Physical fitness detraining due to summer vacation: PROFIT-BR Program

Desentrenamiento de la condición física por vacaciones de verano: Programa PROFIT-BR

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Abstract

Objective: To examine the effect of detraining during the summer vacation period following a physical education-based program (PROFIT-BR) on physical fitness in children of different ages through a longitudinal design.
Methods: One hundred children aged 6–9 years (n = 50) and 10–11 years (n = 50) participated. The PROFIT-BR program was implemented during physical education classes for 19 weeks. Detraining was assessed after a 12-week summer vacation. Body mass index, waist-to-height ratio, cardiorespiratory fitness, abdominal strength, upper and lower limb power, agility, speed, and flexibility were evaluated. Generalized estimating equations examined time × age interactions.
Results: Children aged 6–9 years improved cardiorespiratory fitness and agility during training but showed a decline in cardiorespiratory fitness after detraining. Children aged 10–11 years improved agility during training but showed declines after detraining. Regardless of age, abdominal strength and upper and lower limb power improved during the training period.
Conclusion: The findings suggest that detraining effects varied according to age group and physical fitness component following a school-based intervention.

Keywords

Physical education; school; physical fitness; professional practice; exercise training; children.

Resumen

Objetivo: Examinar el efecto del desentrenamiento, posterior a un programa de educación física de base escolar (PROFIT-BR), sobre la condición física en niños de diferentes edades mediante un diseño longitudinal.
Métodos: Participaron cien niños de entre 6–9 años (n = 50) y 10–11 años (n = 50). El programa PROFIT-BR se implementó durante las clases de educación física a lo largo de 19 semanas. El desentrenamiento se evaluó tras un periodo de 12 semanas de vacaciones de verano. Se evaluaron el índice de masa corporal, la razón cintura-estatura, la condición cardiorrespiratoria, la fuerza abdominal, la potencia de extremidades superiores e inferiores, la agilidad, la velocidad y la flexibilidad. Se utilizaron ecuaciones de estimación generalizadas para examinar las interacciones tiempo × edad.
Resultados: Los niños de 6–9 años mejoraron la condición cardiorrespiratoria y la agilidad durante el entrenamiento, pero mostraron una disminución en la condición cardiorrespiratoria tras el desentrenamiento. Los niños de 10–11 años mejoraron la agilidad durante el entrenamiento, pero evidenciaron disminuciones después del desentrenamiento. Independientemente de la edad, la fuerza abdominal y la potencia de las extremidades superiores e inferiores mejoraron durante el periodo de entrenamiento.
Conclusión: Los hallazgos sugieren que los efectos del desentrenamiento variaron según el grupo etario y el componente de la condición física tras una intervención escolar.

Palabras clave

Educación física, instituciones académicas, condición física, práctica profesional, ejercicio físico, niño.

Introduction

Physical Education (PE) is a mandatory curricular component of basic education in Brazil (Brasil, 1996), referenced in the National Common Curricular Base (Brasil, 2017). In classes, physical practices should be approached as a dynamic cultural phenomenon, developing autonomy for the appropriation and use of the physical culture of movement for various human purposes, favoring their participation in society in a confident and authorial way (Brasil, 1996, 2017). The Physical Activity Guide for the Brazilian Population highlights that PE should be offered, per week, in at least three classes of 50 minutes each. Classes should include content that enables positive experiences and innovative approaches that keep students physically active and participating in most of the class (Silva et al., 2021).

However, keeping students physically active through PE is hampered by some limitations. Examples of these limitations include the large volume of content to be delivered during the academic year, the limited curricular time designated for the PE subject (on average, in Brazil, less than two hours per week), and extended school vacations (Vian et al., 2019). Although long-term programs seem to be the best way to improve children's physical fitness (García-Hermoso et al., 2020; Villa-Gonzalez et al., 2017), other studies have shown that short-term programs applied twice a week can also improve physical fitness (Faigenbaum et al., 2014; Islas Guerra et al., 2025; Pedretti et al., 2021; Reis et al., 2024).

Another important consideration in PE-based interventions is that, unlike adults (Stratton & Oliver, 2013), evaluating performance changes in children after periods of reduced or withdrawn training is complicated by biological maturation, which progresses concurrently. This factor can obscure the interpretation of detraining effects, as some components of fitness may be better maintained than others (Stricker et al., 2020). In the Brazilian context, this challenge is accentuated by the approximately eight-week summer vacation, a period in which school-based physical activity (PA) ceases completely and sedentary behavior tends to increase.

