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Effects of a CrossFit Training Program on Body Composition and Physical Fitness in Novice and Advanced Practitioners: An Inter-Individual Analysis

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Abstract: Background: CrossFit® has become a popular and effective training methodology. This study aimed to compare the effects of a four-week CrossFit training program and analyze the inter-individual variability on body composition (fat mass and fat-free mass) and physical fitness (push-ups, military press, back squat, deadlift, countermovement jump (CMJ), sit-ups, and 30 m sprint speed) in novice and advanced practitioners. **Methods:** A quasi-experimental design was used, with single-blinded (evaluators) and 2 parallel groups: novices (n = 10; age = 22.30 ± 0.81) and advanced practitioners (n = 11; age = 22.80 ± 1.41). The intervention consisted of 3 weekly 75 min sessions (4 weeks), with pre- and post-assessments. A two-factor mixed ANOVA and inter-individual analyses to classify responders (Rs) and non-responders (NRs) were performed. **Results:** No significant interaction effects were found. However, the novice group significantly improved back squat performance ($p = 0.031$). Inter-individual analysis showed higher proportions of Rs in the novice group for back squat (40%), deadlift (20%), military press (10%), CMJ (10%), sit-ups (30%), push-ups (30%), and 30 m sprint speed (10%) compared to the advanced group. **Conclusions:** CrossFit program did not significantly affect body composition, but novices exhibited significant back squat improvements. Considering experience levels can enhance training outcomes.

Keywords: anthropometry; high-intensity interval training; hypertrophy; muscle strength; sports

1. Introduction

Modern lifestyles, which are characterized by increased reliance on technology and enhanced comfort, have significantly reduced physical activity levels, with participation rates falling below 50% [1]. Additionally, poor dietary habits and the rise in sedentary behaviors affect a substantial proportion of the population, with approximately 50% of individuals engaging in minimal physical activity, further amplifying health risks [1]. According to the World Health Organization (WHO) [2], approximately 1 in 4 adults and over 80% of adolescents fail to meet the physical activity guidelines necessary for maintaining optimal health. This lack of activity has been strongly associated with increased morbidity and mortality from non-communicable diseases. The WHO recommends that adults engage in muscle-strengthening exercises at least twice per week to mitigate these risks [2]. Resistance training, in particular, is recognized as a highly effective strategy for improving both physiological and physical health across all age groups [3]. Emerging evidence supports its efficacy, demonstrating substantial gains in muscle mass and strength [4,5].

In recent years, high-intensity interval training (HIIT) has gained prominence due to its adaptability to diverse individual characteristics and fitness levels [6]. Among HIIT methodologies, CrossFit® has emerged as a popular and effective training approach, as highlighted by Gianzina and Kassotaki [7] and Meyer et al. [8]. CrossFit emphasizes general physical fitness by optimizing multiple fitness dimensions, including cardiorespiratory fitness, muscle strength, power, flexibility, speed, agility, and balance [7]. The workouts integrate elements from gymnastics, Olympic weightlifting, endurance exercises, resistance training, and other athletic disciplines [8,9]. The defining characteristic of CrossFit is its focus on high-intensity functional movements, often structured as the “workout of the day” (WOD), which involves rapid, repetitive execution with minimal rest periods [7,10]. The methodology used by CrossFit optimizes exercise efficiency, generating significant physiological adaptations and improving overall physical performance [11–13]. A systematic review has demonstrated the effectiveness of CrossFit on increasing maximal oxygen consumption (VO_2max), improving muscle mass and strength, and enhancing cardiorespiratory fitness [13]. In addition, scientific evidence indicates that CrossFit significantly increases fat-free mass [9]. When appropriately tailored to individual needs, CrossFit can serve as an effective exercise strategy for healthy adults [8,10].

Among training methodologies for improving muscle strength and overall physical fitness, CrossFit is distinctive for avoiding a linear programming structure, instead prioritizing constant variation in stimuli through WODs [10,14]. This variability promotes simultaneous and comprehensive improvements in fitness domains. WODs are highly diverse, targeting cardiorespiratory fitness, muscle strength, or a combination of both, with durations that fluctuate significantly [13]. Research on training and performance processes has explored the impacts of these variations on physical adaptation and performance outcomes. For example, a six-month intervention comparing novice and advanced CrossFit practitioners showed significant improvements in both groups. Females exhibited gains in flexibility, power, muscular endurance (push-ups), and muscle strength (back squat, bench press, and deadlift). Notably, the novice group exhibited greater improvements in running speed (1.5-mile run) [15]. Similarly, another study comparing novice and advanced practitioners with physically active individuals found that the advanced CrossFit group exhibited a lower body fat percentage, greater fat-free mass, higher quadriceps isometric strength, and superior VO_2max and cycling performance [16].

Despite these promising findings, studies documenting the outcomes of different CrossFit protocols often lack specificity in describing training adaptations at varying levels of experience and do not account for individual variability [10,17]. This highlights the need for further exploration of responders (Rs) and non-responders (NRs) to training programs across diverse populations, including athletes, physically active individuals, and clinical patients [17,18]. Consequently, it can be hypothesized that the proportion of Rs and NRs to training programs will differ across diverse populations, with athletes exhibiting a higher Rs rate compared to physically active individuals and clinical patients.

