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RESEARCH ARTICLE

WILEY

Doping in the Ultimate Fighting Championship (UFC): A 4-year epidemiological analysis

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Abstract

Background: Doping is a practice that is present in many sports and organizations, including mixed martial arts and the Ultimate Fighting Championship (UFC). The aim of this study is to explore the epidemiological patterns of doping among UFC athletes.

Methods: We screened the official United-States-Anti-Doping-Agency® (USADA) website, the annual USADA reports and the official UFC website for information on fighters and anti-doping rule violations (ADRVs). Our dataset included gender, age, weight class, testing numbers, date of ADRV, type of ADRV, and duration of suspension. Appropriate statistical tests were conducted to assess for statistical significance.

Results: USADA tested 1070 UFC athletes 2624 times as of late 2015 up till the end of 2019 (N = 1070). A total of 209 adverse findings were recorded; out of which, 102 ADRVs were committed by 93 athletes (8.7%) from all weight divisions. This constituted an adverse finding rate of 16.55 per 1000 test and an ADRV rate of 8.08 per1000 test. Mean age of sanctioned athletes was 32 years. Use of anabolic steroids was significantly the most common ADRV recorded (p = 0.018). The men's heavyweight division had an ADRV rate of 19.3 per 1000 tests, significantly higher than that of women's bantamweight division at 2 per 1000 tests (p = 0.03), women's featherweight division at 0 per 1000 tests (p = 0.009), and men's flyweight division at 3 per 1000 tests (p = 0.035). ADRV rate showed a significantly increasing trend among men's weight divisions (p < 0.001).

Conclusion: Doping is present in mixed martial arts. Increasing testing numbers, raising awareness and education on the risks of doping, and conducting further research on the issue is key to help resolve this problem.

KEYWORDS
anabolic steroids, combat sports, doping, mixed martial arts, MMA

1 | INTRODUCTION

Amidst the increasing global significance of sports competitions, the phenomenon of doping evolved greatly in the recent years, and better understanding of its prevalence and usage is essential for efficient prevention guidelines.[1] This increasing prevalence necessitated the establishment of a unified set of rules and regulations that define and harmonize anti-doping policies across different sports and athletic organizations.[2] The World Anti-Doping Agency (WADA) Code aimed to provide such services in an attempt to inspire true sports and preserve the fairness of competition, and was subsequently adopted by major athletic organizations like the Olympics.[2,3] Doping, as defined by the WADA Code, is the occurrence of one or more of the following violations: (1) presence of prohibited substance in an athlete's sample, (2) use or attempted use of a banned substance or method, (3) evading or failing to submit a test sample, (4) failing to report whereabouts, (5) tampering or attempted tampering with the doping control process, (6) possession of a banned substance or method, (7) trafficking or attempted trafficking of banned substance or method, (8) administration or attempted administration of banned substance or method to a fellow athlete, (9) being an accomplice in a doping process, or (10) involvement in a prohibited association.[3]

One of the sports that have dealt with the burden of doping is mixed martial arts (MMA). MMA is a combat sport that integrates striking, grappling, and other martial arts and is often associated with the brand "Ultimate Fighting Championship"(UFC).[4–6] As such, MMA practitioners need to possess superior physiological requirements to compete, as both aerobic and anaerobic capacities need to be attained at high levels.[7] In addition, high levels of muscular strength, power, flexibility, endurance, cardiorespiratory fitness, and weightcutting abilities are necessary for optimal performance.[7] This high level of competition predisposed several athletes over the past decades to practice doping, in an attempt to gain an unfair advantage over their fellow peers.[8] The UFC had previously adopted the policies of individual states and provincial athletic commissions to counter doping and ensure fair competition.[9] However, as the sport continued evolving, and suspicions of doping among fighters started increasing, the adoption of a strict independent anti-doping program to replace the previously much more lenient program in the UFC became a necessity.

