A COMPARATIVE STUDY AND DATA ANALYSIS FOR THE ULTIMATE FIGHTING CHAMPIONSHIP

A Thesis

by

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ABSTRACT

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Mixed Martial Arts is the fastest growing sport with many organizations worldwide. The biggest stage or biggest organization for Mixed Martial Arts is the Ultimate Fighting Championship (UFC). There are eight weight classes for men. The website: http://www.foxsports.com/ufc/stats provides data on fighters in all these categories. This data measures Striking Accuracy, Take downs, Reversals, Knockdowns, etc. in each category. It is interesting to understand and interpret all these numbers and study their relationships. Statistical tools like both parametric and nonparametric inference may give rise to such interpretations and provide explanations how the weight classes differ from one another. In this study, we selected 30 fighters per weight class and conducted some comparative study. Using Correlation Analysis, Shapiro-Wilk Test, Levene's Test ANOVA, and Kruskal-Wallis Test. We believe that our study will give rise to many striking insights, which may be of help for future research.

DEDICATION

This paper would have not been possible without the support and love from my family/friends. This is dedicated for my father Manuel Villalpando and mother Adela Villalpando for the support throughout the extremely hard years. Without them I would have never had the opportunity for a higher education. Thank you.

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CHAPTER I

INTRODUCTION

Brief Explanation of the Sport

Mixed Martial Arts (MMA) is the fastest growing sport with many organizations worldwide. The biggest stage or biggest organization for Mixed Martial Arts is the Ultimate Fighting Championship (UFC). The UFC has been expanding yearly since it joined forces with Fox Sports media for a multi-million dollar deal averaging around 100 million dollars a year. Now that the two organizations have made a deal, they have begun having more events per year. There are eight weight classes: Flyweight (125 lb.), Bantamweight (135 lb.), Featherweight (145 lb.), Lightweight (155 lb.), Welterweight (170 lb.), Middleweight (185 lb.), Light-Heavyweight (205 lb.), and Heavyweight (207-265 lb.). In 1993, the UFC was first introduced to the world but was not popular due to the high violence and limited rules protecting the fighters. There are many types of fighting styles such as: Karate, Judo, Brazilian Jiu-Jitsu (BJJ), Sambo, Kempo Karate, Muy Thai Boxing etc. Earlier, each art had its own advocates trying to establish its superiority. But with time, the sport has evolved so much that having knowledge of many martial arts is the best way to win. One major impact of the growth of UFC was the addition of three new weight classes, namely, Flyweight, Bantamweight and Featherweight. As a result, there are now more fights compared to the earlier years.

For numerous years the UFC consisted only from Lightweight to Heavyweight fighters. That changed when they purchased fellow promotion World Extreme Cage-Fighting (WEC). As a result, the participants of WEC migrated to the UFC and two new weight classes, Bantamweight and Featherweight, emerged. Then Flyweight, the lightest class for men in the UFC is the latest weight class added to the roster. Several fighters who were originally considered too small for Bantamweight moved to the Flyweight division.

Rules for Determining Winner of Fight

Each bout (fight) is always evaluated by 3 judges who use a 10 point scale per round where the winner of each round is awarded 10 points and the loser receives 9 or less points. The loser of the round always receives 9 points unless they are completely dominated in which case the judges may assign a 10-8 or 10-7 round. There are cases where judges may assign a 10-10 round if they feel that there was an evenly matched round. Points can be taken away from fighters if they disregard certain rules, but only the referee is allowed to penalize the fighter. This can result in a 9-9 round if the winner of the round was penalized. When judges are determining the score of each round, they will consider, effective striking, grappling, who controls the pace of the fight, as well as aggressiveness and defense.

The older weight classes Lightweight to Heavyweight have plenty of data but initially, due to the randomness of the sport and no professional method of collecting data, most of the earlier inferences were opinionated. But, of late, we have the official statistics provider for the UFC, known as, FightMetric which is world’s first MMA Statistics and Analysis system. As a result, we are now able to gather information unlike earlier days. By the use of this system, our knowledge, and statistical methods we are now able to make educated inferences for this sport.

