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Article

Modern Gladiators: Body Composition Profiles of Elite Professional Fighters

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Abstract

Background and Objectives: Professional combat sport athletes represent a unique population characterized by extreme training demands, repeated high-impact loading, and strict weight-class requirements. Despite growing interest in fighter health and performance, limited data exist on comprehensive body composition and bone health characteristics among elite professional fighters across organizations and weight divisions. The purpose of this study was to assess body composition, bone mineral content (BMC), and bone mineral density (BMD) in a cohort of world-class professional fighters and to examine sex-based differences in these variables. **Methods:** Fifty-two professional fighters (45 males, seven females) competing across multiple combat sport organizations (including UFC, Bellator/PFL, WBO Boxing, and BFKC) underwent whole-body dual-energy X-ray absorptiometry (DXA) assessments. Variables measured included body weight, body fat percentage, fat mass, lean mass, BMC, BMD, and bone T- and Z-scores. An independent-samples t-test was used to compare males and females, with statistical significance set at $p < 0.05$. **Results:** Of the total sample of 57 subjects, 20% (10 male, 2 female) are current or past world champions. Male and female fighters were similar in age (30.1 ± 5.4 vs. 33.6 ± 5.6 years; $p = 0.163$). Bone health indices were notably high in both sexes, with elevated T-scores (males: 2.7 ± 1.1; females: 2.3 ± 1.1; $p = 0.407$) and Z-scores (males: 2.6 ± 1.0; females: 2.0 ± 1.0; $p = 0.182$), indicating substantially greater bone density compared to age- and sex-matched norms. Males exhibited significantly greater BMC (3728.0 ± 558.2 g vs. 2569.9 ± 344.4 g; $p < 0.001$) and BMD (1.5 ± 0.1 vs. 1.3 ± 0.1 g·cm^{-2}; $p < 0.001$) than females. Body weight, lean mass, and lean mass plus BMC were also significantly higher in males (all $p < 0.001$). Females demonstrated a higher body fat percentage (21.0 ± 2.1% vs. 14.6 ± 2.0%; $p < 0.001$), though absolute fat mass did not differ significantly between sexes. Body weight ($R^2 = 0.427$) and lean mass ($R^2 = 0.484$) were the most significant predictors of bone mineral density. **Conclusions:** World-class professional fighters exhibit exceptionally high bone mineral density and favorable body composition, likely reflecting the combined effects of resistance training, impact loading, and long-term athletic development.

Keywords: bone; combat; mixed martial arts; DXA

1. Introduction

Body composition assessment is frequently used in sports medicine and athletic performance settings to monitor changes in response to training and nutrition programs. Dual-energy x-ray absorptiometry (DXA) is widely used to evaluate body composition, particularly bone mineral density. A sample of 337 Division I athletes (229 men, 108 women) from eight sports underwent DXA assessment of total and regional body composition [1]. Men showed higher bone mineral density, lower body fat (16.4% vs 25.2%), and greater lean mass (79.2% vs 70.6%, $P < 0.001$). Women had proportionally more trunk lean mass, while men had more in their arms; leg lean mass was similar (35%). Compared with age-matched NHANES data, athletes had higher BMD and lower fat. DXA results varied by sex and sport, underscoring the need for athlete-specific comparison standards when evaluating body composition.

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Another study examined differences in total and regional body composition and bone mineral density (BMD) across sport positions using DXA in NCAA Division I male lacrosse and football players (n = 294; football = 196, lacrosse = 98) [2]. In football, position significantly affected all composition variables ($p < 0.05$; effect size = 0.24–0.79). Offensive linemen had the highest body fat (30.1 ± 2.9%), and wide receivers the lowest (14.5 ± 2.1%). Defensive linemen showed the greatest total BMD (1.70 ± 0.09 g·cm−3), while kickers had the lowest (1.45 ± 0.11 g·cm−3). No positional differences were found in lacrosse ($p > 0.05$). These findings indicate substantial positional variation in football but uniform composition and BMD among lacrosse players, likely reflecting similar training demands.