Therefore, this study aimed to examine the effects of a four-week CrossFit training program on body composition (fat mass and fat-free mass) and physical fitness outcomes including push-ups, military press, back squat, deadlift, countermovement jump (CMJ), sit-ups, and 30 m sprint speed in novice and advanced practitioners. Additionally, the study sought to analyze inter-individual variability in training outcomes. Based on prior evidence [8,13], we hypothesized that the CrossFit training program would: (i) Lead to significant improvements in body composition, maximal muscle strength, CMJ, sit-ups, and 30 m sprint speed in both novice and advanced practitioners; and (ii) Elicit a greater proportion of responders among novice practitioners compared to advanced practitioners.

2. Materials and Methods

2.1. Study Design

This study employed a quasi-experimental design with pre- and post-intervention assessments, adopting a single-blinded approach for evaluators and utilizing two parallel groups. The methodology adhered to the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines [19]. The intervention lasted four weeks, with a total of 12 sessions conducted 3 times per week (Monday, Wednesday, and Friday), each session lasting 75 min. Participants were stratified into 2 groups based on their CrossFit experience: (i) Novice group (n = 10; 3 males, 7 females; mean age = 22.30 $\pm$ 0.81 years), comprising individuals with 6–11 months of CrossFit experience; and (ii) Advanced group (n = 11; 7 males, 4 females; mean age = 22.80 $\pm$ 1.41 years), comprising individuals with $\geq$12 months of CrossFit experience.

We used an experimental design based on a previous study [10]. The intervention focused on assessing fat mass, fat-free mass, and performance metrics, including push-ups, military press, back squat, deadlift, CMJ, sit-ups, and 30 m sprint speed. Participants began the intervention following a one-week rest period from their routine training, which typically involved 3 to 5 sessions per week with durations ranging from 60 to 75 min per session.

2.2. Participants

The study initially included 21 CrossFit practitioners in two groups: Novice group (n = 10; 3 males, 7 females; mean age = 22.3 $\pm$ 0.81 years; height = 1.65 $\pm$ 0.07 m; body weight = 66.64 $\pm$ 10.47 kg), comprising individuals with 6 to 11 months of CrossFit experience and (ii) Advanced group (n = 11; 7 males, 4 females; mean age = 22.8 ± 1.41 years; bipedal height = 1.69 ± 0.06 m; body weight = 69.51 ± 5.43 kg) comprising individuals with 12 or more months of CrossFit experience. A power analysis determined that a sample size of 10 participants per group would provide adequate statistical power. Using the G*Power software (version 3.1.9.6, Franz Faul, Universität Kiel, Kiel, Germany), the calculation was based on a moderate effect size (d = 0.50), a significance level of $\alpha = 0.05$, and a power of 80% ($\beta = 0.80$), with an expected attrition rate of 20% [20,21].

2.2.1. Inclusion Criteria

Participants were required to meet the following inclusion criteria: Age ≥ 18 years, a minimum of six months of CrossFit experience, and active enrollment as university students.

2.2.2. Exclusion Criteria

Exclusion criteria included the presence of musculoskeletal injuries within the past three months, the use of dietary supplements (e.g., creatine, amino acids, protein shakes, pre-workout supplements), and failure to attend at least 85% of the intervention sessions.

The selection process is outlined in Figure 1, which presents the participant recruitment and allocation flowchart.

