

# Post-Workout: How Extreme Conditioning Programs (ECPs) Improve Strength, Fitness, and Skills in Male Basketball Players

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**Abstract Introduction:** Extreme conditioning is crucial in sports, especially basketball, where strength, speed, and power must be maximized under extreme conditions. **Objective:** This study was carried out to examine how extreme conditioning programs (ECPs) affect body composition, muscular power, footwork, and dribbling skills in basketball players. **Methodology:** A random sample of 30 amateur players was used in the study, whereby 15 players were allotted to the experimental group and 15 players to the control group. The two groups were put through an eight-week experimental process. The second step during the ECP training was the primary phase of the training session among the experimental group. The comparison group used the normal training session that did not encompass ECP training. **Results:** Our results also showed that the control group did not perform as well across all the variables that were observed in the present study; the percentage differences as measured in our study were 5.96 and 20.65. **Conclusion:** The experimental program used gave way to increasing the muscle strength, owing to the intensive training program, which enhanced the footwork and dribbling skills of the participants.

**Keywords** Extreme Conditioning Program, Footwork, Dribbling, BMI

## 1. Introduction

Basketball requires quick, explosive motions involving power, strength, and rapid footwork, all during a game characterized by rapid movements, quick changes of direction, and rapid-fire decision-making. All this requires a high degree of skill, together with an extremely good decision-making process [1]. As a versatile team sport with a wide variety of opportunities to develop and perform various offensive and defensive skills, basketball is in a state of constant progress due to scientific studies and the efforts of specialists across the world to develop skill performances and the methods of the game [2]. The emergence of the sport was not accidental but was the result of conscious actions to improve motor characteristics, to consolidate basic skills, and to use field applications to improve technical and planning abilities. Hence, by using systematic sports training methods, specialists have paid significant attention to enhancing training contexts to improve performance levels in practices and in real games [3]. Perciavalle et al. [4] and Perna et al. [5] noted that, apart from the anatomical and functional principles that theoreticians in sports and exercise sciences have developed, many innovative training methods and practices have been devised by specialists in sport training; the extreme conditioning programs method is one of these modern training methods.

Some examples of extreme conditioning programs (ECPs) that are in use include Insanity, Gym Jones, and P90X, among others. Hazardous exercise movements include ECPs that employ high volume and/or intensity with brief intervals of rest, with extension to multiple joint mobilization [6]. CrossFit and similar extreme conditioning programs are based on different forms of training, including resistance training using kettlebells and barbells, repetitive body weight work in gym, explosive movements, sprints, and stretching [7-9]. Extreme conditioning programs are distinguished by the high training volume, giving a vast number of different exercises executed with high intensities at a certain time for several repetitions or a specific task and/or with some short rests between sets [7, 8]. These exercises are mostly dynamic and choric, depending on their trainer.

ECPs were originally devised as a training regimen to enhance people's fitness and have experienced remarkable expansion from 49 ECPs-affiliate gym centers in 2005 to over 13000 at present [10]. ECPs entail "constantly varied, high intensity, functional movement"; functional movement is defined as compound multi-joint exercise [11]. ECPs are an effective form of exercise that is known for combining movements to help boost overall fitness, particularly cardiorespiratory fitness [12]. According to the existing literature, ECPs training results in increased respiratory muscle strength and vital lung capacity for athletes. ECPs also affect other components of fitness, including final point strength, particularly for the upper limbs, flexibility, and cardiorespiratory fitness, which results in improved cardiovascular and respiratory fitness [13, 14]. ECPs are therefore characterized as a fitness sport that seeks to get better undefined. ECPs entail not only physical transformation, but also collegiate strategy when performing the exercises, and present a solution to the problem of the repetitiveness of exercise for adults and, more specifically, for the youth and for athletes [15]. ECPs are the most comprehensive fitness regimen because they incorporate almost all aspects of fitness training, including jumping, running, weightlifting, cycling, aerobics, cardio, gymnastics, daily gymnastics, and many others. The daily gymnastics plan includes the warm-up session, homework, skill movements, the workout of the day, and the cool down/ stretching session that aims to create, develop, and tone the muscles, to assist in losing weight, and to improve the overall health and physique [16, 17]. ECPs studies have revealed improvements in acoustic body composition, hematologic indices, flexibility, muscle strength, and health-related quality of life, indicating that the ECPs concept is sustainable and engaging for both an increasingly desk-bound population of employees and athletes [18].

The innovation of the present study is that it combines eight weeks of Extreme Conditioning Programs (ECPs) known to help in improving specific performance indicators for basketball players, with a special emphasis to be placed on Body Composition, Muscular Power and

Skills in basketball accuracy. Although ECPs are gaining traction in athletic training, no studies have previously focused on the performance outcome of ECPs specific to skills in competitive basketball. This study addresses this gap by implementing a structured program that combines high-intensity modalities, all tailored to improve neuromuscular power and upper-lower body strength. Therefore, the objective of the study was to identify the effects of an extreme conditioning program training via physical changes in the basketball players, Muscular Power, and improvements in their skills by implementing an eight-week experimental program that included ECPs. This study adds to the insights into how extreme conditioning is being systematically applied to increase basketball performance beyond its overall fitness enhancement.

### 1.1. Literature Review

Extreme conditioning programs (ECPs), including CrossFit, have become more popular in the field of athletic training programs in recent years because of their focus on the high intensity of the functional movements that combine strength, endurance, power, and agility. Firstly, these programs were created to suit military, firefighting, and law enforcement officers [6], but in recent years, they have been used in team sports, such as basketball and soccer, to improve their overall physical and sport-specific performance [19, 20]. The essence of ECPs is that they are able to address several physical fitness elements at one time and work with different, functional exercises under high intensity and frequently in a circuit or time-based way [11].