However, there is scant data on professional fighters (e.g., Mixed Martial Arts, or MMA) regarding body composition, particularly bone mineral density. Professional fighters undergo arguably the most difficult training of athletes, yet their characteristics are poorly documented. Therefore, the purpose of this investigation was to characterize the body composition of professional fighters and pay particular attention to bone mineral density.

2. Materials and Methods

Whole-body composition and bone mineral density (BMD) were assessed using dual-energy X-ray absorptiometry (DXA) (Model: Hologic Horizon W, Hologic Inc., Danbury, CT, USA). Participants arrived at the testing facility and were instructed to remove all metallic jewelry, watches, and clothing items with zippers or fasteners before the scan to minimize image artifacts. Subjects were positioned supine on the scanning bed with arms placed comfortably at their sides and legs. Bone, lean mass, and fat mass were determined. The total scan duration was ~7 minutes. Daily calibration and quality assurance procedures were conducted using a manufacturer-supplied phantom spine before each testing session to ensure measurement stability. The coefficient of variation (CV) for repeated phantom measures was maintained below 1.0% for BMD and 1.5% for body composition variables, consistent with current DXA reliability guidelines.

This study was approved by the Institutional Review Board of NSU Florida (Approval No. IRB-2026-28). All procedures were conducted in accordance with the Declaration of Helsinki. Informed written consent was obtained from all participants.

Statistical Analysis

All data are expressed as the mean and standard deviation. An unpaired t-test was used to assess if sex differences existed. A p-value of < 0.05 was considered significant.

3. Results

Descriptive statistics for all dual-energy X-ray absorptiometry (DXA) measures are presented in Table 1. Male fighters exhibited significantly higher bone mineral content (BMC), bone mineral density (BMD), body weight, and lean mass than female fighters ($p < 0.001$ for all comparisons) (Table 1 and Figures 3, 4, 5, 6, and 8). Mean male BMD was 1.508 ± 0.136 g/cm², compared to 1.298 ± 0.094 g/cm² in females. Similarly, male BMC averaged 3720.2 ± 552.3 g, compared with 2569.9 ± 344.4 g in females.

Despite large differences in total body composition, no significant sex differences were found in fat mass, T-scores, and Z-scores (Figures 1,2, and 7), indicating comparable relative bone health when adjusted for sex and age. Mean T-score and Z-score values were well above normative reference ranges for both sexes (T-score: males 2.7 ± 1.1; females 2.3 ± 1.1).

Table 1. DXA and Demographic Summary by Sex.

Variable	Males (Mean ± SD)	Females (Mean ± SD)	*p*-value

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	n=50	n=7	
Age	30.2 ± 5.4	33.6 ± 5.6	0.163
T-Score	2.7 ± 1.1	2.3 ± 1.1	0.407
Z-Score	2.6 ± 1.0	2.0 ± 1.0	0.182
BMC (g)	3720.2 ± 552.3	2569.9 ± 344.4	<0.001*
BMC (lb)	8.2 ± 1.2	5.7 ± 0.8	<0.001*
BMD (g.cm^2)	1.508 ± 0.136	1.298 ± 0.094	<0.001*
body weight (lb)	188.7 ± 28.1	143.9 ± 10.6	<0.001*
Body fat %	14.6 ± 3.3	21.0 ± 2.1	<0.001*
Fat mass (g)	12962.7 ± 4070.9	13661.5 ± 2034.1	0.143
Fat mass (lb)	28.6 ± 9.0	30.1 ± 4.5	0.144
lean mass (g)	68283.2 ± 8876.0	48496.9 ± 4343.1	<0.001*
lean mass + BMC (g)	71999.1 ± 9305.0	51179.9 ± 4510.6	<0.001*
Lean mass (lb)	150.8 ± 19.7	107.3 ± 9.4	<0.001*

Values are presented as mean ± SD. Independent-samples t-tests were performed to compare males and females. Statistically significant differences between males and females are denoted. *.

A total of 57 professional fighters were analyzed (50 males and 7 females). Participants represented multiple major combat organizations, including the UFC, Bellator (now PFL), WBO Boxing, and BKFC. Within this cohort, 48 competed professionally in mixed martial arts (MMA), eight were professional boxers, and one was a bare-knuckle fighter. Several athletes were current or former world champions across multiple sanctioning bodies (Table 2).