In June 2015, and in order to combat doping in MMA, the UFC introduced the UFC Anti-Doping Program, externalizing their anti-doping program to The United States Anti-Doping Agency® (USADA).[10] By doing so, the UFC became one of the few major sports promotions to adopt an independent anti-doping program that is a signatory to the WADA code. Other major sports leagues and promotions like the National Basketball Association (NBA), the National Football League (NFL), and Major League Baseball (MLB) still rely on individual anti-doping policies, whose rules may differ between organizations.[11] The UFC gave USADA full authority to execute testing, sanctions, research, and education and allowed the development of programs and policies to ensure proper adherence to the rules.[10] The UFC Anti-Doping Program went into effect in July 2015, and ever since, violations have been detected and players have been sanctioned and punished.[10]

There are no studies in the literature that describe the prevalence of doping in MMA. As such, the purpose of our study was to explore the prevalence and patterns of doping practices in the UFC across genders and weight classes, in an aim to assess the magnitude of this phenomenon in the sport and extrapolate proper prevention guidelines for the future.

2 | METHODS

2.1 | Study design

Our study is a descriptive epidemiological study aimed at examining the anti-doping rule violations (ADRVs) committed by UFC fighters from the start of the UFC anti-doping program by USADA up until December 31, 2019. The data analyzed are all publicly available on the official USADA website (ufc.usada.org), the annual USADA reports, and the official UFC website (www.ufc.com).[10,12]

2.2 | Data collection

All adverse findings and ADRVs recorded by USADA in the UFC during the study period were analyzed. Information on the fighters and the sanctions were extracted.[10,12] Our dataset included gender, age, weight class, testing numbers, date of ADRV, type of ADRV, and duration of suspension. USADA's UFC anti-doping program ran into effect as of late 2015, and as such, for the purpose of this study, the years 2015 and 2016 were grouped together.

2.3 | Definitions

The UFC categorizes fighters into distinct weight classes. Female fighters compete at women's strawweight (≤115 lb), women's flyweight (≤125 lb), women's bantamweight (≤135 lb), and women's featherweight (≤145 lb) divisions. On the other hand, male fighters compete at the flyweight (≤125 lb), bantamweight (≤135 lb), featherweight (≤145 lb), lightweight (≤155 lb), welterweight (≤170 lb), middleweight (≤185 lb), light heavyweight (≤205 lb), and heavyweight divisions (≤265 lb).

In addition, USADA classifies prohibited substances and methods as per the "Prohibited List" provided by the World Anti-Doping Agency (WADA).[11] WADA classifies prohibited substances into two categories: those prohibited at all times and those prohibited in competition (Table 1). Substances prohibited at all times include governmentally nonapproved substances, anabolic agents, peptide hormones/growth factors/related substances/mimetics, beta-2-agonists, hormone and metabolic modulators, and diuretics and masking agents (Table 1). Substances prohibited only in

TABLE 1 The list of prohibited substances and methods as presented by the World Anti-Doping Agency (WADA)

	Prohibited substances and methods	Prohibition
Substances	Nonapproved substances	All times
	Anabolic agents	All times
	Peptide hormones, growth factors, related substances, and mimetics	All times
	Beta-2-agonists	All times
	Hormone and metabolic modulators	All times
	Diuretics and masking agents	All times
	Stimulants	In-competition
	Narcotics	In-competition
	Cannabinoids	In-competition
Methods	Manipulation of blood and blood components	All times
	Gene and cell doping	All times
	Chemical and physical manipulation	All times

competition include stimulants, narcotics, cannabinoids, and glucocorticoids (Table 1). WADA also defines prohibited methods that shall not be used at any times. These include manipulation of blood and blood components, chemical and physical manipulation, and gene and cell doping (Table 1). Adverse findings are findings that can potentially constitute an ADRV and, if proven so, may result in a sanction or suspension. ADRVs in our dataset were categorized and classified according to the definitions presented.

2.4 | Statistical analysis

ADRV rates were calculated by dividing the number of ADRVs by the total number of tests conducted during our study period. These rates were reported as ADRVs per 1000 tests.

An independent *t* test was used to determine whether any statistical significance exists between the ADRV rates of male and female fighters. A one-way analysis of variance (ANOVA) was used to explore whether there were any statistically significant differences between the rates of different types of ADRVs. In case of ANOVA significance, an appropriate post hoc test was conducted to indicate which types of ADRVs had significantly different rates from each other, depending on whether the assumption of homogeneity of variance was violated or not (Tukey's test vs. Games–Howell test). When comparing between rates of different years, we used a non-parametric Kruskal-Wallis test to assess for significance. Moreover, Joinpoint Regression Analysis was used to determine the statistical significance of the trends of ADRVs across different weight classes.