Previous studies have explored the consequences of detraining in youth populations. Ingle et al. (2006) subjected boys aged approximately 12 years to a strength and plyometric training program for 12 weeks, followed by a 12-week detraining period. After detraining, the observed effects on strength, power, and speed were lost. Faigenbaum et al. (2013) examined the effects of detraining on the physical performance of seven-year-old children after eight weeks of training. After eight weeks of detraining, different strength, power, and balance losses were observed. Children aged eight to 12 years in the study by Qi et al. (2019) performed a strength and plyometric training program twice a week for 12 weeks. After 12 weeks of detraining/reduction, the authors observed a marked loss in the components of physical fitness in the group that ceased training and the maintenance of only one component (lower limb power) in the group that had reduced training (Qi et al., 2019). These findings reflect broader evidence on how structured physical education interventions influence fitness adaptation and regression patterns in schoolchildren (Ortiz-Sánchez et al., 2023).

One potential pedagogical strategy to optimize PE time is circuit training (Pedretti et al., 2024), which allows efficient management of limited class periods while maintaining an adequate training volume. This approach can improve students' physical fitness levels and help teachers simultaneously achieve broader curricular goals. Such evidence-based strategies can guide teachers in designing feasible and effective programs that enhance and sustain students' physical fitness without compromising other educational objectives (Yu & Nurzhan, 2026).

Despite these advances, few studies have examined the impact of summer vacation–induced detraining and how it differentially affects children's physical fitness across age groups. This issue is particularly relevant in countries such as Brazil, where the long school break represents a natural and unavoidable interruption in structured physical activity. Understanding these seasonal effects is crucial, as school-aged children are expected to develop lifelong physical activity habits, and maintaining fitness gains over vacation periods remains a major challenge. Therefore, this study aimed to examine the effects of detraining during the summer vacation period following a physical education–based program on the physical fitness of children of different ages through a longitudinal design.

Method

This longitudinal study adopted a quantitative approach and was developed within the context of school-based PE classes. The study comprised two consecutive phases: an intervention period (PROFIT-BR) (Pedretti et al., 2024) and a detraining period corresponding to the summer vacation.

During the intervention phase, children participated in the PROFIT-BR program, which was implemented during regular PE classes over 19 consecutive weeks, with two sessions per week lasting 60 minutes each. Each class included approximately 15 minutes of PROFIT-BR activities, consisting of circuit-based exercises aimed at improving cardiorespiratory fitness, strength, agility, and coordination, followed by 40 minutes of regular PE content conducted by the classroom teacher. All sessions were supervised by PE teachers previously trained in the PROFIT-BR methodology to ensure consistency in the delivery of the program. Although standard school summer vacation in Brazil lasts approximately eight weeks, the interval between post-intervention (T2) and post-detraining (T3) assessments was 12 weeks. This extended timeline accounts for the 8-week vacation period plus a 4-week post-return logistical period dedicated to re-contacting parents, obtaining renewed consent/notifications, and scheduling standardized testing sessions. This phase represented a natural interruption in organized exercise.

The project that gave rise to this study was registered (CAAE: 2221918.8.0000.5347) and approved by the Research Ethics Committee of the Federal University of Rio Grande do Sul, Brazil, under opinion 3460288. All children and their legal representatives completed written assent and consent forms, respectively.

Participants

Initially, 300 children enrolled across both the morning and afternoon shifts in the school were identified as eligible. To meet logistical feasibility for intervention delivery, only students enrolled in the morning shift (n = 133) were invited to participate in the PROFIT-BR program. All 133 morning-shift children and their guardians accepted (100% initial consent). During the study, nine children dropped out due to school relocation. Additionally, 24 children were excluded from the analysis (22 due to <75% attendance during the 19-week intervention, and two due to absence during follow-up testing). Thus, the final analyzed sample consisted of 100 participants (53.7% girls) divided into two age strata: 6–9 years (n = 50) and 10–11 years (n = 50). Descriptive characteristics of the participants during the study stages are presented in Table 1.