Table 2. Overview of World Champions by Weight Division and Sanctioning Body.

Bellator Lightweight World Champion
Bellator Welterweight World Champion
UFC Light Heavyweight Champion
Strikeforce Middleweight Champion
UFC Middleweight Champion
UFC Interim Lightweight Champion
UFC Welterweight Champion (Two Fighters)
ONE Middleweight World Champion
ONE Light Heavyweight World Champion
Unified Lightweight World Champion (WBA Super, IBF, WBO, The Ring)
WBO & Ring Junior Welterweight Champion
WBO Junior Welterweight World Champion

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ISKA & WKA World Kickboxing Champion
Two individuals fought in the UFC but did not win any titles

Male fighters had an average body fat percentage of 14.6 ± 3.3%, while female fighters averaged 21.0 ± 2.1% ($p < 0.001$). Although absolute fat mass did not differ significantly between sexes, the distribution of fat and lean tissue was notably divergent. Mean lean mass among males was 150.8 ± 19.7 lb, nearly 40% greater than in females (107.3 ± 9.4 lb, $p < 0.001$). Individual T- and Z-score distributions are shown in Figures 1 and 2. Both male and female fighters displayed exceptionally high bone density values relative to reference populations. Nearly all participants had T-scores exceeding +1.0, and many exceeded +2.0, indicating exceptionally high bone mass relative to healthy young adults. Figure 4 further demonstrates the narrow distribution of BMD values, consistent with elite-level bone adaptation among fighters.

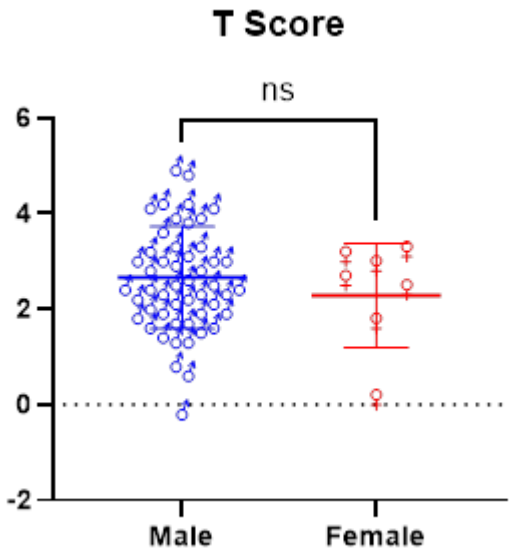

Figure 1. The T-score of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation. The T score compares an individual's BMD to the average BMD of a healthy young population (20-30 years) of the same sex.

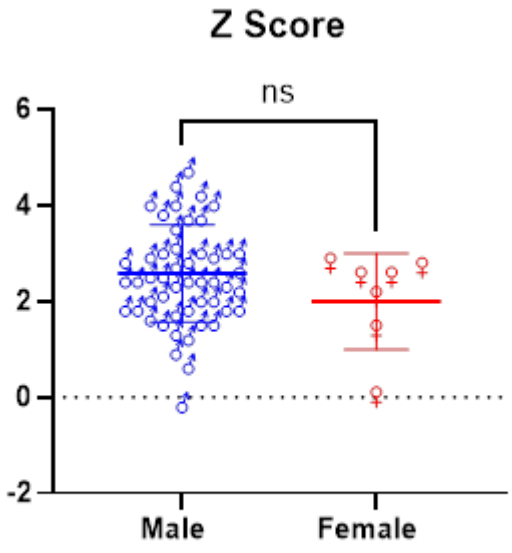

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Figure 2. The Z-score of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation. The Z-score compares an individual's BMD to the average BMD of an age-, sex-, and ethnicity-matched population.