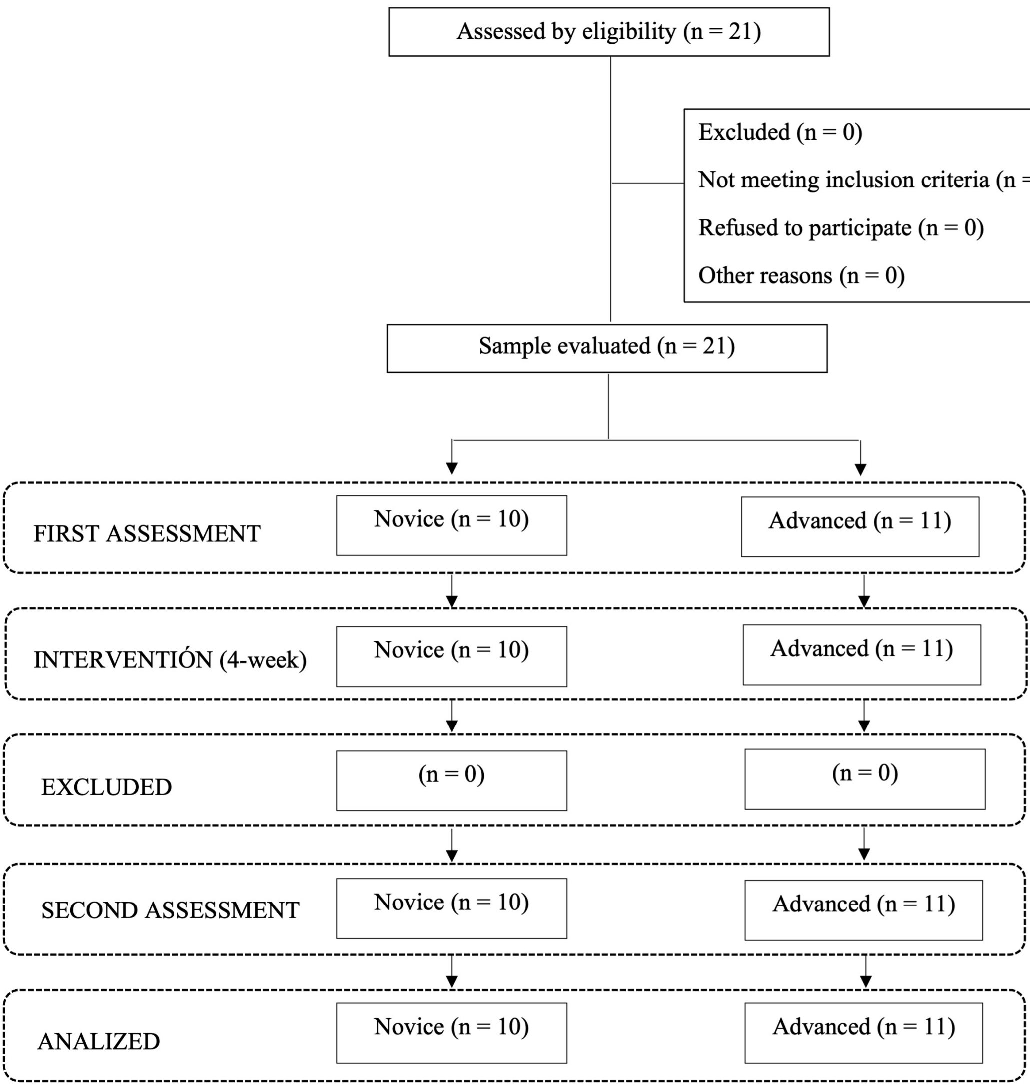

Figure 1. Flowchart of the process followed in the study.

All participants were informed about the study's scope and provided written informed consent, granting permission for their data to be used for scientific purposes. The research protocol was reviewed and approved by the Scientific Ethical Committee of the Universidad Autónoma de Chile (Approval No. 126-18) and adhered to the principles outlined in the Declaration of Helsinki.

2.3. Body Composition

Body composition assessments followed the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK), conducted by a Level II anthropometrist with a technical error of measurement of 0.8% across all variables [22].

Measurements Included

Body weight: Assessed using an electronic scale (Scale-Tronix, USA; accuracy: 0.1 kg).

Bipedal height: Measured with a stadiometer (Seca 220, Germany; accuracy: 0.1 cm).

Skinfolds: Measured using a caliper (Harpenden, England; accuracy: 0.2 mm).

Body perimeters: Measured with a tape measure (Seca 201, Germany; accuracy: 0.1 cm).

Body diameters: Measured with anthropometers (Rosscraft, Canada; accuracy: 0.1 mm).

Body mass index (BMI) was calculated by dividing body weight by the square of bipedal height (kg/m^2). Fat mass and fat-free mass were estimated using the pentacompartmental fractionation technique proposed by Ross and Kerr [23], with measurements taken pre- and post-intervention under identical conditions [22].

2.4. Maximal Strength

Maximal strength was assessed using the one-repetition maximum (1RM) test. Participants underwent an adaptation period designed to ensure proper execution of the exercises, focusing on technical proficiency [24]. The exercises assessed included the military press (upper limbs), back squat (45°), and deadlift (lower limbs).

The testing procedure involved the following steps: (i) Warm-up set: Perform one set of five high-speed repetitions using an Olympic bar (20 kg), followed by a 20 s rest; (ii) Progressive load sets: Perform three sets of five repetitions, gradually increasing the load, with a 2 min rest between sets, and (iii) 1RM testing: Perform single repetitions at a controlled speed, with a rest period of 3–5 min between attempts, until the participant reached their maximum lift (1RM).

The assessments were conducted over two sessions. In the first session, the military press and back squat were tested, and after a 48 h interval, the deadlift was assessed. This methodology ensured a systematic and individualized approach to accurately measure maximal strength.

2.5. Countermovement Jump (CMJ)

The CMJ was assessed using a force platform (Art Oficio, PF-4000/50; Chile). Each participant performed three jumps, adhering to the following protocol:

Starting position: Participants stood with their feet parallel and hands placed on their waist.

Jump execution: After a quick flexion of the knees and hips, participants performed a powerful leg extension to generate a maximum vertical jump [25].

Data recording: The maximum jump height from the best attempt was recorded for analysis.

To ensure optimal performance and recovery, participants rested for 2 min between each repetition.

2.6. Sit-Ups Test

The sit-ups test was conducted as follows:

Starting position: Participants lay in a supine position with their legs flexed at a 90° angle, feet secured by external support, and arms crossed over their chest.

Execution: (i) Correct trunk flexion was defined as the hands sliding along the thighs until they touched the knees; and (ii) a full repetition required the participant to return to lower their back to the ground.

Outcome measure: The number of repetitions completed in either 30 s or 1 min, based on the participant's physical fitness level, was recorded [26].

2.7. Push-Ups Test

The push-ups test protocol involved the following steps:

Starting position: Participants assumed a prone position with their arms flexed so that their hands rested on the ground beneath their shoulders, fingers facing forward. Feet were positioned either: (i) on the ground or (ii) on a platform 30–35 cm high.

Execution: (i) A push-up was considered complete when the participant fully extended their arms while maintaining body alignment, and (ii) During flexion, the elbow joint formed a 90° angle.

Outcome measure: The total number of push-ups completed within 30 s was recorded [26].