An a priori sample size calculation was performed for a longitudinal design with one intervention group assessed at three time points (T1, T2, T3), considering the main effect of time and its interaction with age group (6–9 years vs. 10–11 years) to be tested using Generalized Estimating Equations (GEE). The calculation assumed a significance level of $\alpha = 0.05$, statistical power $(1-\beta) = 0.80$, within-subject correlation r = 0.50, and nonsphericity correction $\varepsilon = 1$. A moderate effect size (Cohen's d ≈ 0.50; equivalent to f = 0.25, $\eta p^2 \approx 0.06$) was adopted based on previous studies examining similar outcomes in school-based interventions (Reis et al. 2024). Under these assumptions, a minimum of approximately 30–40 participants per group was required to detect a moderate effect.

To account for potential attrition and low attendance (~20–25%), a total sample of at least 50 children per age group was targeted. The final analyzed sample included 100 participants (n = 50 aged 6–9 years; n = 50 aged 10–11 years), providing sufficient power (>0.80) to detect moderate effects and interactions between time and age group.

Procedure

The PROESP-Br guidelines (Gaya et al., 2021) for assessment of fitness tests were used. These guidelines advise participants to wear light clothing and appropriate footwear for sports practice whenever possible (except for anthropometry, where it takes place barefoot). Congruent with the PROESP-Br guidelines, one evaluator performed a joint warm-up before each assessment section (there are prescribed warm-up activities within the PROESP-Br guidelines). Assessments were conducted with a maximum of 20 participants per section and used this sequence to carry out the assessments: day 1) body mass measurements (weight); stature (height); waist circumference, and the sit and reach test; 2) Abdominal strength test and Cardio-respiratory 6-min run test; 3) horizontal jump and 20-m speed test; and 4) medicine ball throw and agility test.

Body mass index (kg/m^2)

For the measurement of body mass, we used a portable scale with an accuracy of up to 500 grams. During the assessment, the children remained standing. For height, a measuring tape with a precision of up to 2 mm was used (considering that it normally measures 150 centimeters in length). It was attached to the wall, 100 centimeters from the ground, extending from bottom to top (in this case, the evaluator added 100 centimeters to the result measured by the measuring tape). Body mass index (BMI) was calculated as weight (kg) divided by height (m^2).

Waist circumference

Waist circumference was measured twice, with the participant in a relaxed, upright position, using a flexible, inelastic Sanny® Brasil tape measure with a 1-mm accuracy. The measurement point followed the PROESP-BR protocol, aligned with the World Health Organization guidelines (WHO, 2008), and was demarcated midway between the lower border of the last rib and the upper border of the iliac crest. The tape was positioned horizontally over this point, and the reading, taken at the end of a normal exhalation without skin compression, was recorded in centimeters to one decimal place (cm).

Cardio-respiratory 6-min run test

For cardiorespiratory fitness, we used the 6-minute walk/Running test, which showed good validity criteria (Bergmann et al., 2014). The children were instructed that they should run as long as possible, avoiding speed spikes interspersed with long walks. During the test, the student was informed of the passage of time every 2, 4, and 5 minutes, and a signal indicated the end of the test. The child remained in the place where they finished until the distance covered was recorded to the nearest whole meter. The measure is recorded in meters.

Flexibility

Flexibility was assessed using the sit-and-reach test. The test was conducted without the use of the Wells bench; a measuring tape was extended and fixed to the ground. At the 38 cm mark, another adhesive tape with 30 cm was fixed perpendicular to the first tape. The participants, sitting barefoot and with extended legs, should position their heels on the 38 cm mark, leaving 30 cm between them. Afterwards, with knees extended and hands overlapped, they should slowly lean forward and try to reach as far as possible over the tape (Moreira et al., 2009). In both tests, the evaluation was recorded in centimeters with one decimal place, considering the highest mark in two attempts.

Abdominal strength test

For abdominal strength assessment, we used the Sit-Ups for 1 minute, a test that can assess localized muscle resistance of the core. There is also some evidence that the test can be used to screen lower back pain in Brazilian adolescents (Dorneles et al., 2016). The child was in a supine position, with knees bent at 45º and arms crossed over the chest. The evaluator, with his hands, held the child's ankles, fixing them to the ground. At the signal, the child started the trunk flexion movements until touching the elbows with the thighs, returning to the initial position. The child performed the most complete repetitions in 1 minute.

Horizontal jump test

We used the Horizontal Jump Test, which has good criterion validity (Mello et al., 2016). The child stands behind landmark 0, with feet parallel, slightly apart, knees semi-flexed, and trunk slightly forward. At the signal, the child jumps as far as possible, landing with both feet simultaneously. The jump distance was recorded from landmark 0 to the nearest heel. Two attempts were made, with the best result recorded in centimeters.