P-value less than 0.05 (95% CI) was used to determine statistical significance. Statistical analyses were performed using Statistical Package for the Social Sciences for Windows software version 25.0 (IBM SPSS, 2017) and JoinPoint regression analysis.

3 | RESULTS

3.1 | Demographics

Over the studied period, a total of 1070 UFC athletes were tested by USADA 12,646 times (N = 1070). A total of 209 adverse findings were recorded; out of which, 102 sanctioned ADRVs were committed by 93 positively tested athletes (8.7%) from all weight divisions. Of the sanctioned athletes, 10 were females (11%), and 83 were males (89%). Overall adverse finding rate was 16.5 per 1000 tests, whereas ADRV rate was 8.08 per 1000 tests. Age of the sanctioned athletes ranged from 22 to 43, with a mean of 32 years (SD = 4.918) (Figure 1).

The 1070 tested athletes were divided between 922 males (86%) and 148 females (14%). Males were tested 10,615 times, at an average of around 12 tests per athlete, whereas females were tested 2031 times, at an average of 14 tests per athlete (Table 2). Male fighters committed a total of 92 ADRVs, amassing an ADRV rate of 8.7 per 1000 tests. That rate was greater than their female counterparts, who committed a total of 10 ADRVs, with an ADRV rate of 4.9 per 1000 tests (Table 2). Nevertheless, this difference was not deemed statistically significant (p = 0.096).

3.2 | Type of ADRV

Usage of anabolic agents was the most common ADRV committed across all weight divisions and genders with a total of 55 ADRVs (54%), followed by hormone and metabolic modulators with 15 ADRVs (15%) and diuretics and masking agents with 11 ADRVs (11%) (Table 3). Sanctions due to usage of narcotics or gene and cell doping were not recorded. Usage of anabolic steroids was significantly higher than all other ADRVs committed during the studied period (p < 0.05) (Table 4).

3.3 | ADRVs and weight divisions

Higher weight divisions showed a higher number of ADRVs when compared with lower weight divisions (Table 2). Particularly among male fighters, a JoinPoint regression analysis showed a significantly increasing slope in ADRV rates as the weight divisions go higher (p < 0.001) (Figure 2). The heavyweight division was the division with the highest ADRV rate at 19.3 per 1000 tests. This was followed by the light heavyweight division with a rate of 15.4 per 1000 tests, and the middleweight division with a rate of 12.6 per 1000 tests. In contrast, the women's featherweight division did not record any ADRVs, followed by the women's bantamweight division at 2 per 1000 tests, and the men's flyweight division at 3 per 1000 tests (Table 2). When checking for statistical significance between rates of different weight divisions, the heavyweight division was found to have a significantly higher ADRV rate when compared with women's bantamweight (p = 0.03), women's featherweight (p = 0.009), and men's flyweight