2.8. 30-Meter Sprint Speed Test

The 30 m sprint speed test assessed participants' reaction speed and acceleration on a flat, smooth surface with clearly marked start and finish lines [26]. The procedure was as follows:

Starting position: Participants began at the starting line in a stationary stance.

Signal: On the evaluator's cue ("ready, go"), participants initiated the sprint.

Measurement: The elapsed time from the start signal to crossing the finish line was recorded using a chronometer.

This test provided an objective measure of sprint performance, reflecting participants' speed and acceleration capacity.

2.9. Intervention

The intervention process began with an initial session, during which participants were: (i) interviewed to gather baseline information, (ii) informed about the scope and objectives of the study, and (iii) provided written informed consent form to authorize their participation and the use of their data for research purposes.

In the second session, participants received detailed instructions on the correct execution of the exercises included in the intervention program. This ensured standardized performance across all participants, minimizing technical variability and reducing the risk of injury.

2.10. Intervention Design

The intervention sessions were standardized, with a total duration of 75 min distributed as follows:

2.10.1. Warm-Up (15 Minutes)

The warm-up phase consisted of activation exercises targeting large muscle groups, as well as cardiovascular activities and isometric exercises, designed to prepare participants for the central workout part.

2.10.2. Central Part (45 Minutes)

Primary Block (20 Minutes)

Focused on high-energy expenditure using the following basic exercises:

Military press: Participants performed elbow and shoulder flexion-extension while maintaining a straight trunk, using an Olympic bar.

Back squat: Participants executed knee flexion to at least 45°, keeping their trunk straight, feet and knees parallel, and completed with full knee extension.

Deadlift: Participants engaged in hip flexion-extension with slight knee flexion, maintaining a straight trunk, and using an Olympic bar.

Secondary Block (20 Minutes)

Composed of complementary or accessory exercises aimed at reinforcing the primary muscle groups worked in the main block. Examples include lunges and jump squats to support lower body muscles related to squats.

Workout of the Day (WOD) (15 Minutes)

Circuit training incorporating exercises from weightlifting, cardiovascular activities, and jumps, emphasizing functional fitness and high intensity.

2.10.3. Cool-Down (5 Minutes)

Participants performed static flexibility exercises to promote recovery and reduce muscle soreness.

2.10.4. Training Program Progression

All participants followed an equivalent CrossFit training program, ensuring consistency in volume, intensity, density, and total rest time.

The program involved 4 sets of 10 repetitions, with progressive weekly increases in load percentage and decreases in repetitions (10, 8, 6, and 4).

Load percentages started at 65–70% of 1RM and progressed to 80–85%, tailored to each participant's baseline assessment results.

A comprehensive summary of the intervention design and progression is provided in Table 1.

2.11. Statistical Analysis

Data analysis was conducted using SPSS (version 26) for Mac (SPSS Institute, Chicago, IL, USA). Results are expressed as mean ± standard deviation (SD). Homoscedasticity of variance and normality were assessed using Levene's test and the Shapiro–Wilk test, respectively. Potential sex-related biases were evaluated using an unpaired *t*-test. A repeated-measures mixed ANOVA was employed to analyze the interaction between group (inter-subject factor: novice vs. advanced group) and time (intra-subject factor: pre- and post-intervention). When significant main effects or interactions were identified, the Bonferroni post hoc test was applied to correct for multiple comparisons between group means.

Effect sizes (ES) for ANOVA outcomes were calculated using partial eta squared (η^2p). Additionally, post-intervention changes within and between groups were assessed using Cohen's d, with interpretation based on Rhea's classification for recreationally trained participants (individuals training consistently for 1–5 years): trivial (<0.25), small (0.25–0.50), moderate (0.50–1.0), and large (>1.0) [27].

Table 1. Assessments and progression for intervention.

Pre-Test	INTERVENTION				Post-Test
	Week 1 **65% to 70%**	**Week 2** **70% to 75%**	**Week 3** **75% to 80%**	**Week 4** **80% to 85%**	
Session 1 Body composition Sit-ups	**Session 1** 1°LBP/2°UBP Warm-up Block 1° 4 × 10 Deadlift Block 2° 4 × 10 DLKB one leg, Half kneeling press WOD	**Session 1** 1°LBP/2°UBP Warm-up Block 1° 4 × 8 Deadlift Block 2° 4 × 8 DBRDL, Seated press WOD	**Session 1** 1°LBP/2°UBP Warm-up Block 1° 4 × 6 Deadlift Block 2° 4 × 6 Dual DBDL, Half kneeling press WOD	**Session 1** 1°LBP/2°UBP Warm-up Block 1° 4 × 4 Deadlift Block 2° 4 × 6 DLKB one leg, half kneeling WOD	**Session 1** Body composition Sit-ups
Session 2 1RM Back squat Deadlift Military press CMJ	**Session 2** 1°UBP/2°LBP Warm-up Block 1° 4 × 10 Military press Block 2° 4 × 10 Handstand Push-up RDL WOD	**Session 2** 1°UBP/2°LBP Warm-up Block 1° 4 × 8 Military press Block 2° 4 × 8 Jerk supported DBDL WOD	**Session 2** 1°UBP/2°LBP Warm-up Block 1° 4 × 6 Military press Block 2° 4 × 6 Strict handstand push-ups, barbell good morning	**Session 2** 1°UBP/2°LBP Warm-up Block 1° 4 × 4 Military press Block 2°4 × 10 Push press DBDL WOD	**Session 2** 1RM Back squat Deadlift Military press CMJ
Session 3 30 m sprint speed Push-ups	**Session 3** 1°LBP/2°UBL Warm-up Block 1°4 × 10 Back squat Block 2° 4 × 12 Reverse lunge seated band row WOD	**Session 3** 1°LBP/2°UBL Warm-up Block 1° 4 × 8 Back squat Block 2° 4 × 8 Step up, box jump, Barbell row WOD	**Session 3** 1°LBP/2°UBL Warm-up Block 1° 4 × 6 Back squat Block 2° 4 × 6 Dual DB lunge, Sumo DL High pull WOD	**Session 3** 1°LBP/2°UBL Warm-up Block 1° 4 × 4 Back squat Block 2° 4 × 10 Reverse lunge, barbell row WOD	**Session 3** 30 m sprint speed Push-ups