Medicine ball throw test

For upper muscle power assessment, we used the 2kg Medicine Ball Throw Test. This test proved to be valid for screening low bone density in Brazilian children (Mello et al., 2022). The child sits with knees extended, legs together and back fully supported by the wall. The child holds the medicine ball to their chest with elbows bent. At the evaluator's signal, the student throws the ball as far as possible, keeping their back against the wall. The pitch distance is recorded from point zero to the place where the ball first touched the ground. Two shots are taken, registering the best result for evaluation purposes, recorded in centimeters.

20-m sprint speed test

For speed assessment, we used the 20-meters sprint test, as prior research identified this test as valid for screening low bone density in Brazilian children (Mello et al., 2022). The researcher demarcates a 20-meter runway with three parallel lines on the ground as follows: the first (start line), the second, 20m away from the first (timeline) and the third line, marked by two meters from the second (finish line) to serve as a finishing reference for the student in an attempt to avoid deceleration before crossing the timeline. The appraiser must start the stopwatch when the participant takes the first step and touches the ground for the first time, and the stopwatch will be stopped when the participant crosses the second line (timeline). The 20 m sprint speed is recorded in seconds to two decimal places.

Agility test

For agility assessment, we used the 4-m square test, a field-based test with good criterion validity (Oliveira, 2017). The researcher demarcates, with cones, a square with four meters on a side. At the evaluator's signal, the participant should move at full speed and touch the cone located in the diagonal corner of the square with one hand. Next, they run to touch the cone to their left (or right) and then move to touch the cone diagonally. Finally, they run towards the last cone, which corresponds to the starting point (total distance 19.31 m). Two attempts were made: the shortest time being registered for evaluation purposes. The measurement of agility speed was recorded in seconds (two places after the decimal point).

Maturity Offset

Initially, the height value was subtracted from the sitting height, obtaining the leg length value. Maturity offset (MO), defined as the time before/after Peak Height Velocity (PHV), was calculated using the predictive equations established by Mirwald et al. (2002). For girls, MO = −9.376 + 0.0001882·Leg Length and Sitting Height interaction + 0.0022·Age and Leg Length interaction + 0.005841·Age and Sitting Height interaction − 0.002658·Age and Weight interaction + 0.07693·Weight by Height ratio, where R = 0.94, R2 = 0.890, and SEE = 0.569. As detailed in Table 1, all participants maintained negative maturity offset values across all evaluation periods, confirming the strictly prepubertal status of the sample.

Physical Activity

The PA level of the schoolchildren was measured using an Actigraph accelerometer (wGT3X-BT), which was placed on the hip, and they were encouraged to wear it for seven consecutive full days. Directed the children to wear the accelerometer on the right hip, secured by an elastic band, during their waking hours, except for aquatic activities such as showering or swimming. Participants who did not provide valid data were requested to wear the accelerometers for another period. Use for five days (including at least one weekend day), with at least 10 hours/day of wear time, was considered acceptable for analysis purposes. To classify physical activity, we used a counts calculation proposed by Evenson et al. (2008) for periods of 15 seconds: ≤ 25 counts/15 seconds for sedentary time; < 573 counts/15 seconds for light physical activity; ≥ 574 counts/15 seconds for moderate physical activity and ≥ 1003 counts/15 seconds for vigorous physical activity. Physical activity levels (MVPA) were objectively monitored via accelerometry across all three study time points (T1, T2, and T3) to account for extracurricular physical activity behaviors during both the school term and the vacation detraining period.

Intervention period

The physical education session plan and intervention schedule are available in Pedretti et al. (2024). Briefly, the program was planned and conducted by a group of trained researchers who were qualified physical education teachers. Sessions were applied twice a week during physical education lessons, lasting 60 minutes each throughout the school year (19 weeks).

The physical education sessions were organized into 5 stages (with PROFIT-BR being the main differential): 10 min of commuting to the sport court and warm-up; 15 min of circuit training (PROFIT-BR); 10 min of gymnastics components and rhythmic activities; 15 min of motor skills and pre-sports games; and 5 min of rest activities and feedback. The warm-up consisted of aerobic recreational activities. The circuit was performed twice, with each participant staying at each station for one minute, with an interval of 30 s between them.