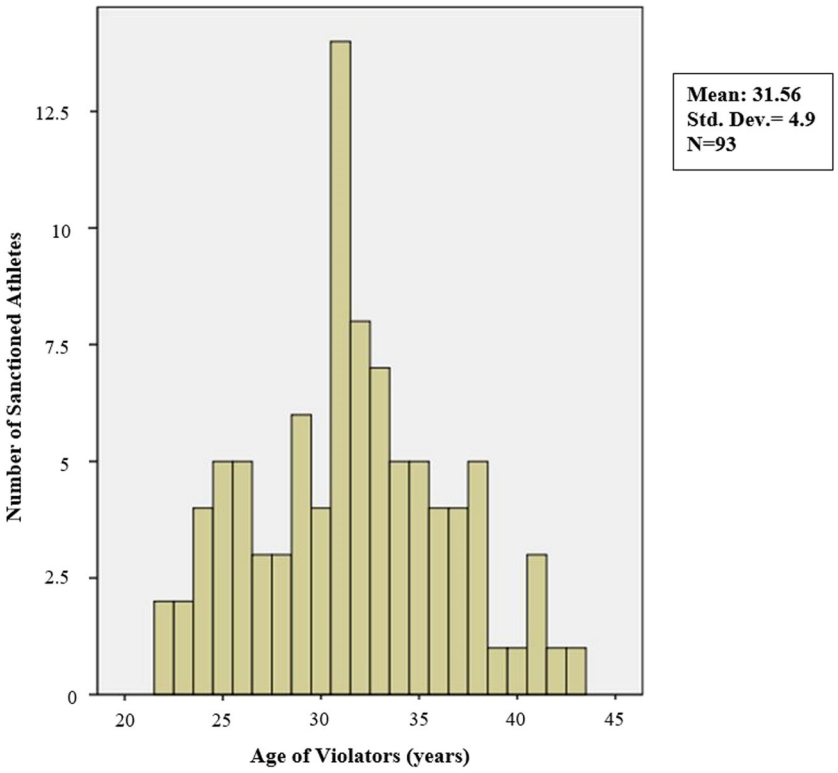

FIGURE 1 Distribution of sanctioned fighters by age

TABLE 2 Distribution of number of athletes tested, number of violations, number of tests, and rate of violations per weight division

	Weight division	Number of athletes tested	Number of violations	Number of tests	Rate of violations (per 1000 test)
Females	Strawweight	62	3	832	3.6
	Flyweight	47	6	537	11.2
	Bantamweight	33	1	510	2
	Featherweight	6	0	152	0
	Total	148	10	2031	4.9
Males	Flyweight	54	2	672	3
	Bantamweight	127	8	1322	6.1
	Featherweight	137	8	1373	5.8
	Lightweight	163	9	1685	5.3
	Welterweight	163	10	2042	4.9
	Middleweight	106	17	1353	12.6
	Light heavyweight	79	15	977	15.4
	Heavyweight	93	23	1191	19.3
	Total	922	92	10,615	8.7

(p = 0.035). Moreover, the ADRV rate of the light heavyweight division was significantly higher than that of the women's featherweight division (p = 0.02).

We then assessed the distribution of different types of ADRVs per different weight divisions. With respect to anabolic agents, the heavyweight division recorded the highest number of ADRVs with 11 ADRVs (20%), followed by the middleweight division with 9 ADRVs (16%), and the light heavyweight division with 8 ADRVs (15%). With respect to hormone modulators, the light heavyweight division had the highest number of ADRVs with 5 ADRVs (33%), followed by the heavyweight division with 4 ADRVs (27%). And as for ADRVs related to diuretics and masking agents, the heavyweight, the women's flyweight, and the bantamweight divisions recorded the highest number of ADRVs with 3 ADRVs each (27% each). The distribution of other ADRVs across different weight divisions can be seen in Table 5.

TABLE 3 Statistical comparison of anabolic agents violations to other types of violations (*= significance).

				Confidence interval	
	Violations	**Mean difference**	***p* value**	**Lower bound**	**Upper bound**
Anabolic agents	Peptide hormones, growth factors, related substances, and mimetics	3.69	0.009*	1.098	6.278
	Beta-2-agonists	4.3	0.012*	1.647	6.95
	Hormone and metabolic modulators	3.13	0.015*	0.779	5.482
	Diuretics and masking agents	3.51	0.018*	0.702	6.328
	Stimulants	4.27	0.011*	1.676	6.864
	Cannabinoids	3.93	0.012*	1.406	8.464
	Manipulation of blood and blood components	4.24	0.012*	1.605	6.88
	Chemical and physical manipulation	4.12	0.012*	1.521	6.714
	Whereabouts failure	4.27	0.011*	1.676	6.864

TABLE 4 Distribution of violations committed during the studied period by type

Type of violation	**2015/2016**	**2017**	**2018**	**2019**	**Total**
Anabolic agents	10	11	16	18	55
Peptide hormones, growth factors, related substances, and mimetics	4	0	0	5	9
Beta-2-agonists	0	0	0	1	1
Hormone and metabolic modulators	4	5	2	4	15
Diuretics and masking agents	0	1	6	4	11
Stimulants	0	0	1	0	1
Cannabinoids	2	1	1	1	5
Manipulation of blood and blood components	0	0	0	1	1
Chemical and physical manipulation	1		1	1	3
Whereabouts failure	0	0	1	0	1
Total	21	18	28	35	102