Legends: LBP: Lower body push, UBP: Upper body push, UBL: Upper body pull, DLKB: deadlift kettlebell, DBRDL: dumbbell Rumanian deadlift, DBDL: dumbbell deadlift, DB: dumbbell, DL: deadlift, WOD: Workout of the day.

Participants were further classified as Rs or NRs using the two-technical error (TE) criterion, following a previously established methodology [28]. NRs were defined as individuals who failed to demonstrate a beneficial change in sport-related physical fitness exceeding twice the TE threshold. The TE was calculated using two replicates for all analyzed outcomes. Changes exceeding twice the TE threshold were considered to have a high probability (12:1 odds) of representing true physiological adaptation rather than technical or biological variability [18].

All assessments demonstrated acceptable reliability, with a coefficient of variation (CV) below 5% and intraclass correlation (ICC) values greater than 0.90 [29]. Statistical significance was established at $p < 0.05$.

3. Results

3.1. Morphological Variables

Table 2 presents the analysis of the time × group interaction factor for the morphological variables; body weight ($F_{(1,8)} = 1.302$; $p = 0.2868$), bipedal height ($F_{(1,8)} = 6.714$;

$p > 0.9999$), BMI ($F_{(1,8)} = 1.328$; $p = 0.2824$), fat mass ($F_{(1,8)} = 0.329$; $p = 0.5822$), and fat-free mass ($F_{(1,8)} = 0.819$; $p = 0.3918$). No significant differences are reported for any variable in the time × group interaction.

Table 2. Time by group interaction factor on morphological variables in novice and advanced CrossFit practitioners.

Variables	Novice Group (n = 10)		Advanced Group (n = 11)		Group by Time Interaction
	Pre-Test	Post-Test	Pre-Test	Post-Test	
Body weight (kg) [a]	66.64 ± 10.47	66.19 ± 10.76	69.51 ± 5.43	69.86 ± 6.40	$F_{(1,8)} = 1.302$; $p = 0.2868$
Bipedal height (m)	1.646 ± 0.067	1.646 ± 0.067	1.687 ± 0.056	1.687 ± 0.056	$F_{(1,8)} = 6.714$; $p > 0.9999$
BMI (kg/m^2)	24.46 ± 2.28	24.28 ± 2.37	24.41 ± 1.47	24.52 ± 1.89	$F_{(1,8)} = 1.328$; $p = 0.2824$
Fat mass (%) [b,c]	32.45 ± 4.56	31.20 ± 4.40	27.27 ± 3.76	25.15 ± 3.80	$F_{(1,8)} = 0.329$; $p = 0.5822$
Free-fat mass (%) [d]	40.63 ± 4.04	41.57 ± 3.88	44.05 ± 3.27	46.35 ± 3.24	$F_{(1,8)} = 0.819$; $p = 0.3918$

a: Differences pre-novice vs. pre-advanced; b: Post-advanced vs. pre-novice; c: Post-advanced vs. post novice; d: Post-novice vs. pre-advanced.

3.2. Muscle Strength and Physical Fitness Variables

Table 3 presents the analysis of the time × group interaction factor for maximum muscle strength and physical fitness variables. A significant difference is only evident for the back squat ($F_{(1,8)} = 6.852$; $p = 0.0308$), with results favoring the novice group. In the case of the variables deadlift ($F_{(1,8)} = 6.852$; $p = 0.0690$), military press ($F_{(1,8)} = 4.406$; $p = 0.5424$), CMJ ($F_{(1,8)} = 2.596$; $p = 0.1458$), sit-ups ($F_{(1,8)} = 4.612$; $p = 0.0640$), push-ups ($F_{(1,8)} = 0.760$; $p = 0.4087$), and 30 m sprint speed test ($F_{(1,8)} = 0.001$; $p = 0.9717$), no significant differences are reported.

Table 3. Time by group interaction factor in physical fitness assessments in novice and advanced CrossFit practitioners.