The article of Li, W. et al. [1] affirmed the conclusion that basketball-specific agility demands complex training interventions that involve both perceptual-cognitive and physical performance, involving the necessity to use sport-specific training protocols rather than generic training. On the same note, Hassan, A. [19] established that training in the CrossFit® program yields great benefits in the form of muscle strength, physiological adaptations, and technical skills like rebounding and footwork in basketball players, implying that it can be used as an assistant tool for developing an athlete. The results of Alsharab, O. et al. [16] on the effects of CrossFit 12 programs demonstrated that the body composition and blood indicators of young soccer players improved significantly, supporting the high-intensity functional training as an efficient training method in team sports. As Cui, L. [20] states, structured CrossFit interventions have a positive impact on the overall physical fitness of university basketball players, which means that they can be used at various levels of competitions. Although the viability and the safety of extreme conditioning programs were also questionable in the work by Tibana, R. A., and de Sousa, N. M. F. [7], it was also observed that these programs were increasingly becoming part of athletics as long as they are supervised.

Consistent with this, Brandt, T. et al. [17] have provided positive results of CrossFit interventions in the workplace, which could justify their viability and ease of implementation under controlled settings. Nevertheless, the relatively high rate of musculoskeletal injuries in CrossFit participants noted in the research by Stephanie, S. S., et al. [12] and Fisker et al. [8], is also a reminder of the need to be cautious with supervision and periodization and of the necessity to monitor the frequency of musculoskeletal injuries in CrossFit users. Such concerns were also endorsed by Grier, T. et al. [9], who observed a rise in an injury rate in one of the U.S. Army Brigade Combat Teams after the adoption of an ECP, which casts doubt on the safety of the program in the absence of proper monitoring. Nonetheless, despite these risks, recent studies have indicated that some aspects of high-intensity functional training (HIFT) have the potential to fill the physical conditioning gaps in off-season or transition training, so it may be of use as an additional practice to regular training programs [21, 22].

## 2. Materials and Methods

### 2.1. Participants

In determining the sample size of this study, G\*Power 3.1 software was used to ensure sufficient sensitivity to measure significant effects. A priori power analysis was performed, assuming a between-groups design (two independent groups) with  $f = 0.40$  (medium),  $\alpha = 0.05$ , and statistical power  $1 - \beta = 0.80$ . The analysis of these parameters showed that the size of the sample taking part in the research should be 30 individuals. Thus, it was possible to recruit and assign 30 male amateur basketball players into the experimental ( $n = 15$ ) and control groups ( $n = 15$ ). All participants were males, 20 to 22 years of age, with at least five years of involvement in basketball (amateurs), willing to train four times a week, and with no history of chronic diseases or medications that could affect performance or training outcomes. To ascertain comparability of the two groups at pre-intervention, the research variables were measured to determine homogeneity. Informed consent was signed by all the participants.

### 2.2. Procedure

The three-day period involved testing the body composition, muscle power, and skills. On the first day, anthropometry was done under the standardized conditions. The height of participants was measured with Martin Anthropometric Scale, which is one of the instruments with the highest validity and reliability in both clinical practice and research [23]. They were asked to stand on their bare feet, in the straight position, with the feet together, arms crossed over the chest, and the heels, buttocks, and top

back in firm contact with the vertical backboard. When measuring, subjects were asked to breathe deeply, close their eyes, and hold a neutral head position, and the vertex of the head had to be captured firmly and soundly against the horizontal headpiece. Height was measured to 0.1cm.

































Body mass (weight) and advanced body composition parameters, including the fat-free mass, fat mass, total body water, bioelectrical impedance vector, and phase angle, were measured using InBody 720(R) (InBody Co., Seoul, South Korea), a multi-frequency bioelectrical impedance analysis (BIA) device commonly used in both sport and clinical studies. The participants were standing on the electrode-equipped platform with bare feet, using hand electrodes with arms out to the sides and holding an upright position during the measurement. The automatically derived variables were the following: Body Mass Index (BMI) ( $\text{kg}/\text{m}^2$ ), Fat Mass (FM) (kg), Fat-Free Mass (FFM) (kg), and Body Fat Index (BFI) ( $\text{kg}/\text{m}^2$ ). InBody 720 has proven to be highly valid and reproducible in measuring body composition in athletic groups [19], thus, it is an effective instrument when monitoring changes in response to conditioning programs.

On the second day, muscular power was measured using two reliable validated field tests, the Vertec® Jump (VJ) test and the Medicine Ball Javelin Quadrathlon (MBQJ) test [19-25]. Before testing, every participant took a standard 10-minute warm-up before participating in 5 minutes of light aerobic exercise (walking and then jogging in turns) and then performing dynamic exercises on major muscle groups involved in jumping and throwing movements. On the third day, footwork and dribbling skills were tested with the use of established protocols in assessing basketball skills [26]. These tests were carried out to investigate the effects of the intervention on some basic movement skills, which are crucial to performance in court (see appendix A).

### 2.3. Study Design

All the participants were put under supervised conditions and subjected to various forms of training during the intervention period. Participants in the experimental group were placed under an 8-week Extreme Conditioning Program (ECPs) (described in Appendix B), whereas the control group undertook a standard training program of the same duration that did not involve ECPs elements. The intervention was done within eight weeks between February and April 2025. Pre- and post-testing were completed to observe the improvement in muscular power and skills. All players were aware of the objectives, procedures of the study, and possible risks before their involvement. All participants gave written informed consent considering the ethical principles of the position described by the Declaration of Helsinki. The Ethics Committee of King Faisal University approved the research study under the reference KFU-REC-2024-FEB-ETHICS672.