CHAPTER II

DATA

The data was gathered from the website http://www.foxsports.com/ufc/stats provided by FightMetric where each weight class has its respective information for each fighter. This information consists of the number of Strikes landed, Strike Accuracy, Takedowns landed, Takedown Accuracy, Knockdowns, Passes, Reversals, and Submissions for the fighters. We use the data provided by the website mentioned above for our statistical analysis. We aim to determine how weight classes are different for a particular variable and we have quite a few variables to determine that. We collected the data from the website in July 2015 and immediately started our analysis. So, for consistency, we have not updated our data although the website has been updated several times due to a high number of events throughout the year. Here, we give a brief description of these terms.

Explanation of Terms

The variable **Strikes** counts the number of significant strikes that landed on the opponent. A **Takedown** occurs when a fighter wrestles his opponent on the ground. **Knockdown** doesn't imply that the opponent was knocked out and the number of **Knockdowns** doesn't represent the number of knockouts for that particular fighter's resume. This value is the number of times the fighter dropped his opponent with a strike or strikes. This further leads to Passes, Reversals, and Submissions which all come when the fight occurs on the ground aspect of the sport. When a fighter is in full guard, a **Pass** is considered when they transition to half guard, side control, fullmount, and north south position. A **Reversal** happens when the bottom fighter is able to change his position and becomes the top fighter. **Submission** happens when a fighter traps the opponent in a position such as a choke or a limb lock and the trapped opponent can no longer stay in the fight and finally will tap out.

One trend that may seem obvious is that if a fighter has more fights then they must have more strikes landed. This is not exactly true because of the varying nature of fighters. In fact, different fighters prefer different aspects of the game. We see a perfect example in the welterweight division (See APPENDIX), where one fighter has almost the same number of strikes landed compared to another fighter who has half the number of fights. On the other hand, the fighter (D. Maia, See APPENDIX) with more fights does have a significant number of submissions compared to fighters in his respective weight class as well as other weight classes. One may be taken down and we do see that submissions do occur when a fighter is on his back. Another trend we do see is that more the number of take downs for a fighter, the higher the number of passes he will have. This happens to be frequent with heavy oriented wresting and BJJ fighters. A pattern that is seen in all weight classes is that reversals and submissions are relatively low (high number of ties, See APPENDIX) compared to other variables. Without further ado we examine how each statistical method is being used to evaluate the data.

CHAPTER III

METHODOLOGY

To initiate our investigation, the first thirty fighters were selected from each weight class. As mentioned in the previous chapter, the variables we examined were Strikes landed, Strike Accuracy, Takedowns landed, Takedown Accuracy, Knockdowns, Passes, Reversals, and Submissions. For analyzing the data, we used several statistical methods, such as, Correlation Analysis (CA), Shapiro-Wilk Test, Levene's Test, One-Way Analysis of Variance (One-Way ANOVA), Fisher Multiple Comparison, Tukey Multiple Comparison, and the Kruskal Wallis Test. With Correlation Analysis we aim to study how each pair of variables are correlated. In case of the correlation between variables, we test if the slope of the equation line is significant. For all other procedures, we need to perform some tests of hypotheses. To check if the assumptions are met for ANOVA, the Shapiro-Wilk and Levene's test are conducted. In order to compare various weight classes for each variable, we use One-Way ANOVA and the Kruskal-Wallis tests. In each case, for studying statistical significance, we use $p - value$ approach. We need to have a level of significance α fixed beforehand for comparing with the $p - value$. Actually, we check if $p - value \leq \alpha$. If it is so, there is a relationship between the pair of variables under study. In case of ANOVA or Kruskal Wallis, we check if the mean/median of the variable under study differs across weight classes etc.

Correlation Analysis

The first statistical study is Correlation Analysis (CA) for various pairs of variables. The main idea is to use the data that would relate *y* with *x*.

$$(x_1, y_1), (x_2, y_2), \dots, (x_{n,} y_n)$$

While conducting CA we considered one pair of variables at a time. As mentioned before, our variables are strikes, strike accuracy, etc. For example, we considered paired variables as follows:

- Strike Accuracy vs Take Down Accuracy
- Strikes vs Take Downs….