Variables	Novice Group (n = 10)		Advanced Group (n = 11)		Group × Time Interaction
	Pre-Test	Post-Test	Pre-Test	Post-Test	
Back squat (kg) [a,b,c]	61.5 ± 19.2	79.6 ± 27.78	96.73 ± 20.94	98.91 ± 20.79	$F_{(1,8)} = 6.852$; $p = 0.0308$
Deadlift (kg) [b]	76.7 ± 30.4	91.7 ± 30.64	110.3 ± 33.16	111.2 ± 27.52	$F_{(1,8)} = 4.406$; $p = 0.0690$
Military press (kg) [a,c,d]	29.5 ± 11.28	32.1 ± 12.13	41.91 ± 10.22	42.91 ± 9.607	$F_{(1,8)} = 0.405$; $p = 0.5424$
CMJ (cm)	23.9 ± 8.535	25.41 ± 8.161	29.42 ± 6.924	28.69 ± 5.788	$F_{(1,8)} = 2.596$; $p = 0.1458$
Sit-ups (reps) [a,b,c]	28.1 ± 6.74	35.0 ± 4.397	34.82 ± 4.708	36.45 ± 3.83	$F_{(1,8)} = 4.612$; $p = 0.0640$
Push-ups (reps) [c]	17.1 ± 6.839	21.8 ±4.709	23.36 ± 8.453	26.18 ± 6.646	$F_{(1,8)} = 0.760$; $p = 0.4087$
30 m sprint speed (s)	6.152 ± 0.902	5.897 ± 0.928	5.648 ± 0.798	5.404 ± 0.608	$F_{(1,8)} = 0.001$; $p = 0.9717$

Reps: repetitions; a: Differences pre-novice vs. pre-advanced; b: Post-advanced vs. pre-novice; c: Post advanced vs. post-novice; d: Post-novice vs. pre-advanced.

3.3. Inter-Individual Variability (Rs vs. NRs)

Table 4 provides a detailed comparison of performance changes for the novice and advanced groups. It focuses on the mean differences between pre- and post-test scores, along with the percentage of participants who responded positively to the training (responders) and the effect size (Eta squared, η^2) for each variable. The analysis of inter-individual variability of body weight, BMI, fat mass, and fat-free mass, showing Rs only in the advanced group, where there was an Rs for BMI (n = 1; 9%; 0.03), fat mass (n = 1; 9%; 0.19), and fat-free mass (n = 1; 9%; 0.22). The novice group did not present any individual response in the morphological variables. The novice group presented Rs in back squat (n = 4; 40%;

0.51), deadlift (n = 2; 20%; 0.44), military press (n = 1; 10%; 0.09), CMJ (n = 1; 10%; 0.34), sit-ups (n = 3; 30%; 0.47), push-ups (n = 3; 30%; 0.50), and 30 m sprint speed (n = 1; 10%; 0.22). Concerning the advanced group, they only presented Rs in sit-ups (n = 2; 18%: 0.13), push-ups (n = 2; 18%; 0.27), and 30 m sprint speed tests (n = 1; 9%; 0.09). Figure 2 presented the inter-individual variability of physical fitness; the novice group presented Rs in back squat (n = 4; 40%), deadlift (n = 2; 20%), military press (n = 1; 10%), CMJ (n = 1; 10%), sit-ups (n = 3; 30%), push-ups (n = 3; 30%), and 30 m sprint speed (n = 1; 10%). For the advanced group, they only presented Rs in sit-ups (n = 2; 18%), push-ups (n = 2; 18%), and 30 m sprint speed tests (n = 1; 9%).