**Table 1.** Distribution of an 8-week extreme conditioning programs (ECPs) for basketball players

Week	Intensity	Session	Intensity	Intensity %	Organizing the Session				Session Time (min)
					Warm-up (min)	Main Phase		Recovery (min)	
						ECPs (min)	Skills (min)		
1	Yellow	1		75%	15	35	25	10	85
		2		80%	15	35	30	10	90
		3		80%	15	35	30	10	90
		4		75%	15	35	25	10	85
2	Green	5		85%	15	40	30	10	95
		6		90%	15	50	30	10	105
		7		75%	15	30	25	10	80
		8		80%	15	35	30	10	90
3	Green	9		90%	15	45	35	10	105
		10		75%	15	30	25	10	80
		11		90%	15	50	35	10	110
		12		90%	15	50	40	10	115
4	Yellow	13		75%	15	35	25	10	85
		14		80%	15	35	30	10	90
		15		85%	15	35	30	10	90
		16		75%	15	35	35	10	85
5	Green	17		80%	15	35	30	10	90
		18		90%	15	40	35	10	100
		19		75%	15	35	25	10	85
		20		90%	15	45	35	10	105
6	Red	21		90%	15	50	45	10	120
		22		75%	15	35	25	10	85
		23		90%	15	50	40	10	115
		24		90%	15	40	35	10	100
7	Yellow	25		75%	15	30	25	10	80
		26		80%	15	30	35	10	90
		27		85%	15	35	30	10	90
		28		75%	15	35	25	10	85
8	Green	29		90%	15	35	40	10	100
		30		80%	15	35	30	10	90
		31		75%	15	35	25	10	85
		32		80%	15	35	30	10	90

## 2.4. Experimental Procedures

The ECPs were gradually applied over a period of eight weeks, and a gradual rise in intensity and volume was done with a view of maximizing neuromuscular adaptation. Functional, high-intensity exercises (strength, power, and anaerobic capacity) and exercises with kettlebells (e.g., clean and jerk, thrusters), plyometrics (e.g., box jumps, depth jumps), kettlebell swings, medicine ball throws, and bodyweight circuits (e.g., burpees, jump squats) were the main phase of each session (35–50 min). The exercises were structured in the form of circuits or intervals, 3-5 sets, 6-10 repetitions per set, and brief rest (30-60 s between sets,

30-50 s between exercises) to sustain the metabolic stress. The intensity was gradually increased to 75, 90 percent of the estimated maximum effort in periods of microcycles with the same framework of nonlinear periodization, with one day of high load being replaced by active recovery to avoid overtraining. Footwork and dribbling skills drills (20-45 min) were applied directly after the ECPs phase to promote the transfer performance under fatigue. Certified coaches (CF-L1/L2) supervised all of the sessions, making sure they were technically accurate and safe. Tables 1 and 2 provide comprehensive information on the structure of the session and the flow of exercises (eight weeks).

**Table 2.** Distribution of an 8-week extreme conditioning programs (ECPs), detailing exercises, reps, sets, and rest periods for basketball players

Week	Day	ECPs						Rest
		Exercises no./Sets/Reps/Rest BS						BE
1	Sunday	2/3/6/30s	34/3/6/40s	50/4/6/40s	70/3/8/40s	34/3/6/30s	30/3/7/35s	30-50 sec
	Tuesday	12/3/7/40s	48/3/8/35s	57/3/6/40s	66/3/8/30s	12/4/6/40s	40/3/10/40s	
	Wednesday	1/3/8/35s	41/3/8/30s	55/3/8/40s	64/3/8/40s	8/3/8/40s	68/4/10/40s	
	Thursday	11/3/8/50s	33/3/10/40s	57/3/8/40s	62/3/10/45s	66/4/8/40s	69/4/10/40s	
2	Sunday	3/3/10/40s	47/3/8/40s	56/3/8/45s	65/4/10/50s	13/3/8/45s	60/3/8/40s	
	Tuesday	14/3/10/45s	37/4/10/45s	51/3/8/50s	67/3/10/40s	18/3/10/55s	44/4/8/45s	
	Wednesday	4/3/10/55s	46/3/10/45s	60/3/8/55s	64/4/10/55s	2/4/8/60s	66/4/10/60s	
	Thursday	13/3/10/55s	39/4/10/60s	53/4/8/60s	63/4/10/60s	10/3/10/60s	70/4/10/60s	
3	Sunday	5/3/8/35s	37/3/8/40s	56/3/8/55s	68/3/10/50s	4/3/8/40s	64/4/6/40s	
	Tuesday	26/3/8/50s	35/4/10/45s	59/3/8/40s	66/4/10/55s	20/3/8/40s	65/4/10/55s	
	Wednesday	6/4/10/55s	47/3/8/35s	55/3/8/40s	69/4/6/40s	17/3/8/55s	32/3/8/50s	
	Thursday	7/3/8/55s	36/3/10/50s	49/4/6/40s	70/3/8/35s	21/3/8/50s	63/3/8/55s	
4	Sunday	25/3/10/50s	40/4/6/40s	58/3/8/40s	16/3/8/40s	47/4/8/60s	66/4/10/55s	
	Tuesday	8/4/10/55s	45/3/8/40s	60/3/8/55s	68/4/10/50s	22/3/10/40s	64/3/8/40s	
	Wednesday	15/3/10/45s	42/3/8/40s	49/3/8/40s	70/4/10/55s	5/4/6/40s	61/3/10/45s	
	Thursday	4/4/8/60s	9/3/10/60s	28/4/8/40s	37/4/6/50s	49/4/10/60s	65/4/10/35s	
5	Sunday	24/3/8/40s	45/3/7/40s	58/3/8/55s	64/4/8/60s	23/3/10/40s	44/3/8/55s	
	Tuesday	10/3/8/55s	46/4/6/40s	52/3/10/45s	62/3/10/40s	27/4/10/50s	4/4/10/55s	
	Wednesday	21/3/10/40s	32/3/8/40s	57/4/8/60s	68/4/10/55s	14/4/10/45s	70/3/10/40s	
	Thursday	16/3/10/50s	44/4/7/40s	52/4/8/50s	63/4/8/60s	24/3/8/50s	61/4/10/45s	
6	Sunday	30/4/8/50s	34/4/10/45s	53/3/8/40s	61/4/10/55s	69/3/8/35s	25/3/8/40s	
	Tuesday	17/3/7/40s	43/3/10/40s	61/3/10/40s	66/3/10/45s	55/3/10/45s	28/3/10/50s	
	Wednesday	19/3/8/40s	37/3/10/50s	51/4/8/50s	52/4/8/60s	67/3/8/55s	29/4/10/45s	
	Thursday	18/3/8/50s	39/4/10/45s	62/3/8/55s	69/4/8/60s	50/4/10/45s	19/3/10/40s	
7	Sunday	29/4/10/55s	40/3/8/40s	53/3/10/45s	63/3/7/40s	26/4/6/40s	68/3/8/40s	
	Tuesday	21/3/10/40s	35/4/8/60s	55/4/8/60s	70/4/10/55s	11/3/8/50s	48/4/8/60s	
	Wednesday	20/3/7/40s	33/3/10/45s	56/3/8/40s	68/3/10/40s	9/3/10/40s	44/3/10/45s	
	Thursday	28/4/10/45s	38/4/7/40s	50/3/8/55s	64/3/10/50s	19/3/10/40s	33/3/8/55s	
8	Sunday	31/3/7/40s	37/4/8/60s	59/3/7/40s	67/4/8/60s	1/4/10/45s	69/4/10/55s	
	Tuesday	27/4/10/45s	39/4/6/40s	60/3/10/45s	65/3/7/40s	3/3/8/50s	39/3/8/40s	
	Wednesday	22/3/10/40s	48/3/8/50s	54/3/10/45s	63/3/10/40s	15/3/8/40s	32/4/10/45s	
	Thursday	23/4/6/40s	47/4/10/45s	62/4/8/60s	69/4/10/55s	7/3/8/55s	34/4/8/60s	