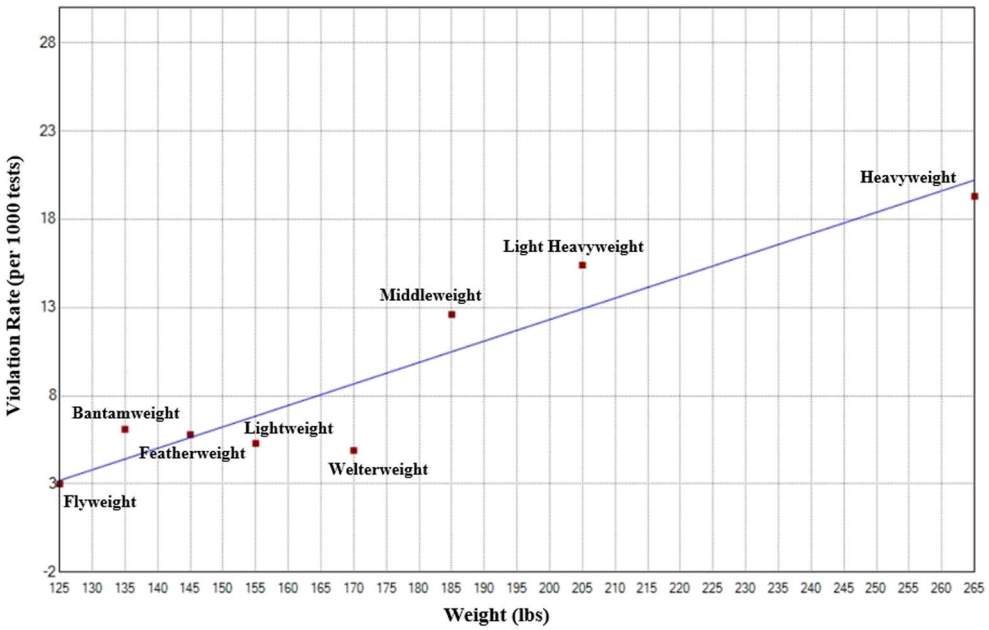

FIGURE 2 The trend of USADA violations across different weight divisions

TABLE 5 Distribution of different types of violations by weight division

Type of violations	Strawweight	Women's flyweight	Women's bantamweight	Women's featherweight	Flyweight	Bantamweight	Featherweight
Anabolic agents	2	3	1	0	5	5	4
Peptide hormones, growth factors, related substances, and mimetics	0	0	0	0	0	1	1
Beta-2-agonists	0	0	0	0	0	0	0
Hormone and metabolic modulators	0	0	0	0	0	0	1
Diuretics and masking agents	0	3	0	0	3	3	0
Stimulants	0	0	0	0	0	0	0
Cannabinoids	1	0	0	0	0	0	1
Manipulation of blood and blood components	0	0	0	0	0	0	0
Chemical and physical manipulation	0	0	0	0	0	0	1
Whereabouts failure	0	0	0	0	0	0	0
Total	3	6	1	0	8	9	8

TABLE 5 (Continued)

Type of violations	Lightweight	Welterweight	Middleweight	Light heavyweight	Heavyweight	Total
Anabolic agents	5	6	9	8	11	55
Peptide hormones, growth factors, related substances, and mimetics	1	1	2	0	3	9
Beta-2-agonists	0	0	0	1		1
Hormone and metabolic modulators	1	2	2	5	4	15
Diuretics and masking agents	0	0	1	1	3	11
Stimulants	0	1		0	0	1
Cannabinoids	1	0	2	0	0	5
Manipulation of blood and blood components	1	0	0	0	0	1
Chemical and physical manipulation	0	0	0	0	2	3
Whereabouts failure	0	0	1	0	0	1
Total	9	10	17	15	23	102

3.4 | ADRVs per year

Our studied period spanned from the beginning of the UFC USADA program in late 2015 up till the end of 2019. A total of 35 ADRVs were recorded in 2019, making it the year with the highest number of ADRVs. On the other hand, 2017 had the lowest number of ADRVs at 18. However, testing numbers differed between years. The highest number of tests occurred in 2019 with 4296 tests, whereas the lowest number of tests occurred in late 2015/2016 with 2643 tests (Table 6).