For progression, the load and complexity of the exercises were changed according to age group. Before the intervention, the cardiorespiratory fitness test was performed, and, according to the observed performance, the participants were divided into four groups with similar conditioning characteristics to compose the stations. During classes, the participants should reach at least 75% of their maximum heart rate (indicating moderate-to-vigorous intensity), which was controlled via one participant from each group wearing a portable heart rate monitor (Polar Team2 Pro, Polar, Finland). Participants were assigned to groups of approximately five people with similar performance in the cardiorespiratory fitness test, and each week, a different participant would use the heart rate monitor. Part of the components of gymnastics and rhythmic activities were carried out for the development of motor skills. The exercises consisted of throws, jumps, kicks, etc. Finally, the pre-sports games consisted of handball, volleyball, frisbee, and wrestling, among others.

Data analysis

Data were expressed as means (M) and standard deviations (SD). The analysis was performed using Generalized Estimating Equations (GEE) to examine the effects of the PROFIT-BR intervention on children's physical fitness across three time points – pre-training (T1), post-training (T2), and post-detraining (T3) – and to test the potential interaction between time and age group (6–9 years vs. 10–11 years). A robust covariance matrix estimator and an unstructured working correlation matrix were employed to account for intra-subject dependencies. Different distribution families (Gaussian, Gamma, and Logit) were tested, and the optimal model specification was selected based on the lowest Quasi-Likelihood under the Independence Model Criterion (QIC). The identity link function was used for continuous variables. When significant main or interaction effects were detected, Bonferroni-adjusted pairwise comparisons were conducted to identify specific differences between time points or age groups. Effect sizes (Cohen's d) were calculated and interpreted as small (0.20–0.30), moderate (0.40–0.70), and large (≥ 0.80), following Cohen (1988). Somatic maturation (PHV) and extracurricular physical activity levels were included in the analytical framework to control for growth-, maturation-, and behavioral-driven influences on physical fitness performance over time. All analyses were performed using SPSS software (version 27.0; IBM Corp., Armonk, NY, USA), with the significance level set at $\alpha < 0.05$.

Results

Among children aged 6–9 years, MVPA decreased significantly over time. On weekdays, no significant change was observed from baseline to post-intervention (70.0 vs. 50.9 min/day; $p = 0.084$), but MVPA dropped markedly after detraining (50.9 vs. 25.7 min/day; $p = 0.003$), resulting in a significant overall reduction from baseline to post-detraining. On weekends, values also declined from 55.0 to 39.0 and 28.0 min/day, with a significant difference only between baseline and detraining ($p = 0.004$). Among children aged 10–11 years, MVPA followed a similar pattern but with a smaller magnitude (table 1).

Weekday MVPA decreased from 81.3 to 67.6 min/day ($p = 0.355$) and further to 53.4 min/day after detraining ($p = 0.447$), with no significant difference between time points. On weekends, MVPA dropped from 68.0 to 47.0 and 33.0 min/day, without reaching statistical significance (all $p > 0.05$). These results indicate a significant decline in MVPA after detraining younger children, while older children showed a trend toward reduction without statistical significance.

Table 1. Characterization of participants.

	Pre	Post	Detraining	Pre	Post	Detraining
		6-9 years			10-11 years	
	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	
Age (years)	7.61 (±1.06)	7.83 (±0.91)	8.05 (±0.90)	10.13 (±0.34)	10.52 (±0.51)	10.65 (±0.63)
Weight (kg)	30.33 (±8.96)	32.00 (±9,65)	32.78 (±10,30)	42.94 (±8,70)	43.72 (±10,15)	46.67 (±11,49)
Height (cm)	130.80 (±8.66)	132.83 (±8.69)	134.72 (±9.25)	145.16 (±7.22)	148.40 (±6.81)	149.43 (±6.86)
WC (cm)	60.25 (±9.55)	59.88 (±8.67)	60.85 (±10.59)	69.73 (±7.79)	65.28 (±8.72)	66.88 (±9.17)
PHV (years)	-4.72 (±0.85)	-4.48 (±0.72)	-4.28 (±0.73)	-2.90 (±0.79)	-2.48 (±0.86)	-2.22 (±0.94)
PA weekdays	70 (±6.2)	50.90 (±5.9)	25.70 (±11.8)	81.3 (±17.6)	67.6 (±5.2)	53.4 (±5.2)
PA weekends	55 (±5.8)	39 (±5.1)	28 (±7.9)	68 (±6.5)	47 (±5.9)	33 (±7.5)

Data presented as Mean (±Standard Deviation). SD = standard deviation; KG = kilograms; CM = centimeters; WC = waist circumference; PHV = peak height velocity; PA = physical activity; MVPA = moderate-to-vigorous physical activity.