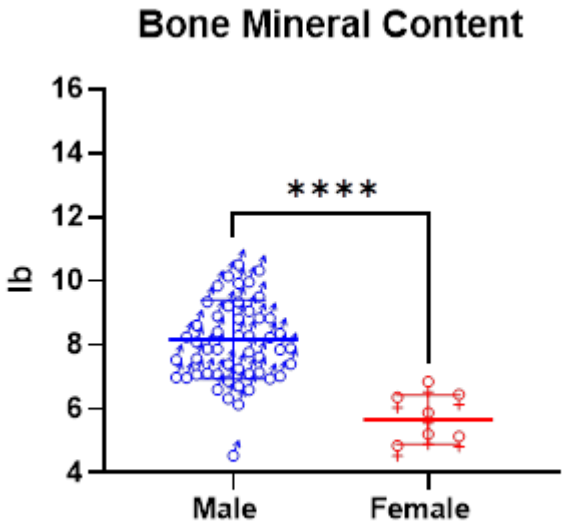

Figure 3. The bone mineral content of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

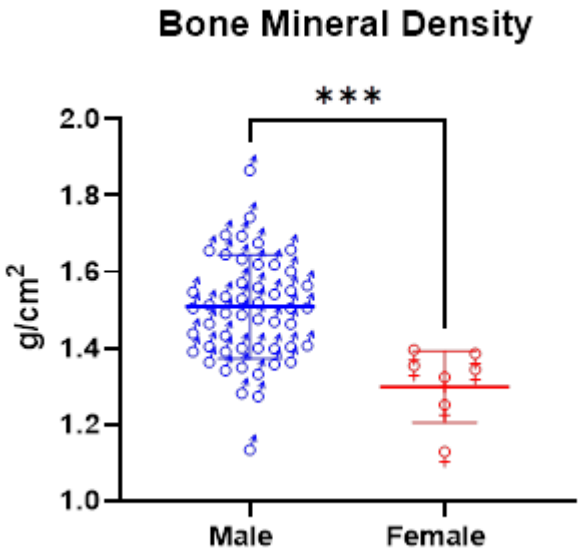

Figure 4. The bone mineral density of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

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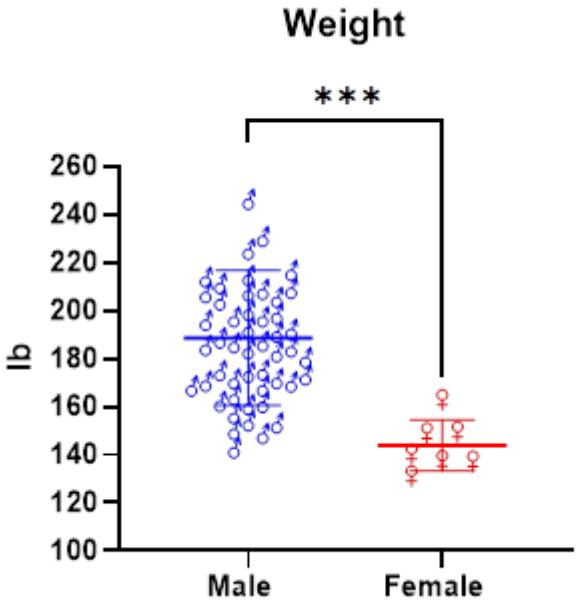

Figure 5. The body weight of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