When each pair was determined, we had to decide which pair made sense logically. Such as Strikes vs Takedowns, where Takedowns in most cases should dependent on Strikes. In a match (fight) one fighter would use his strikes set up an opportunity for a takedown. There are particular pairs that do not make sense in this study, Takedown Accuracy vs Knockdowns and Takedowns vs Knockdowns. Given that we know how each variable is defined, we know that Knockdowns occurs when a fighter falls due to a strike or strikes. Meaning that Knockdowns should not depend on Takedowns or Takedown Accuracy. Conversely Takedowns and Takedown Accuracy should not dependent on Knockdowns. The simple linear regression model:

$$y = \beta_0 + \beta_1 x + \epsilon$$

was used for pair-wise situations. The constant term β_0 , is known as the intercept which is the predicted value of *y* when $x = 0$. The coefficient x, namely, β_1, is our slope of the line. This is the predicted change in *y* when one-unit of change is in *x*. Thus the prediction equation for each pair is:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$$

when finding the equation for the prediction line, the method used is known as the least-squares method. The least-squares estimates of the slope and intercept are defined as:

$$\hat{\beta}_1 = \frac{S_{xy}}{S_{xx}}$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

Where,

$$S_{xy} = \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

$$S_{xx} = \sum_i (x_i - \bar{x})^2$$

S_{xy} is the sum of x deviations multiplied by y deviations, S_{xx} is the sum of x deviations squared, $\bar{x}$and $\bar{y}$ are the respective means of the two samples. Each test was conducted at a significance level of $\alpha = .05$.

Test for Normality

To check if the assumptions are met for ANOVA, we conducted the Shapiro-Wilk test to determine which variables per weight class follow a normal distribution. That being said, first we must rearrange the data in an ascending order $x_1 \leq \cdots \leq x_n$ then state our hypotheses. The hypotheses follow:

- Null Hypothesis, H_O : The population is normally distributed

Vs

- Alternative Hypothesis, H_A: The population is not normally distributed

We then calculated a test statistic defined as:

$$W = \frac{b^2}{SS}$$

Where,

$$SS = \sum_{i=1}^{n} (x_i - \bar{x})^2$$

And b is:

$$b = \sum_{i=1}^{m} a_i x_i$$

Where a_i are weights based on the value *n* in the Shapiro-Wilk Tables, note that

$$m = \frac{n}{2}$$

if *n* is even, and in the case that *n*, is odd replace *n*, with *n* minus one. For our study *n* is thirty so *m* was fifth-teen Based on the test statistic we would reject or fail to reject H_0.

Test for Homogeneity of Variances

Levene's test for the equality of variances was also done to see if the assumption was met for ANOVA. Where the null hypothesis is that the population variances are equal vs alternative that there is a difference between the variances in the population. In the Levene's test we replace the j-th observation from the i-th sample, with the random variable $z_{ij} = \left|y_{ij} - \tilde{y}\right|$, where $\tilde{y}$ is the sample median of the i-th sample. For simplicity the p-value approach was used from the SPSS output, but a test statistic L can be calculated:

$$L = \frac{\sum_{i=1}^{t} ni(\bar{z}_i. - \bar{z}..)^2/(t-1)}{\sum_{i=1}^{t} \quad \sum_{j=1}^{n_i} \left(z_{ij} - \bar{z}_i.\right)^2/(n_T - t)}$$

Where $\bar{z}_i.$ =mean $\left(z_{i1}, \ldots z_{in_i}\right)$ and $\bar{z}..$ =mean $\left(z_{11}, \ldots, z_{tn_t}\right)$.Then for a specified value of alpha, we reject H_0 if $L \geq F_{\alpha;t-1;n_T-1}$.

Parametric Tests

We would also like to study if there exist differences in means across all the weight classes for each variable. Simply having the sample means would not imply differences among the population means for each weight class. With this in mind we conducted a parametric test known as One-Way Analysis of Variance (One-Way ANOVA). Assumptions for ANOVA are:

- Each of the eight populations have a normal distribution
- Homogeneity of variances

$$\sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma_4^2 = \sigma_5^2 = \sigma_6^2 = \sigma_7^2 = \sigma_8^2 = \sigma^2$$

- The eight sets are independent random samples from their respective populations

Since we are testing the equality of the population means it would have been possible to conduct pairwise comparisons of two population means at a time, which would have resulted in twenty-eight *t* tests in comparing the pairs of means. This process would have been very tedious and time consuming. Also, an extremely important disadvantage of conducing multiple *t* test is that the probability of falsely rejecting the true null hypothesis, namely the Type I error, would have significantly increased. So ANOVA allows that the Type I error to remain at 5% and so we could be confident that our results are not by chance. While conducting ANOVA our hypotheses are the following:

- Null Hypothesis, H_O : All the means for the variable across all weight classes are equal:

$$\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$$

- Alternative Hypothesis, H_A: At least one pair of means is different

This method is used to compare the means of at least three samples using what is known as an ANOVA table. The ANOVA table is used to show the statistics used to test hypotheses about the population means. When constructing the ANOVA table we need to know the following:

$$SST = \sum_{ij} (y_{ij} - \bar{y}_{i}.)^2 + \sum_{i} n_i (\bar{y}_{i}. - \bar{y}..)^2$$

$$SSW = \sum_{ij} (y_{ij} - \bar{y}_{i}.)^2$$

$$SSB = \sum_{i} n_i (\bar{y}_{i}. - \bar{y}..)^2$$

$$s_B^2 = \frac{SSB}{t-1}$$

$$s_W^2 = \frac{SSW}{n_T - t}$$

Here $y_{ij}$is the j-th sample observation from i-th population, $n_i$is the number of sample observations from i-th population and *t* is the number of observations per weight class. For example $n_1$would represent the sample size for Flyweight, $n_2$would represent the sample size for Bantamweight etc. The total sample size, is written as

$$n_T = \sum_{i} n_i$$

for our case we have

$$n_T = 240$$

the average of n_i samples from i-th populations is

$$\bar{y}_{i}. = \sum_{ij} \frac{y_{ij}}{n_i}$$

and the average of all sample observations is

$$\bar{y}.. = \sum_{i} \sum_{j} \frac{y_{ij}}{n_T}$$

SST is known as the total sum of squares of the measurements around the overall mean. SSW is the sum of squares of variations within samples which measures the variability of an observation y_{ij}around its respective mean. SSB is the sum of squares of variations between samples, which measures the variability of each sample mean$\bar{y}_{i}.$ around the overall mean $\bar{y}_{..}$. The variance between samples is written as $s_B^2$with degrees of freedom of $t - 1$ and the variance within samples is written as s_W^2, with degrees of freedom $n_T - t$. Each variances is also known as the mean square variation between samples (MSB), and the mean square variation within sample (MSW). The last part of the ANOVA table is the Fisher-Statistic (F-Statistic), where the F statistic is the ratio of the two variances. The numerator is variance between groups and the denominator is the variance within groups, denoted as

$$F = \frac{s_b^2}{s_w^2}$$

Once we have calculated the F-Statistic we can either reject or fail to reject our null hypothesis depending on the F-critical value. In the case of rejection of the Null Hypothesis in the ANOVA test, we immediately do not know where actually the equality fails. Given that the One-Way ANOVA test is limited for determining which pair of means differ from each other, we looked at the Post Hoc Test multiple comparisons procedures, such as, Fisher's Least Significant Difference (LSD) and Tukey Honestly Significant Difference (HSD).

Subsequently, we are concerned in finding which population means differ, once we have rejected the hypothesis of equality of t population means in ANOVA. Fisher's LSD makes it possible for all pairwise comparisons. In order to conduct a Fisher multiple comparison test we would:

- First an analysis of variance must have been conducted testing

$$H_0: \mu_1 = \mu_2 = \cdots = \mu_t$$

Vs

$$H_A\text{: at least one of the means are different}$$

- In the case where there is not enough evidence to reject the null hypothesis, we would not need to proceed.
- If the null hypothesis is rejected, we need to have a specific value for the least significant difference for each pair of observations
- Where is alpha is fixed, and the value for the least significant difference when comparing each pair (μ_i to μ_j) is defined as

$$LSD_{ij} = t_{\alpha/2}\sqrt{s_W^2\left(\frac{1}{n_i}+\frac{1}{n_j}\right)}$$

Or when the sample sizes are the same size

$$LSD_{ij} \equiv LSD = t_{\alpha/2}\sqrt{\frac{2s_W^2}{n}}$$

- $t_{\alpha/2}$ is the critical t value with degrees of freedom $df = n_T - t$
- Then for each pair of sample means, if:

$$\left|\bar{y}_i.-\bar{y}_j.\right| \geq LSD_{ij}$$

- We would state the pair of population means are different

Similar to ANOVA each pairwise comparison of population means has the same fixed probability of conducting a Type I error with the probability of conducting a Type I error being fixed at alpha. Fisher's LSD method is similar to the two-sample t-test for comparing two population means but instead of using the pooled variance (s_p^2) from samples i and j, we use the mean square within samples (s_W^2) which is also pooled across all observations. Also the Fisher's LSD method can be used to construct a confidence interval for $\mu_i - \mu_j$. Where the confidence interval has the form of:

$$(\bar{y}_i. - \bar{y}_j.) \pm LSD_{ij}$$

An important aspect of this test is that there is a likelihood the F test in ANOVA is significant but in the pairwise comparisons no pairs are significant with the LSD method. This possibility could happen since the null hypothesis for the F test is identical to the chance that the potential comparisons among the population means are zero.

Since there is high change of falsely inferring that at least one pair of means is statistically significantly different when conducting multiple comparisons by Fisher's LSD test, another multiple comparison method that allows us to avoid this, which controls different error rates is known as the Tukey's HSD procedure. This method uses the Studentized Range Distribution. If more than two sample means are in comparison, the test statistic used to test the largest and smallest sample means is:

$$\frac{\bar{y}_{largest} - \bar{y}_{smallest}}{s_p\sqrt{\frac{1}{n}}}$$

This is analogous for comparing two means but does not follow a *t* distribution. The reason is the comparison is not determined until the largest and smallest sample means are observed. When conducting a Tukey multiple comparisons test we first need to rank the sample means.

- If

$$|\bar{y}_i. - \bar{y}_j.| \geq W$$

We will state that $\mu_i$and μ_j are statistically different

Here,

$$W = q_\alpha(t, \nu)\sqrt{\frac{s_W^2}{n}}$$

with s_W^2 being the mean square variation within samples with ν degrees of freedom. As when comparing *t* different populations $q_\alpha(t, \nu)$ is the upper-tail critical value of the Studentized Range Distribution where n is the number of observations in each sample. As mentioned before, this method avoids falsely declaring a pair to be significant by controlling the error rate known as the experiment-wise error rate fixed at alpha.

It happens that both methods do have an experiment-wise error rate but the per-comparison error rate is found to be larger for Fisher's LSD than to Tukey's HSD procedure. We mainly did more detailed study with the Tukey HSD for the Post Hoc Test since the approach is quite conservative which states less significant differences than to Fisher's LSD method. Likewise to Fisher's LSD method, a confidence interval can be constructed for Tukey. The Tukey method can construct confidence intervals for all pairs of differences. Once W is calculated from a specific alpha level the probabilities (1-α) of population differences $\mu_i - \mu_j$ will be in the interval:

$$(\bar{y}_i. - \bar{y}_j.) \pm W$$

Similarly each test was conducted with a significance level of $\alpha = .05$. In case it is a rejection for a certain pair of weight classes for a particular variable under study, we conclude that this pair of weight classes is at least one contributor for the rejection of the ANOVA test.

Non-Parametric Test

We conducted a non-parametric test as well to determine if the samples do come from identical distributions. The particular non-parametric technique that was used is the Kruskal-Wallis Test. This is a rank sum test used to test if each of the *k* samples do belong to an identical distribution. Unlike for the ANOVA test, in order to conduct a non-parametric test we do not need the assumption that our data follows a normal distribution. Thus we will test the hypothesis that *k* samples were drawn from identical distributions. To conduct the Kruskal-Wallis Test we would:

- State our hypotheses

  H_O : The *k* distributions are identical

  H_A: At least one of the distributions of *k* samples is different

- Calculate a test statistic but before finding *H* (test statistic) we would have to rank the values for each variable under study from lowest to highest.