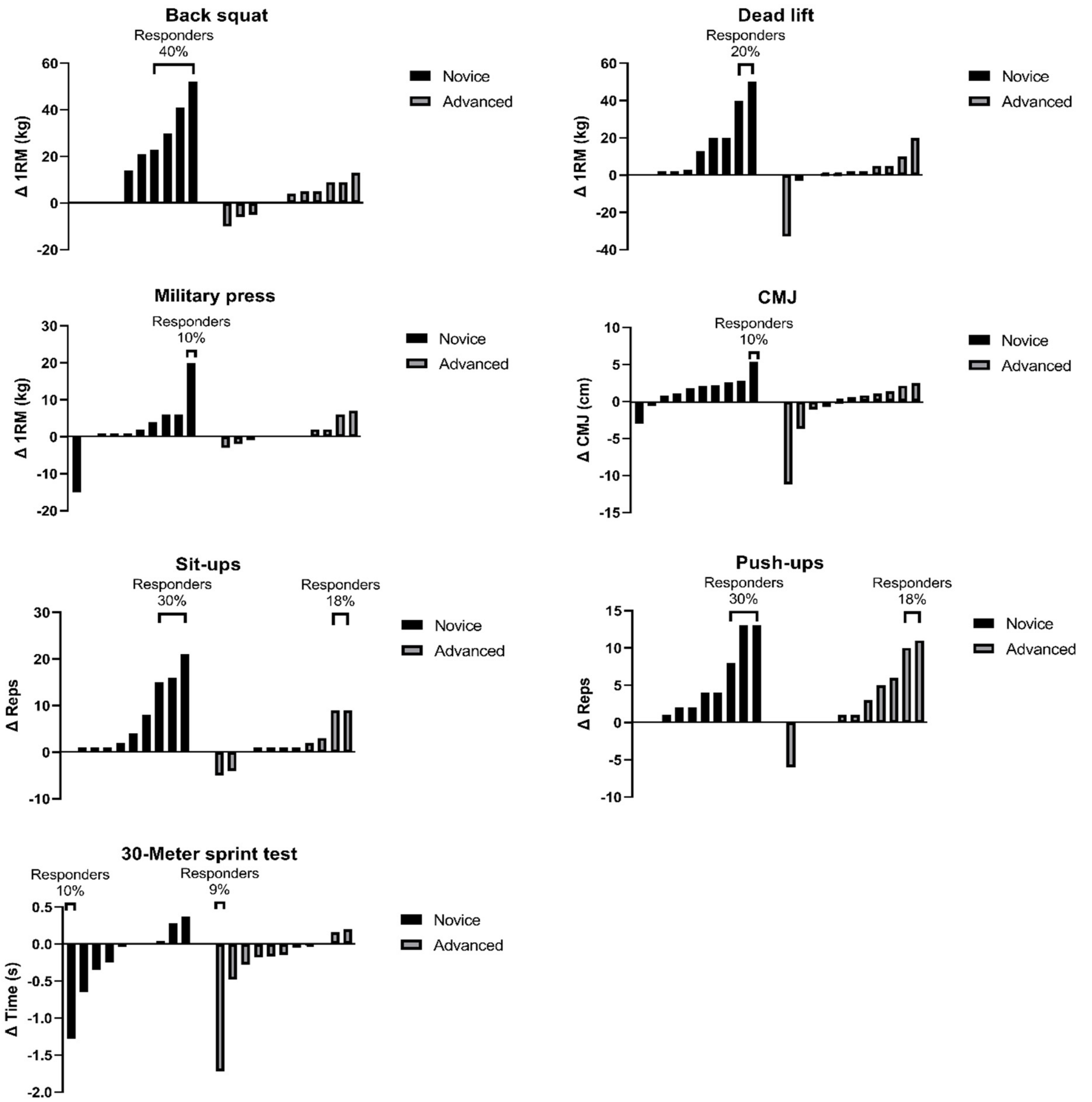

Figure 2. Inter-individual variability in physical fitness in novice and advanced CrossFit practitioners. 1RM: One-repetition maximum; CMJ: Countermovement jump; Reps: Repetitions.

Table 4. Inter-individual variability of morphological variables and physical fitness in novice and advanced CrossFit practitioners.

Variables	Novice Group (n = 10)			Advanced Group (n = 11)		
	Mean Difference (SD)	Responders (%)	Eta^2 Pre vs. Post	Mean Difference (SD)	Responders (%)	Eta^2 Pre vs. Post
Body weight (kg)	−0.45 (1.14)	0 (0)	0.15 ^	0.36 (1.95)	0 (0)	0.04 ^
BMI	−0.18 (0.41)	0 (0)	0.17 ^	0.10 (0.67)	1 (9)	0.03 ^
Fat mass (%)	−1.25 (1.36)	0 (0)	0.49 °	−2.12 (4.58)	1 (9)	0.19 ^
Fat-free mass (%)	0.94 (1.36)	0 (0)	0.35 °	2.31 (4.58)	1 (9)	0.22 ^
Back squat (kg)	18.10 (18.78)	4 (40)	0.51 †	2.18 (7.11)	0 (0)	0.09 ^
Deadlift (kg)	15.00 (17.75)	2 (20)	0.44 °	0.91 (12.84)	0 (0)	0.01 ^
Military press (kg)	2.60 (8.51)	1 (10)	0.09 ^	1.00 (3.10)	0 (0)	0.10 ^
CMJ (cm)	1.51 (2.21)	1 (10)	0.34 °	−0.74 (3.87)	0 (0)	0.04 ^
Sit-ups (rep)	6.90 (7.70)	3 (30)	0.47 °	1.64 (4.37)	2 (18)	0.13 ^
Push-ups (rep)	4.70 (4.97)	3 (30)	0.50 †	2.82 (4.92)	2 (18)	0.27 °
30 m sprint speed (s)	−0.26 (0.51)	1 (10)	0.22 ^	−0.25 (0.53)	1 (9)	0.19 ^

SD = standard deviation; Eta^2: ^ = trivial; ° = small; † = moderate; rep = repetitions.

4. Discussion

This study aimed to compare the effects of a four-week CrossFit training program and analyze inter-individual variability in body composition and physical fitness among novice and advanced practitioners. Regarding body composition, the time × group interaction factor did not reveal significant effects. For physical fitness, the results showed a significant improvement only in back squat performance among novice CrossFit participants. No significant effects were observed in the other performance tests, including deadlift, military press, CMJ, sit-up, and 30 m sprint speed. These findings suggest that the training program had limited overall effects on the measured outcomes, with greater Rs observed in novice practitioners compared to their advanced counterparts. In terms of inter-individual Rs, the novice group demonstrated higher scores, particularly in the back squat, deadlift, military press, sit-ups, push-ups, and 30 m sprint speed assessments compared to the advanced group. Although the study hypothesis was not confirmed, the novice group showed significant improvement in the squat test.

4.1. Morphological Variables

The CrossFit training program did not significantly change body weight, height, BMI, fat mass, and fat-free mass assessments. Similar results were observed in a 4-week CrossFit training program, where a study assessing its effects in young adults reported no significant changes in body weight (p = 0.678) or body fat percentage (p = 0.082) after the intervention [30]. Similarly, another investigation found no significant effects on body weight or BMI after 3 months of CrossFit training in a similar population [31]. In contrast, evidence from other studies indicates that individuals with greater CrossFit experience tend to exhibit higher levels of fat-free mass and, notably, lower body fat percentages compared to those with less experience in this discipline [16,32]. Given the current findings, future studies should focus on long-term interventions, such as increasing the number of training sessions or extending the intervention duration, to achieve more pronounced effects on body composition in adults [11].