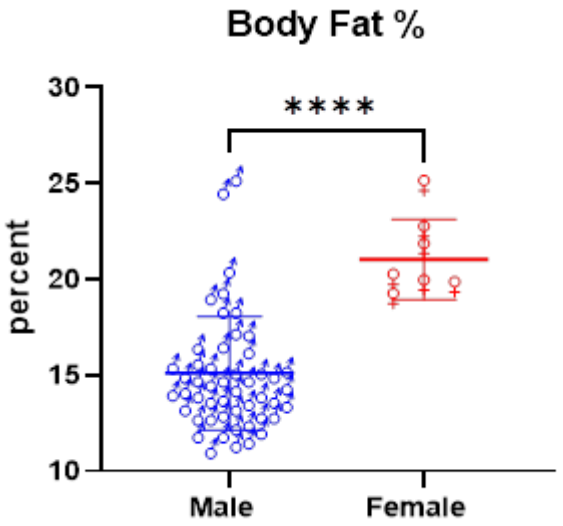

Figure 6. Body fat % of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

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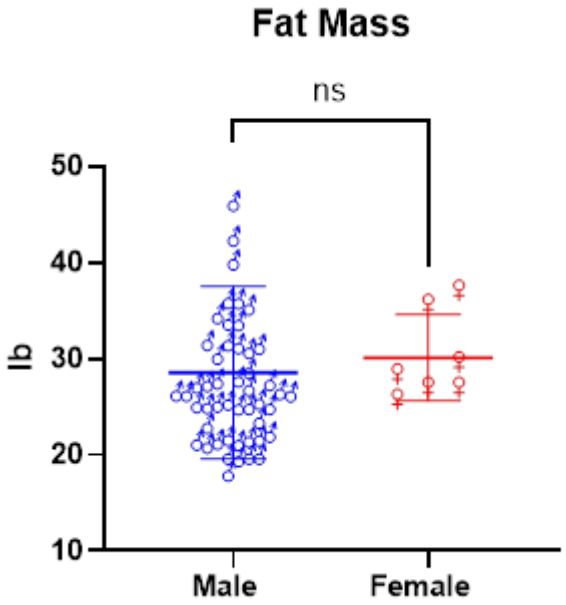

Figure 7. The fat mass of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

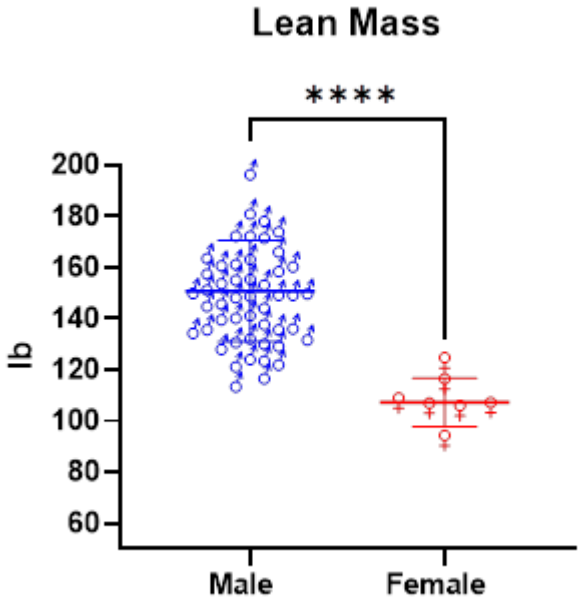

Figure 8. The lean mass of individual data points is shown. The middle line shows the mean, and the lines above and below the middle line are the standard deviation.

Table 3 presents the results of simple linear regression analyses examining the relationships between bone mineral density (BMD) and two predictors expressed in pounds: body weight (lb.) and lean mass (lb). Note: the R^2 value of 0.427 (body weight) and 0.484 (lean mass) shows a moderate relationship between body weight and BMD (i.e., predicts approximately half of the BMD variation).

When stratified by sex, these associations persisted in males (lean mass: $R^2 = 0.361$, $p < 0.001$; body weight: $R^2 = 0.308$, $p < 0.001$) but were not statistically significant in females, likely due to the smaller sample size (lean mass: $R^2 = 0.050$, $p = 0.630$; body weight: $R^2 = 0.256$, $p = 0.247$).

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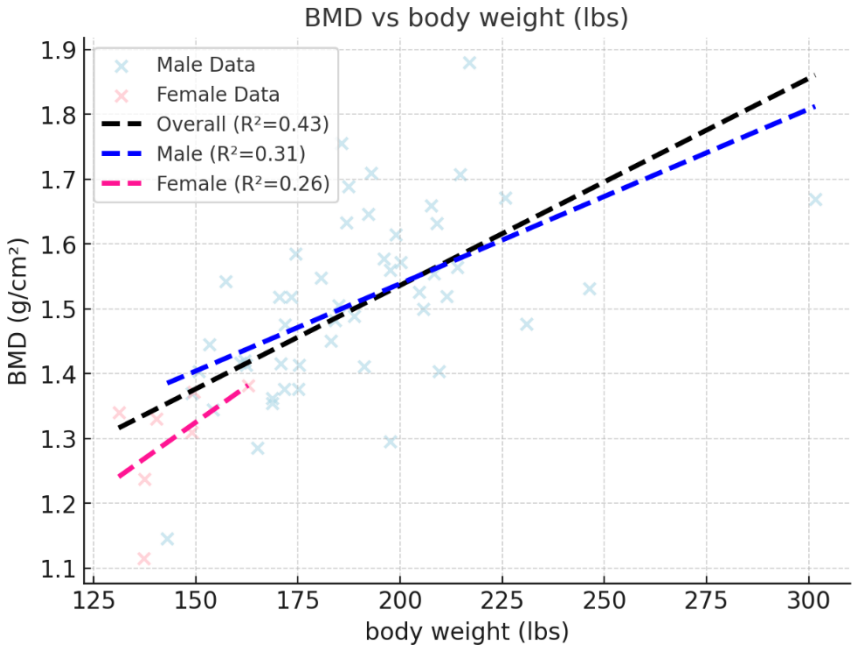