The overall ADRV rate of our studied period was 8.07 ADRVs per 1000 tests. The highest rate was observed in 2018 with 9.7 ADRVs per 1000 tests, and the lowest was observed in 2017 with 6.39 ADRVs per 1000 tests (Table 6). There was no statistically significant difference between rates across the years ($p = 0.697$).

4 | DISCUSSION

Doping proved to be a present phenomenon in the UFC, with a total of 102 sanctioned ADRVs committed by 93 fighters as of late 2015 and up till the end of 2019. Male fighters had a higher ADRV rate when compared with females, albeit without statistical significance. With respect to age, 63% of the sanctioned fighters were older than 30 years, with the majority belonging to the age group 30–35 years. This finding may be related to the age of peak performance in MMA. Ages of peak performance in sports have long been debated, and these have often been reported to range between mid-20s to early 30s.[13–16] It is thus understandable to witness that the majority of the sanctioned athletes were older than 30 years. At that age, fighters are either in their prime or have passed it, and maintaining previous high level-performances is key for career development and prosperity. Thus, many may resort to doping to help boost performance and speed up recovery, without taking into account the harms that can potentially arise on the long run.

A variety of harmful banned substances were found to be used in our study. Anabolic agents were significantly the most commonly used banned substance in the UFC during our studied period. These agents mimic the effects of testosterone and boost performance by increasing protein uptake in muscular cells, consequently allowing for speedier recovery rates, enhanced training abilities, and greater resultant muscle mass and strength in the setting of MMA.[17] Other commonly abused substances were hormone and metabolic modulators, diuretics and masking agents, and peptide hormones. Hormone and metabolic modulators act by blocking the conversion of testosterone to estrogen; exerting similar effects to that of anabolic agents, like boosting recovery and increasing strength.[18] Diuretics and masking agents are often used to cause rapid weight loss or hide the use of other banned substances; these are often used in the setting of weightcutting—the process of losing a large amount of weight shortly before competition to qualify for a lower weight class and attain the greatest size advantage possible.[19,20] Other agents like peptide hormones are used to boost cardiorespiratory fitness and aerobic capacities, parameters that are essential in the sport of MMA.[21] This variation in the use of banned substances reflects the different physiological needs of the sport, and highlights the lengths many athlete are willing to take in order to meet these requirements, no matter the harm or damage that can be caused to their bodies.

Weight was found to be a significant variable with respect to ADRVs as our study showed that ADRV rates significantly increased with higher weight divisions. Multiple factors may contribute to this finding. For starters, heavier weight divisions are associated with greater power and more dangerous striking, and consequently, a higher rate of knockout finishes.[4] This emphasis on striking power and strength may push fighters further toward using banned anabolic substances in an aim to increase muscularity and boost performance as was evident in our study. In addition, age might play a major factor in this situation, as higher weight divisions are known to have older participants.[14] As explained earlier, with age, fighters often find it harder to retain their previous training capacities, cut weight effectively, recover from injuries, and maintain impressive performance.[14] As such, it would be more tempting to use banned substances as the need for it is greater.

A total of 209 adverse findings were recorded by USADA's UFC Anti-Doping program since its initiation in late 2015, constituting an adverse finding rate of 1.65% (16.5 per 1000 tests). A study by Aguilar-Navarro et al analyzed doping-control test results conducted by WADA in individual and team sports, from 2003 to 2015. Among individual sports, this study reported adverse finding rates of 3.3% ± 1% in cycling, 3% ± 0.6% in wrestling, and 2.9% ± 0.6% in boxing.[22] On the other hand, team sports like hockey, rugby, and basketball reported adverse finding rates of 2.2% ± 0.5%, 2% ± 0.5%, and 2% ± 0.5% respectively.[22] Similarly to the UFC, this

TABLE 6 Distribution of violations, sanctions, and incidence rates (IR) over the studied period (2015–2019)

	2015/2016	2017	2018	2019	Total
Athletes tested	742	623	674	698	2738
Total tests	2643	2819	2888	4296	12,646
Adverse finding	37	43	40	89	209
Violations	21	18	28	35	102
Sanctioned athletes	19	17	26	31	93
IR[a] (violations/total tests)	7.95	6.39	9.70	8.15	8.07

[a]Per 100 tests.