BE = Between Exercise, BS = Between Sets.

## 2.5. Data Analysis

The results of the study were processed statistically using IBM-SPSS 26 (Chicago, IL, USA) software. The following statistical information was calculated to highlight the significance of the obtained results: mean, standard deviation, coefficient of variation, confidence interval with lower and upper limits (95% CI), and effect size ( $\eta^2$ ). The interpretation of the effect size was eta squared, and the  $\eta^2$  values of the sizes were small (0.01), moderate (0.06), and large (0.14). The mean differences between the experimental and control groups were calculated using a repeated measures analysis of variance (ANOVA). In this study, the chosen reference value for statistical significance was  $p \leq 0.05$ . An ANOVA was used in the current study based on statisticians' advice about data samples for the experimental and control groups and for the applied tests.

## 3. Results

Table 3 indicates descriptive statistical properties of the experimental group (EG) and the control group (CG) participants by their age, height, weight, years of experience, body composition, muscular power, and basketball-specific skills.

The descriptive statistics indicate that the experimental group (EG) and control group (CG) are closely matched at baseline across all measured characteristics. Mean age is nearly identical (EG  $20.72 \pm 0.68$  vs. CG  $20.81 \pm 0.71$  years; range 20–22 in both), so is height (EG  $176.45 \pm 1.15$  vs. CG  $176.28 \pm 1.08$  cm; range 174–178), with minimal variability. Body weight is also similar, with EG slightly heavier on average ( $78.33 \pm 2.94$  vs.  $77.85 \pm 2.67$  kg; ranges 74–83 and 73–82, respectively), but the difference is small relative to the low standard deviations. Training exposure shows comparable levels (EG  $6.15 \pm 0.82$  vs. CG  $6.03 \pm 0.76$ ; ranges 5–8 and 5–7, respectively), again indicating tight clustering. Overall, the narrow ranges and small standard deviations suggest a homogeneous sample, and the close means between groups support baseline equivalence, making them suitable for fair comparison of subsequent intervention effects.

In Table 4, pre- and post-measurements included body composition, muscle strength, and skills such as footwork and basketball passing for both the experimental and control groups. The experimental group showed significant improvement in all variables, with improvement rates

ranging from 7.20% to 34.80%, with effect sizes between 0.52 and 1.05 ( $p < 0.01$ ). Measurement dispersion decreased from pre-measurement coefficient of variation values of approximately 2.83% to 7.52% to a lower post-measurement range of approximately 2.55% to 5.50%. The control group showed less extensive improvement, with improvement rates ranging from 1.24% to 14.15%, with effect sizes between 0.09 and 0.92 ( $p < 0.01$ ). The coefficient of variation for some variables decreased slightly, from approximately 2.93%–7.61% pre-measurement to approximately 2.95%–7.51% post-measurement. Overall, the experimental group outperformed the control group in terms of improvement across all variables.

Table 5 reports the ANOVA outcomes for the main effects of measurement and group, as well as the partial eta-squared ( $\eta^2$ ) for the measurement-by-group interaction. Bonferroni-adjusted post hoc comparisons indicated that gains across all variables were significantly greater in the experimental group than in the control group. Overall,  $p$ -values below 0.05 supported significant effects across all study variables.

Table 5 presents post hoc ANOVA results with partial eta-squared ( $\eta^2$ ) for the main effects of Measurement and Group, the Intercept, and the Measurement  $\times$  Group interaction. For Measurement,  $F$  values ranged from 42.31 to 675.28 with  $p < 0.01$  across all outcomes, and  $\eta^2$  ranged from 0.587 to 0.959, indicating large effects. For Group,  $F$  ranged from 1.87 to 126.74;  $p$  was  $< 0.01$  for FM, FFM, VJ, and MBJQ (with  $\eta^2 = 0.196, 0.805, 0.807, \text{ and } 0.794$ , respectively), while BMI, BFI, and DR showed non-significant group effects ( $p = 0.092, 0.065, \text{ and } 0.180$ ;  $\eta^2 = 0.092, 0.105, \text{ and } 0.059$ ). The Measurement  $\times$  Group interaction was significant for all variables ( $p < 0.01$ ), with  $F$  values from 14.01 to 322.45 and  $\eta^2$  from 0.318 to 0.916, reflecting medium to very large interaction effects. Intercept terms were uniformly large and significant ( $p < 0.01$ ), as expected for centered repeated-measures models.