Figure 9. BMD vs Body Weight Linear Regression.

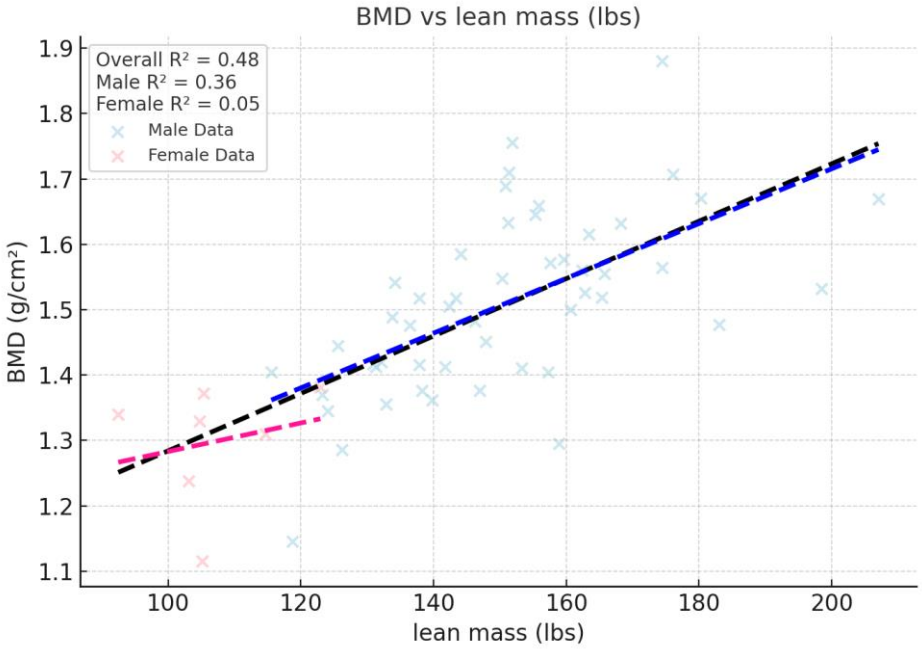

Figure 10. BMD vs. Lean Mass Linear Regression.

Table 3. Linear Regression Results for Predictors of Bone Mineral Density (BMD).

Group	Predictor	R^2	p-value
Overall	Body weight (lb)	0.427	<0.001
Overall	Lean mass (lb)	0.484	<0.001
Male	Body weight (lb)	0.308	<0.001
Male	Lean mass (lb)	0.361	<0.001
Female	Body weight (lb)	0.256	0.247

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Female	Lean mass (lb)	0.050	0.630

4. Discussion

One of the most unique aspects of this study was the subject population that consisted of current and former world champions in the UFC, Bellator, and other fight promotions. This is the first investigation to report data on champion fighters. The skeletal robustness observed in this cohort of world-class fighters exceeds that reported in most studies of professional athletes.

Previous studies in athletic populations suggest that BMD varies across sports and may be influenced by the mechanical loading associated with training and competition. In competitive athletes, football players, and mixed martial arts athletes have demonstrated some of the highest BMD values, while swimmers had lower BMD and T-scores compared with several land-based athletic groups [3,4]. These findings are consistent with the concept that sports involving impact, resistance training, and repeated high-load movement may provide a strong skeletal stimulus. Prior research has also reported higher BMD in athletes engaged in boxing, wrestling, judo, karate, and other high-load or combat-based activities, supporting the idea that sport-specific loading may be associated with skeletal adaptations.