Source: Own elaboration.

Tables 2 and 3 present the results of children`s physical fitness performance across three assessment periods (pre-training, post-training, and detraining) according to age groups (6-9 years and 10-11 years). Generalized Estimation Equations (GEE) analysis showed a significant interaction effect between periods and age groups in BMI (Wald (2) = 8.887, p = 0.012), waist height ratio (Wald (2) = 7.604, p = 0.022), cardiorespiratory fitness (Wald (2) = 10.962, p = 0.004), agility (Wald (2) = 22.974, p < 0.001), and velocity (Wald (2) = 22.284, p < 0.001).

Table 2. Physical fitness, delta, effect size and significance level at baseline. post-intervention and detraining of children aged 6 to 9 years.

	Pre (T0)	Post (T1)	Detraining (T2)		T0 vs. T1			T0 vs. T2			T1 vs. T2	
	Mean (±SD)	Mean (±SD)	Mean (±SD)	delta	effect	p value	delta	effect	p value	delta	effect	p value
BMI	18.18 (±0.46)	18.72 (±0.49)	18.52 (±0.51)	0.54	0.15	0.03	0.34	0.09	0.35	-0.20	0.05	0.78
WHtR	0.46 (±0.01)	0.46 (±0.01)	0.46 (±0.01)	0	0.00	0.19	0	0.00	1	0	<0.01	1
CRF	672.47 (±20.64)	744.28 (±17.77)	681.19 (±22.26)	71.81	0.51	<0.01	8.72	0.06	1	-63.09	0.49	0.01
FLEX	35.95 (±1.06)	36.71 (±1.16)	38.66 (±1.27)	0.76	0.09	0.88	2.71	0.36	0.03	1.95	0.27	0.23
AS	22.39 (±1.28)	26.58 (±1.21)	26.35 (±1.35)	4.19	0.42	<0.01	3.96	0.39	0.01	-0.23	0.02	1
ULP	159.55 (±6.36)	184.01 (±5.72)	181.09 (±6.35)	24.46	0.62	0.01	21.54	0.53	0.02	-2.92	0.08	1
LLP	108.09 (±3.19)	119.55 (±3.11)	119.44 (±3.95)	11.46	0.56	<0.01	11.35	0.51	0.01	-0.11	0.01	1
AGI	7.51 (±0.12)	7.11 (±0.12)	6.83 (±0.14)	-0.4	0.50	<0.01	-0.68	0.87	<0.01	-0.28	0.37	0.04
VEL	4.80 (±0.09)	4.59 (±0.16)	4.34 (±0.16)	-0.21	0.32	0.64	-0.46	0.76	0.01	-0.25	0.34	0.06

Data presented as Mean (±Standard Deviation). BMI = body mass index; WHtR = waist-to-height ratio; CRF = cardiorespiratory fitness; FLEX = flexibility; AS = abdominal strength; ULP = upper limb power; LLP = lower limb power; AGI = agility; VEL = 20-m sprint speed; T0 = baseline (pre-intervention); T1 = post-intervention (19 weeks); T2 = post-detraining (12 weeks summer vacation); delta = absolute mean change; effect = Cohen's d effect size. Bonferroni-adjusted p-values are presented for pairwise comparisons.
Source: Own elaboration.

The Bonferroni test showed that children at 6-9 years significantly gained in BMI (p = 0.03), increased in cardiorespiratory fitness (p ≤ 0.01), and enhanced agility performance (p ≤ 0.01) from pre to post training. No effect was observed in the WHtR across periods (p values between 0.19 and 1.00). No difference in BMI was observed from post to detraining periods (p = 0.78). Further, these children significantly decreased cardiorespiratory fitness and significant improvement in execution time for agility performance from the post to the detraining period (p = 0.01 and p = 0.04, respectively). The Bonferroni test also showed that children at 10-11 years significantly gain BMI only from post to detraining periods (p = 0.01). No effect was observed in cardiorespiratory fitness and velocity across periods (p values between 0.50 and 1.00). Further, concerning agility performance, a significant improvement in execution time from pre to post (p ≤ 0.01) and decline in agility performance from post to detraining (p ≤ 0.01) were observed in this children's age group.

Table 3. Physical fitness, delta, effect size, and significance level at baseline, post-intervention, and detraining of 10 and 11-year-old children.