Table 6 shows statistically significant post-test differences between the experimental and control groups across all outcomes, with the experimental group outperforming the control group on BMI, FM, BFI, FFM, VJ, MBJQ, FW, and DR ( $p < 0.01$ ). The between-group percentage improvements were 6.64% (BMI), 11.44% (FM), 12.62% (BFI), 5.96% (FFM), 19.50% (VJ), 20.65% (MBJQ), 15.39% (FW), and 10.32% (DR). Corresponding effect sizes ranged from 1.42 to 6.33, indicating large effects favoring the experimental group.

**Table 3.** Descriptive statistics

	EG				CG			
	Mean	Std.	Min	Max	Mean	Std.	Min	Max
<b>Age</b>	20.72	0.68	20.00	22.00	20.81	0.71	20.00	22.00
<b>Height</b>	176.45	1.15	174.00	178.00	176.28	1.08	174.00	178.00
<b>Weight</b>	78.33	2.94	74.00	83.00	77.85	2.67	73.00	82.00
<b>Training</b>	6.15	0.82	5.00	8.00	6.03	0.76	5.00	7.00

**Table 4.** Descriptive statistics of experimental and control groups in Body composition, muscle strength, physiological adaptations, rebounding, and footwork skills

Group	Outcome measures	Pre			Post			ES	Sig.	Imp. %
		Mean	Std.	CV %	Mean	Std.	CV %			
Experimental	BMI (kg)	22.15	1.42	6.41	20.33	1.01	4.97	0.52	<0.01	8.22
	Fat mass (kg)	17.84	1.31	7.34	15.22	0.98	6.44	0.78	<0.01	14.68
	Body fat index (kg/m <sup>2</sup> )	24.6	1.85	7.52	20.3	1.12	5.50	0.85	<0.01	17.48
	Fat-free mass (kg)	58.72	2.03	3.46	62.95	1.87	2.98	0.97	<0.01	7.20
	VJ (cm)	54.3	1.62	2.98	68.7	1.85	2.69	1.02	<0.01	26.52
	MBJQ (m)	6.12	0.24	3.92	8.25	0.21	2.55	1.05	<0.01	34.80
	FW (s)	14.18	0.41	2.89	11.32	0.33	2.91	0.93	<0.01	20.17
	DR (s)	18.35	0.52	2.83	14.88	0.44	2.97	0.88	<0.01	18.91
Control	BMI (kg)	22.20	1.45	6.53	21.85	1.39	6.38	0.09	0.03	1.58
	FM (kg)	17.89	1.33	7.43	17.31	1.28	7.41	0.18	<0.01	3.24
	BFI (kg/m <sup>2</sup> )	24.7	1.88	7.61	23.5	1.76	7.51	0.34	<0.01	4.86
	FFM (kg)	58.68	2.01	3.43	59.41	1.94	3.27	0.38	<0.01	1.24
	VJ (cm)	54.1	1.60	2.96	57.9	1.71	2.96	0.84	<0.01	7.02
	MBJQ (m)	6.15	0.25	4.07	7.02	0.23	3.28	0.92	<0.01	14.15
	FW (s)	14.22	0.43	3.02	13.54	0.40	2.95	0.52	<0.01	4.78
	DR (s)	18.40	0.54	2.93	16.82	0.50	2.98	0.76	<0.01	8.59

Key: Min—Minimum; Max—Maximum; BMI—Body fat index; FM—Fat mass; BFI— Body fat index; FFM—Fat-free mass; MBJQ—Medicine Ball Javelin Quadrathlon; FW—footwork; DR— Dribbling; CV—coefficient of variation; ES— Effect size; Imp. % — improvement percent.

**Table 5.** Presents post hoc results based on ANOVA, including partial eta-squared ( $\eta^2$ ) estimates for the main effects (Measurement and Group) and their interaction (Measurement  $\times$  Group)

Outcome measures	Measurement			Group			Intercept			Group $\times$ time interaction		
	F	P	$\eta^2$	F	P	$\eta^2$	F	P	$\eta^2$	F	P	$\eta^2$
<b>BMI (kg)</b>	42.31	<0.01	0.587	3.02	0.092	0.092	8924.56	<0.01	0.997	18.44	<0.01	0.382
<b>FM (kg)</b>	378.45	<0.01	0.927	7.33	0.012	0.196	19205.33	<0.01	0.998	88.67	<0.01	0.748
<b>BFI(kg/m<sup>2</sup>)</b>	218.94	<0.01	0.881	3.65	0.065	0.105	6350.22	<0.01	0.995	14.01	<0.01	0.318
<b>FFM (kg)</b>	675.28	<0.01	0.959	124.15	<0.01	0.805	348120.44	<0.01	0.999	322.45	<0.01	0.916
<b>VJ (cm)</b>	498.33	<0.01	0.944	126.74	<0.01	0.807	122150.67	<0.01	0.999	235.18	<0.01	0.887
<b>MBJQ (m)</b>	348.92	<0.01	0.921	118.33	<0.01	0.794	61200.38	<0.01	0.999	158.26	<0.01	0.838
<b>FW (s)</b>	378.45	<0.01	0.927	7.33	0.012	0.196	19205.33	<0.01	0.998	88.67	<0.01	0.748
<b>DR (s)</b>	125.67	<0.01	0.808	1.87	0.180	0.059	11032.18	<0.01	0.997	45.12	<0.01	0.598

Key: BMI—Body fat index; FM—Fat mass; BFI— Body fat index; FFM—Fat-free mass; MBJQ—Medicine Ball Javelin Quadrathlon; FW—footwork; DR— Dribbling;  $\eta^2$ — Effect size.