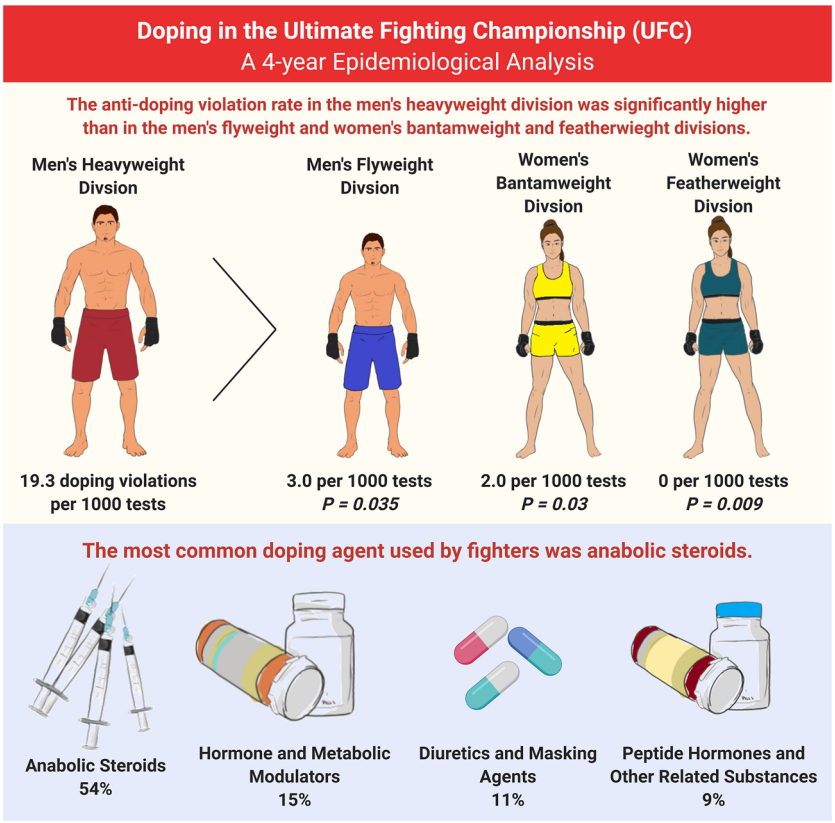

FIGURE 3 Weight was a significant variable with respect to doping trends in MMA, and anabolic agents were the most common doping agent used by the fighters

shows that doping is a pervasive phenomenon and that a comprehensive exploration of this topic is warranted. Increasing education and awareness of the athletes with regards to the health risks involved in taking these banned substances/methods is crucial in helping to halt such practices. In addition, a much more holistic approach with regards to testing—from the moment a competition is scheduled—can thoroughly help identify potential violators. Finally, research on the attitudes of athletes with regards to doping can help identify certain factors that predispose them toward resorting to such practices. USADA has prominently increased its response with regards to doping in the UFC, and one indicator would be increasing its testing numbers over the past few years. Such commitment is needed in order to preserve and protect the rights of the fighters and to allow the fans to enjoy the sport in the setting of fair competition.

5 | CONCLUSION

Doping exists among UFC athletes, with a total of 102 sanctioned ADRVs committed by 93 athletes (8.7%) in the span of around 4 years. The use of anabolic steroids was significantly the most common ADRV in our study. Furthermore, fighter weight was shown to be a significant predictor with regards to doping (Figure 3).

Further exploring the practice of doping in the UFC is essential, and this can be done through raising awareness on the risks of using banned substances/methods, increasing testing numbers, and conducting additional research in the future. This is needed to preserve the integrity of the sport, protect the fighters, and ensure fair competition.

CONFLICT OF INTEREST

None declared

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None

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