	Pre (T0)	Post (T1)	Detraining (T2)		T0 vs. T1			T0 vs. T2			T1 vs. T2	
	Mean (±SD)	Mean (±SD)	Mean (±SD)	delta	effect	p value	delta	effect	p value	delta	effect	p value
BMI	18.05 (0.46)	18.24 (±0.56)	18.93 (±0.60)	0.19	0.05	1	0.88	0.22	0.05	0.69	0.17	0.01
WHtR	0.47 (0.01)	0.43 (±0.01)	0.44 (±0.01)	-0.04	0.73	<0.01	-0.03	0.55	<0.01	0.01	0.18	1
CRF	768.61 (31.44)	747.88 (±27.02)	727.12 (±26.78)	-20.73	0.16	1	-41.49	0.31	0.51	-20.76	0.15	1
FLEX	31.78 (1.96)	35.49 (±1.31)	38.79 (±1.75)	3.71	0.32	0.05	7.01	0.58	<0.01	3.3	0.28	0.03
AS	23.26 (2.73)	28.60 (±2.17)	28.26 (±1.94)	5.34	0.48	0.03	5	0.42	0.15	-0.34	0.03	1
ULP	228.61 (9.18)	230.57 (±9.95)	236.80 (±12.62)	1.96	0.05	1	8.19	0.18	1	6.23	0.13	1
LLP	101.86 (6.56)	113.16 (±3.73)	113.15 (±4.06)	11.3	0.55	0.23	11.29	0.48	0.12	-0.01	<0.01	1
AGI	7.82 (0.17)	6.74 (±0.09)	7.16 (±0.13)	-1.08	2.36	<0.01	-0.66	1.14	<0.01	0.42	0.73	<0.01
VEL	4.80 (0.22)	4.46 (±0.20)	4.77 (±0.21)	-0.34	0.72	0.50	-0.03	0.06	1	0.31	0.63	<0.01

Data presented as Mean (±Standard Deviation). BMI = body mass index; WHtR = waist-to-height ratio; CRF = cardiorespiratory fitness; FLEX = flexibility; AS = abdominal strength; ULP = upper limb power; LLP = lower limb power; AGI = agility; VEL = 20-m sprint speed; T0 = baseline (pre-intervention); T1 = post-intervention (19 weeks); T2 = post-detraining (12 weeks summer vacation); delta = absolute mean change; effect = Cohen's d effect size. Bonferroni-adjusted p-values are presented for pairwise comparisons.
Source: Own elaboration.

Significant period effects were observed in the flexibility (Wald (2) = 28.808, p < 0.001), abdominal strength (Wald (2) = 17.613, p < 0.001), upper limb power (Wald (2) = 9.375, p = 0.009), and lower limb power (Wald (2) = 15.805, p < 0.001). The Bonferroni test showed significant improvement in flexibility across three periods (from pre to post: p = 0.027; from post to detraining: p < 0.001; from pre to detraining: p = 0.006). Observed significant increase in abdominal strength, upper limb, and lower limb power performance from pre to post training (p < 0.001, p = 0.021, and p < 0.001, respectively) but not from post to detraining (p values = 1.00).

Discussion

The objective of this study was to investigate the effect of detraining during the summer vacation period following a physical education-based program (PROFIT-BR) on the physical fitness of children of different ages through a longitudinal design. The main findings demonstrated that children aged 6–9 years showed a statistically significant increase in BMI, as well as improvements in cardiorespiratory fitness and enhanced agility performance after training. However, during detraining, cardiorespiratory fitness significantly decreased, while agility was maintained. In contrast, children aged 10–11 years showed significant improvements in execution time for agility after training, followed by a decline during detraining, although overall maintenance was observed from pre- to post-detraining assessments.

The key observation in this study is that the effects of detraining after a medium-term integrative neuromuscular training intervention delivered during PE classes vary according to age group, reflecting distinct adaptation and regression patterns. This finding aligns with the scoping review by Dambel et al. (2025), which synthesized evidence on the impact of lifestyle disruptions—including lockdowns, school holidays, and training interruptions—on children's and adolescents' physical fitness. Their results indicated that such disruptions exert a substantial influence on youth physical fitness, with varying but consistently negative effects across age groups.