**Table 6.** Descriptive statistics of the post-test performance, means, standard deviations, and percentage improvements of the experimental and the control groups

Outcome measures	Experimental		Control		ES	D. Imp.	CI		P
	Mean	Std. Deviation	Mean	Std. Deviation			Lower	Upper	
<b>BMI</b>	20.33	1.01	21.85	1.39	1.42	6.64%	1.18	2.66	<0.01
<b>FM</b>	15.22	0.98	17.31	1.28	1.96	11.44%	1.52	3.40	<0.01
<b>BFI</b>	20.3	1.12	23.5	1.76	2.25	12.62%	1.80	3.70	<0.01
<b>FFM</b>	62.95	1.87	59.41	1.94	1.88	5.96%	1.45	3.31	<0.01
<b>VJ</b>	68.7	1.85	57.9	1.71	5.92	19.50%	4.50	7.34	<0.01
<b>MBJQ</b>	8.25	0.21	7.02	0.23	5.84	20.65%	4.45	7.23	<0.01
<b>FW (s)</b>	11.32	0.33	13.54	0.40	6.33	15.39%	4.80	7.84	<0.01
<b>DR (s)</b>	14.88	0.44	16.82	0.50	4.18	10.32%	3.20	6.12	<0.01

D. Imp. — Differences in improved percent.

## 4. Discussion

This investigation aimed to identify the therapeutic impact of ECPs on basketball players' body composition (BMI, FM, BFI, and FFM) and muscular power (VJ, MBQJ) and the development of their footwork and dribbling skills. One can identify the impact of ECPs training on the variables being measured based on the outcome of each test. A comparison between the pre- and post-measurements, as well as the results of the ANOVA for the experimental group, showed statistically significant improvements in all the variables that were included in this study. The improvements in the experimental group were positive and statistically significant compared to the control group's improvements in all the tests ( $p < 0.001$ ). Furthermore, the effect sizes achieved by the experimental group indicated the effectiveness of ECPs in improving the performance potential of the basketball players who participated in the study. Regarding body composition and muscle strength, ECPs training resulted in statistically significant reductions in the percentage of body fat and increases in muscle mass among the participants, with effect sizes indicating significant improvements ( $p < 0.001$ ) [16]. The experimental group demonstrated improved muscular power, as evidenced by improved performances in the tests (VJ, MBQJ) compared to the control group [20].

According to the findings, the evidence shows that ECPs training enhances the selected fitness parameters in basketball players. At a conceptual level, the approach is typified by the concepts of diversity, complexity, and collaboration, which could form the basis of its significant effecting power in muscular strength. In a study that specifically examined college basketball players who took part in a 12-week ECPs training program, researchers recorded an improvement in strength, speed, and endurance among the players compared to those who had undergone conventional training [24]. Students who took part in distant ECPs classes in high schools showed similar results in increased strength and stamina and showed

enhanced performance on plank holds, squats, etc. [21]. In accordance with these results, a survey of first-year university students reported that ECPs training was effective at producing functional fitness, muscular strength, flexibility, and cardiovascular health [22].

This training method fosters a positive reciprocal relationship between physical characteristics and physiological improvements; the association highlights the importance of tailored training programs in optimizing athletic performances [27, 28]. In this study, ECPs training was found to fundamentally improve physical functions, which are essential for basketball players' skill acquisition. A study showed that ECPs training not only led to enhanced physical fitness but also had a positive impact on the effectiveness of basketball players' skill-related movements [29]. ECPs training enhances lung capacity, muscle endurance, and physical self-efficacy, which are essential for athletes, and the increased physical characteristics acquired from ECPs, such as flexibility and agility, increase performances in skill-based games such as basketball [20].

The significant difference between the experimental and the control groups in technologies and skills in footwork and dribbling can be logically explained using Extreme Conditioning Programs (ECPs) along with basketball-specific exercise regimens. The evidence shows that footwork training can boost both offensive and defensive games, enhance shooting and dribbling skills and achieve a better result on standardized tests after 12 weeks [30, 31]. Specific footwork workouts also enhance other main physical abilities in basketball—speed, agility, and coordination—related to dribbling and overall performance success [32, 33]. Furthermore, such results are supported using the functional training methods, which revealed that specialized conditioning leads to substantial improvements in the values of athletic performance indicators [33, 34]. Taken together, these findings indicate that ECPs can be a useful tool for enhancing core basketball skills under well-structured training activities.

#### 4.1. Study Limitations and Future Study

This research has several limitations to consider when interpreting the results. To start with, the sample consisted solely of male basketball players, which limits the applicability of the findings to women athletes. Since it is known that there are physiological, hormonal, and training-response differences between sexes (e.g., muscle hypertrophy patterns, recovery kinetics, neuromuscular activation), future studies should incorporate gender-balanced cohorts to determine whether ECPs produce similar performance improvements in both sexes. Second, there was no objective monitoring and control over dietary intake and sleep-wake patterns during the 8 weeks of the intervention. These are universally recorded muscle protein synthesis modulators, hormonal controls (e.g., cortisol, testosterone), and neural recovery, all of which are essential to adaptive responses produced by high-intensity training [35, 36]. The improvements in strength, agility, or shooting accuracy might have been confounded by variability in nutrition (e.g., timing of protein intake, caloric balance), or sleep duration/quality, which might inflate or conceal the actual effects of training. Third, there was no standardization of environmental factors, including ambient temperature, training location (indoor and outdoor), and time of day of sessions, so these factors could have brought about variability in physiological stress and performance output [37].