In contrast, water-based activities such as swimming may not provide the same level of skeletal loading as land-based activities, although they may still be more beneficial than sedentary behavior [5]. Resistance training also appears to be an important activity for maintaining or improving BMD, as studies have shown positive effects of resistance training on bone density and attenuation of bone loss during weight loss interventions [6,7]. Biological factors should also be considered, as males often demonstrate higher BMD than females, and genetic factors may explain a substantial portion of variation in bone strength and density [8,9]. Overall, the available literature suggests that BMD in athletes is likely influenced by sport type, loading characteristics, sex, genetics, and training history.

The current study shows that professional fighters exhibit exceptionally high bone mineral density (BMD) and bone mineral content (BMC) compared with reference populations [10,11]. Average T- and Z-scores were markedly above normative means for both sexes, with many athletes exceeding +2.0. Although males displayed higher absolute values for BMD, BMC, and lean mass than females, their T- and Z-scores did not differ significantly. This indicates that, after adjustment for sex, bone density was comparably elevated in both groups, suggesting similar relative skeletal adaptations despite physiological differences. Female fighters, despite having higher body fat percentages, maintained lean mass and bone characteristics that exceeded those of the general population [12].

As a comparison, prior work has shown that the mean BMD values reported in athletes at the higher end include male rugby (1.381 g/cm^2), male soccer (1.341 g/cm^2), male volleyball (1.399 g/cm^2), female volleyball (1.207 g/cm^2), and female basketball (1.220g/cm^2) while endurance athletes often display lower BMD (e.g., male swimmers, 1.167 g/cm^2; female swimmers, 1.095 g/cm^2; male triathletes, 1.153 g/cm^2; female triathletes, 1.068 g/cm^2) [13]. These comparisons emphasize that combat athletes are likely to represent the upper physiological limits of bone mass in sport. Such adaptations confer clear advantages for impact tolerance and injury prevention, particularly in reducing fracture risk and supporting rapid recovery following the high-force collisions or strikes experienced by fighters. In a study by Santos et al., body composition was determined in a large group of athletes comprising 15 female and 45 male wrestlers and judokas [13]. They did not separate wrestlers and judoka; thus, it is not possible to determine if differences exist between the two groups. Nonetheless, in the female cohort (n = 15), BMD was 1.238 g/cm^2, whereas in the male cohort (n = 45), BMD was 1.365 g/cm^2 [13]. Compared with female professional fighters (1.298 g/cm2), male professional fighters showed higher BMD (1.508 g/cm^2).

Regression analyses demonstrated a moderate-to-strong association between body weight, lean mass, and BMD, particularly among male fighters. Weaker and nonsignificant correlations observed in females are likely attributable to the small sample size (n = 7). Future studies with larger female cohorts are necessary to confirm these preliminary findings.

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Limitations

The primary limitation of this study is the small female sample size, which restricted statistical power for sex-specific regression analyses. Additionally, a cross-sectional design precludes causal inference; longitudinal tracking would better characterize the trajectory of bone adaptation across different career stages or training intensities. Finally, variability in training modalities (e.g., striking vs. grappling disciplines) was not controlled, which may influence site-specific bone adaptations. Nonetheless, one could posit that since the majority of the subjects were MMA athletes, they engage in both striking and grappling disciplines. Thus, they are a unique group of athletes distinct from pure strikers (e.g., boxers, Muay Thai) or grapplers (e.g., freestyle wrestling, judo, Greco-Roman wrestling).

5. Conclusions

These findings demonstrate that professional fighters, particularly males, possess remarkably high bone mineral density and content, along with elevated lean mass and favorable body composition. The moderate-to-strong correlation between lean mass and BMD supports the role of high-impact training in promoting skeletal robustness in elite combat athletes. From a practical standpoint, interventions to optimize bone health in athletic populations should focus on increasing lean mass and promoting mechanical loading through resistance or high-impact training (e.g., plyometrics), thereby enhancing BMC and, consequently, BMD.

Author Contributions: Conceptualization and methodology, AR, CP, and JA; formal analysis, JA, CP, and AR; investigation AR, CP, SC, and JA; writing—JA; writing—review and editing: JA, CP, AR, and LJ. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: Data may be available upon request.

Conflicts of Interest: The authors have no COIs to declare.

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