4.2. Muscle Strength and Physical Fitness Variables

As mentioned, CrossFit has actions that contemplate muscle strength and power [20]. In this regard, an intervention analyzed the relationship between CrossFit performance in the back squat exercise, primarily during WOD training sessions. It concluded that this exercise has a moderate to strong positive correlation (ranging from r = 0.47 to 0.69) for training performance [20]. Similarly, an experimental study with a 6-month intervention (60 min sessions) obtained a significant increase in back squat exercise performances ($p < 0.001$) [15]. Another 8-week intervention program in healthy adults who had greater CrossFit experience (greater than 12 months) obtained a significant increase in results after the intervention for back squat exercises ($p < 0.001$) [33]. A study that performed an intervention in healthy adults with little experience for less than 6 months in CrossFit, which had a duration of 9 weeks, concluded that muscle strength in the back squat exercise is significantly improved ($p < 0.001$) [12]. On the other hand, in our study, there were no significant changes in deadlift, military press, CMJ, sit-ups, push-ups, or 30 m sprint speed in novice and advanced CrossFitters. A study with similar characteristics over a 4-week period did not obtain significant changes in physical fitness [30]. Nevertheless, the novel response of significant improvements in the back squat from our program supports the importance of this exercise as a key factor for enhancing performance in short-term training cycles. Moreover, the results suggest that these improvements can be optimized by adjusting workloads according to each individual's 1RM in 4-week intervention; this information could be highly valuable for coaches in planning and prescribing training periods in CrossFit [15,20]. The existing literature indicates that novice athletes (those with less experience) tend to show rapid and notable improvements due to their lower baseline physical fitness levels. In contrast, advanced athletes experience more gradual and specific improvements, requiring more precise adjustments in their training to continue progressing [15]. Therefore, these results could be explained by the possibility that the stimulus was insufficient to induce changes in the experienced participants, who had a longer training history. In contrast, the novice group was likely in an initial phase of performance improvement during the training intervention.

4.3. Inter-Individual Variability (Rs vs. NRs)

The inter-individual variability among CrossFit athletes revealed a significant increase in physical fitness assessments after 4 weeks of intervention. Among the main results, the novice group showed improvements in back squat (40%), push-ups (30%), CMJ (10%), and sit-ups (30%). The advanced group reported a small push-up improvement of Rs (18%). The literature on the relationship of Rs and NRs to CrossFit protocols is limited or nearly non-existent. However, studies in other disciplines have reported Rs over similar 4-week periods [17,18]. The results indicate inter-individual Rs in jump performance and sprint speed assessments. These findings are beneficial, indicating that the program produces adaptations leading to overall improvements in CrossFit performance within the specified time frame. As highlighted in the literature, achieving short-term benefits requires careful monitoring and planning tailored for individuals needs [30].

The evidence identifies various factors influencing individual responses to training stimuli, including genetic maturation, sex, age, time-of-day variation, stress, and sleep quality [17]. CrossFit training has been shown to enhance glucose metabolism and improve insulin sensitivity, particularly benefiting novices [6]. Additionally, it stimulates the release of hormones such as testosterone and growth hormone, which may explain the more pronounced responses in novices, as they have had less cumulative exposure to training stimuli compared to advanced individuals [15].

4.4. Limitations and Strengths

The study's limitations include: (i) lack of control over diet and sleep, which could affect body composition and physical fitness; (ii) short intervention duration; (iii) absence of blood tests; (iv) not assessing muscle strength through objective measures such as maximal isometric handgrip strength, which could enhance result consistency; and (v) lack of sample randomization. Key strengths were: (i) a well-planned intervention with load progression tailored to participant characteristics and baseline assessments; (ii) professional supervision during training; and (iii) high adherence, with no dropouts or injuries.

4.5. Practical Implications

This study highlights that novice CrossFit practitioners can achieve significant improvements in back squat strength within 4 weeks. For trainers and coaches, this emphasizes the importance of focusing on foundational strength exercises, such as the back squat, during short-term training cycles for novice athletes. Programs should prioritize progressive overload, starting at 65–70% of 1RM and increasing to 80–85% by week 4. Additionally, trainers should ensure proper exercise execution, load monitoring, and individualized progression to optimize performance gains while minimizing injury risk [10]. For advanced practitioners, where improvements were less pronounced, coaches should incorporate more varied and targeted training stimuli to overcome performance plateaus and elicit further adaptations. These findings can guide the design of evidence-based CrossFit training programs tailored to experience levels, ensuring efficiency and safety in strength development.

5. Conclusions

The four-week CrossFit training program did not produce significant changes in body composition in novice and advanced practitioners, although the novice group showed significant improvement in back squat exercise. While other physical fitness assessments, such as the military press, deadlift, and 30 m sprint speed, showed no significant changes in the novice and advanced groups, the novice group exhibited more Rs than the advanced group. For professionals and practitioners, this study highlights the importance of individualized training, showing that the back squat can effectively and rapidly improve strength in novice CrossFit practitioners. Additionally, it calls for further research on long-term adaptations to enhance training strategies for both novice and advanced athletes.

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