Also, although the researchers used validated measures (e.g., BlazePod to measure reaction time, standardized shooting protocols), the lack of biomarkers (e.g., serum testosterone, cortisol, creatine kinase) makes it hard to understand the mechanism by which ECPs trigger neuromuscular and endocrine changes. Lastly, the absence of long-term follow-up does not allow for conclusion about the sustainability of performance improvements following the program discontinuation, which is essential when it comes to athletic programming. The upcoming study ought to include controlled nutrition and sleep regimens, physiological biomarkers, and longitudinal evaluations to determine the cause-and-effect relationships and maximise ECPs in promoting long-term improvements in performance in basketball players.

#### 4.2. Practical Implications for Coaches and Athletes

The results of this study show that using Extreme Conditioning Programs (ECPs) as an addition to the standard training program of male basketball players can have a dramatic positive impact on the main performance measures, such as muscular strength, body composition, and sport-specific skills, such as footwork and dribbling. In the case of coaches, it means that ECPs, when applied as a structured, time-bound (e.g., 8 weeks) microcycle within the macrocycle, may be a highly efficient post-workout stimulus bridging the gap between general physical preparation and technical perfection. Instead of considering conditioning a distinct or a strictly

endurance-related element, coaches ought to perceive ECPs as a neuromuscular primer that enhances the ability of an athlete to repeat high-velocity and multi-directional movements under fatigue, all of them resembling actual requirements of the game [11].

In caches of strength and conditioning experts, the 8-week ECP protocol employed in the given study can serve as a convenient template that would accommodate both metabolic and skill maintenance. Interestingly enough, the achievements of the experimental group in dribbling and footwork, even though the intensity of ECPs is high, contradict the widespread belief that the programs undermine the quality of the technical performances. This is consistent with recent findings that intricate motor activities could be optimized when metabolic fatigue occurs in well-considered training planning [38]. Coaches must, however, not schedule ECPs separately, but they ought to follow ECPs with skills-based drills (e.g., dribbling under fatigue, defensive slides, and reaction-based shooting) to help cement motor learning in a fatigued condition, which is a more realistic simulation of end-game conditions than otherwise.

In athletes, the findings support the idea that high-intensity block training over relatively short periods can deliver quantifiable improvements not only in strength (in terms of body composition changes) but also in the technical reliability during physical training. This is especially useful among amateur players who need to develop their competitive preparedness and have no access to elite training programs on a year-long basis. Nonetheless, during ECPs, athletes need to be educated about the recovery management practice, such as sleep, hydration, and nutrition, as this process is characterized by high metabolic and neuromuscular activity. The loss of performance gains can be countered, however, with the risk of overtraining or non-contact injuries unless recovery is done properly [9].

The results are consistent in athletes, in that high-intensity block training that is relatively brief allows providing measurable gains not just in strength (in the sense of changes in body composition) but also in the technical reliability of the physical training. This becomes particularly helpful with the help of amateur players who are to train their competitive readiness and are deprived of the elite training programs during the year. However, when athletes are on ECPs, they should be informed of the recovery management practices, like sleep, hydration, and nutrition, because such a process is marked with high metabolic and neuromuscular activity. Performance gains can be neutralized, though, at the cost of overtraining or non-contact injuries unless it is performed correctly [9, 19].

## 5. Conclusions

The results of the current study show that ECPs training intervention of eight weeks duration induces a considerable number of positive changes in body composition (BMI,

FM, BFI, FFM), muscular power (vertical jump and medicine-ball chest pass jump), and basketball-specific skills (footwork and dribbling). Such benefits seem to be accruable to the adaptation of contemporary ECP practices and instruments in the framework of a systematic training program. Synthetically, the results corroborate the efficacy of the ECPs training in the improvement of the physical capabilities and skill execution, which reflects that the ECPs have specific benefits regarding prowess requirements in basketball. In practice, coaches are encouraged to have ECPs as a regular training component in their training programs to ensure overall physical development and acquisition of skills. It is encouraged that the adoption of these exercises remains throughout the club and national setup to maintain further performance impacts.

Thus, the coach is advised to make ECPs an inseparable and not auxiliary part of his or her training programs and focus on progressive intensity and individual training depending on the position and requirements of each player. Interactive tools like the FitLight Trainer™ system should also be used, as it has been demonstrated that many studies have indicated that it has enhanced visual reaction time, hand-eye coordination, and decision-making in a pressured environment. Moreover, the post-workout sessions should include visual training to increase cognitive-motor skills and decrease the risk of injury, as well as improve performance under pressure.

To conduct future studies, it is suggested to bring bigger research since it is not only boys who are affected by ECPs but also a wider age group (amateurs and professionals) to identify whether ECPs have long-term consequences on sport performance and general health. The contribution made by factors like sleep, nutrition, and recovery in the training responses should also be evaluated. With other studies suggesting that injury rates may be high when high-intensity training occurs without proper supervision, there is an extreme necessity to come up with safe training conditions and monitor the working loads with the help of wearable devices and kinesiological analysis. Lastly, the proposal is that new tests, based on technology and diagnostic tests (like non-interactive flexibility tests with FitLight), should be set that would prove more accurate in terms of measuring complex skills than the traditional tests, so that coaches and researchers can objectively and continuously measure performance.

## Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

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## Data Availability Statement

The data that support the findings of this study are available within the article.

## Additional Information

No additional information is available for this paper.