Studies with similar designs further support our results. Qi et al. (2019) found a marked decline in physical fitness components after 12 weeks of detraining in children aged 8–12 years, with maintenance observed only for lower-limb power in those who continued reduced training. Likewise, Ingle et al. (2006) reported that 12 weeks of detraining eliminated previously gained improvements in strength, power, and speed among boys aged 11–12 years. Faigenbaum et al. (2013) observed reductions in strength, power, and balance in 7-year-old children after eight weeks of detraining. Conversely, Mayorga-Vega et al. (2013) documented significant gains in abdominal strength and cardiovascular endurance after a four-week detraining phase followed by four weeks of maintenance in children aged 10–12 years.

Few authors (Duncan et al., 2018; Faigenbaum et al., 2015) have explicitly based their school-based interventions on the theoretical framework of integrative neuromuscular training. The results of the present study compare favorably with these investigations, all of which reported significant improvements in multiple physical fitness components—particularly strength, power, and endurance—following 8-week programs conducted within PE settings. However, methodological differences hinder direct comparison, including variations in participant age, detraining duration, and training modality.

In a study with Brazilian schoolchildren aged 12–17 years, Vieira et al. (2022) evaluated physical fitness before and after an 8-week vacation period without intervention. Their findings revealed significant increases in BMI, waist circumference, and flexibility, but no meaningful changes in cardiorespiratory fitness or muscular strength/endurance. Taken together, current evidence remains inconsistent regarding the impact of school vacations on children's physical fitness (Mellado-Rubio et al., 2023). Two practical implications arise from this variability: 1. the importance of high-quality physical education that promotes active engagement and educates students on maintaining activity during vacations; and 2. the need for regular physical fitness assessments to guide PE teaching practices, motivate students, and foster autonomy and self-efficacy toward lifelong physical activity.

It is noteworthy that PROFIT-BR was implemented among children from first to fifth grade, covering all early elementary school years. This demonstrates the pedagogical applicability and developmental relevance of the program, as it effectively improved multiple components of fitness across children aged 6–11 years, a period marked by heterogeneous growth and motor development. Another strength of the present study was the control for somatic maturation, a factor well known to influence motor performance (Stratton & Oliver, 2013), as well as the consideration of extracurricular physical activity, which allowed us to account for habitual behavioral changes during the vacation break that could have affected physical fitness outcomes.

As previously described, PROFIT-BR incorporates multiple fitness components—dynamic stability, strength, plyometrics, coordination, speed, agility, and fatigue resistance (Fort-Vanmeerhaeghe et al., 2016)—making it challenging to isolate the contribution of each component to the overall improvements observed. Additionally, while sex differences were not a focus here, previous evidence (Faigenbaum et al., 2014) suggests that younger girls may be more responsive to integrative training stimuli than boys. Furthermore, reviews such as Dudley et al. (2022) have highlighted both the benefits and challenges of implementing structured pedagogical models in PE, including issues related to fidelity, time constraints, and teacher preparedness. These reviews also emphasize critical research gaps, such as the underrepresentation of girls, children with low fitness levels, those with special educational needs, and the long-term sustainability of intervention effects.

Regarding the applied evidence, some methodological limitations should be acknowledged when interpreting these findings. First, the non-randomized longitudinal design without a parallel control group precludes definitive causal assertions regarding the exclusive effects of the PROFIT-BR program compared to regular physical education or natural maturation. Second, physical activity outside of school was measured via accelerometry, but overall seasonal routines during vacation were not objectively monitored, which may have influenced detraining outcomes. Third, although the PROESP-BR battery provides valid and reliable field-based measurements, laboratory-based physiological assessments could provide deeper mechanistic insights. Finally, the follow-up period was limited to a single 12-week detraining phase; longer tracking is needed to establish the long-term retention of physical fitness adaptations.

Conclusions

In conclusion, the findings suggest that a medium-term integrative training program implemented within regular PE classes (PROFIT-BR) was associated with improvements in multiple components of physical fitness in prepubertal children, with partial retention of gains—particularly in agility—even after vacation detraining.

From a practical perspective, these findings reinforce the value of structured, evidence-based PE programs that transcend traditional models. PE teachers should consider incorporating integrative training elements—such as coordination, strength, and agility exercises—into weekly lesson plans to optimize physical development. Schools and policymakers should recognize the pivotal role of quality physical education in promoting not only health and fitness but also the holistic development of children. Investment in teacher training, curriculum innovation, and consistent program implementation, as exemplified by PROFIT-BR, is essential to ensure sustainable benefits. Finally, future studies should explore how such programs can be adapted and scaled to meet the diverse needs of different student populations.

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