prevent rapid regression. Incorporating resistance training as a core element may help prolong neuromuscular adaptations, while maintaining some aerobic stimulus is necessary to support cardiovascular and metabolic health. Educational settings should be leveraged to provide regular adapted physical education and monitor fitness progression. Collaboration between pediatric therapists, teachers, and caregivers is critical to embed movement into daily routines and make physical activity safe, enjoyable, and consistent beyond short-term interventions.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. The study was approved by the university ethics committee (IR.PNU.REC.1402.238).

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