## Appendix

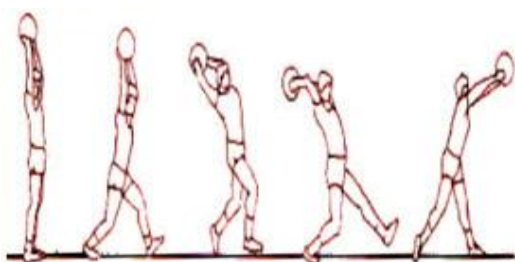
### Appendix A: Tests

**Vertec® Jump:** The Vertical Jump Test was conducted using (JUMP USA, Sunnyvale, CA, USA) [28,29], which consists of a set of rotating plastic vanes arranged in half-inch increments attached to an adjustable metal pole (Figure 1). Participants stood beneath the vertec, performing jumps from a uniform position, facing the vanes at a distance of 10 cm from the vertec, with their dominant shoulder aligned with the end of the vanes. Participants were instructed to jump as high as possible, using their dominant hand to reach and displace the highest plastic vane by swinging their arm at the peak of their jump. The jump height was calculated by counting the number of vanes displaced above the metal pole, which was then converted from inches to centimeters. Each participant performed three attempts, with a 30-second rest interval between each attempt, and the best jump height was recorded.



**Figure 1.** The Vertical Jump Test

Medicine Ball Javelin Quadrathlon: Each subject stood with the feet parallel, and about shoulder width apart, slightly staggered in the throwing direction (Figure 2). They cupped the ball in both their hands and placed it in front of the body of the football and there was a general teamwork effort to push the ball forward. In the view of three-step throw, the athlete started the throw with feet joined together and was allowed two steps with the ball into the throwing box, while the last step was allowed after the ball was released. This distance was taken from the front foot, at the time of release of the ball to the time the ball touched the ground. An assistant took down the measurements from each throw made by the participant. Every subject was given the chance to take three shots, and the longest distance was recorded [32,33].



**Figure 2.** The Medicine Ball Javelin Quadrathlon Test

Plank Test (P): This is a test to measure the strength of the core muscles (Figure 3). The aim is to maintain the elevated plank position for as long as possible. The body is flat on the ground with the elbows and forearms, the legs are straight, and the weight is supported by the toes. The hips are lifted off the ground to create a straight line from the head to the toes. Once the subject is in the correct position, the stopwatch starts. The head should be facing the ground and not forward. The test ends when the subject is unable to maintain a straight back and the hips are lowered. The test is calculated based on the time it takes the participant to be in the correct position. The participant is given two attempts, and the best attempt is scored [29,30].



**Figure 3.** Plank Test

Rebound Test: The player is asked to stand at the starting point 1 meter away from the Basketball Rebound Height Tester Model GA-5503 (Changsha, Hunan Province,

China) (Figure 4.). When the start signal is heard, the player must run towards the device. The player jumps vertically to try to catch the placed basketball. The player is allowed three attempts to achieve the highest jump possible. The highest height achieved by the player in the three attempts is recorded.



**Figure 4.** Rebound Test





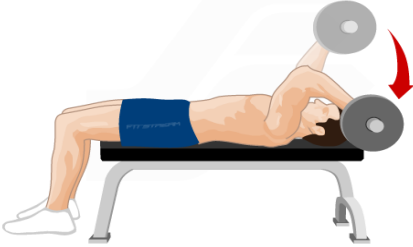


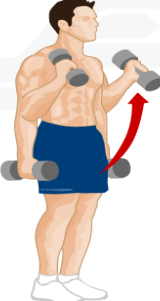


Modified T-test (footwork skill): Measures the rate at which the feet are moved either forward, sideways or in a backward manner. The test involves a tape measure, marker cones, a stopwatch, Basketball, and FitLight. Four cones (5 yards = 4.57 m, 10 yards = 9.14 m) are set up (see Figure 5.). The subject starts at cone A. On the sound of the timer, the subject immediately goes to the side of the cone light with Fitlight and rapidly touches the light off with his right hand. He then banks towards the other side and then changes sideways to the other illuminated cone, and then taps on the light to switch it off and this is done with his left hand. He then sways left and touches the side of the third illuminated cone with his right hand before going to cone A. The process is repeated on all four cones. The attempt will not be counted if the subject steps one foot in front of the other during the shuffle, or if he/she does not touch the correct cone light. To the nearest 0 is counted the best of the three successful attempts of time [31].



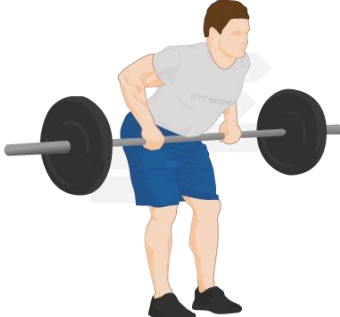
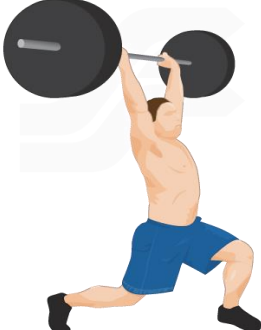


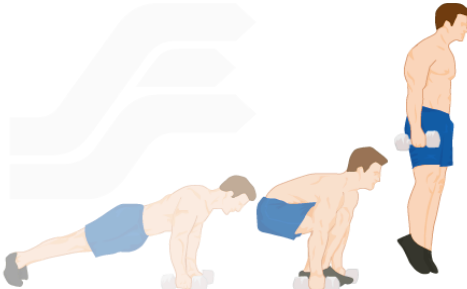













**Figure 5.** Modified T-test (footwork skill)

Appendix B: Programme

S1. Extreme conditioning program (ECPs) training

		No.	Exercises	No.	Exercises
Weight & Plyometrics	1			2	
	3			4	
	5			6	
	7			8	
	9			10	













11		12	
13		14	
15		16	
17		18	
19		20	
21		22	

23		24	
25		26	
27		28	
29		30	
31			

TRX	32		33	
	34		35	
	36		37	
	38		39	
	40		41	
	42		43	
	44		45	

46		47	
48			
49		50	
51		52	
53		54	
55		56	
57		58	

Kettle Bell

	59		60			
	61		62			
Battle Rope	63		64			
	65		66			
	67		68			
	69			70		

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