$$H = \frac{12}{n_T(n_T+1)} \sum_i \frac{T_i^2}{n_i} - 3(n_T+1)$$

Where $T_i^2$is the squared rank sum for the i-th group. Then if *H* were to exceed the critical value of χ^2 with degrees of freedom = $k-1$, we will reject our null hypothesis. In our case we did have ties for the rank sum test, therefore we would have to calculate a H'(test statistic). Where H' is define as:

$$H' = \frac{H}{C}$$

$$C = 1 - \sum_j \frac{\left(t_j^3 - t_j\right)}{(n_T^3 - n_T)}$$

and $t_j$is the number of ties in the j-th group of ties. Once the Kruskal-Wallis test claims that at least one of the distributions are different, we are interested in recognizing which pair of groups are significantly different. Then the rank sum test can be extended for the comparisons of more than two populations using the means of the rank sums. The number of pairwise comparisons for each variable is:

$$m = \frac{k(k-1)}{2}$$

which is a total of twenty eight comparisons per variable for our case. The hypothesis for testing the pairs follows:

- The distribution of the $\bar{T}_i$ group is the same as the $\bar{T}_j$ group

$$H_0: \bar{T}_i = \bar{T}_j$$

- The distributions are not identical to one another

$$H_A: \bar{T}_i \neq \bar{T}_j$$

Then we will reject the null hypothesis if:

$$\left|\bar{T}_i - \bar{T}_j\right| > \frac{q_{\infty;k;\alpha}}{\sqrt{2}} \sqrt{\left[\frac{n(n+1)}{12}\right]\left[\frac{1}{n_i} + \frac{1}{n_j}\right]}$$

Where $q_{\infty;k;\alpha}$ is the upper-tail critical value of the Studentized Range Distribution with degrees of freedom infinity. With the presence of several ties in our data the following equation can be performed, and we reject H_0 if:

$$\left|\bar{T}_i - \bar{T}_j\right| > \sqrt{\frac{1}{C}\chi^2_{k-1;\alpha}\left[\frac{n(n+1)}{12}\right]\left[\frac{1}{n_i} + \frac{1}{n_j}\right]}$$

Having done each method for examining the variables across all weight classes, there is sufficient output. Organizing the data we can determine which pair of variables correlate with each other, where exactly we have similarities and differences across our groups, which groups actually have distributions that are identical as well as which samples come a normally distributed population and which groups have equal variances. This will give an understanding how certain weight classes are affected by particular variables.

CHAPTER IV

RESULTS

All data investigation was carried out with SPSS statistical analysis software package version 22. Some of the data output was organized in Microsoft Excel spread sheet 2013. In the appendix section, all these output have been included.

While conducting Correlation Analysis for paired variables, there were a few that were particularly interesting because of their slopes. All regression out puts were plotted in an excel sheet displaying their intercepts, slopes, their significance levels, and if they were significant. For **Strikes vs Takedowns** we see that every single slope is significant in the model (See APPENDIX). This intuitively makes sense if a fighter desires to take a fight to the ground, the best way is to use Strikes to set up a Takedown. In **Strikes vs Passes,** we see that there are significant slopes in all models (See APPENDIX) except Bantamweight and Middleweight. Just like fighters using strikes to attempt takedowns, they can use their strikes to increase their chances of passing guard as well. With this in mind, it raised the question if guard defense is similar between Bantamweight and Middleweight. The data provided by website mentioned in Chapter 2 does not report any information on how many times a particular fighter's guard is passed. If this information can be provided it would be great to analyze. **Takedowns vs Passes** have significant slopes all across each weight class (APPENDIX See). This is significant to observe, since when a fighter achieves a Takedown in many cases they are able to at least pass from full guard to half-guard. Note that a Takedown does not imply at least one Pass will occur. With **Passes vs Submissions**, five of the eight models produced statistically significant slopes (See APPENDIX). This makes sense since in order for a fighter to position their selves for an offensive submission attempt they must pass certain guards. As for the other comparisons we don't see as many interesting results compared to the above mentioned pairs. No other paired observations produced at least half of the weight classes to have significant slope outputs (SEE APPENDIX). It was odd for **Strikes vs Strike Accuracy** to produce insignificant slopes all across each weight class. Perhaps outliers or high leverage points are influential that are possibly affecting the slopes of each equation's line. An outlier may represent imprecise data, so one method that could be used is robust regression. This can be used to detecting influential observations. For future results we can possibly run an outlier test, detect whether or not outliers exist and re run the data. Then maybe we could result more interesting correlations.

After seeing four paired variables that correlated the most with each other, we were interested to see where the similarities exist for the means of each variable between the weight classes. In order to begin with ANOVA, we first must check if the assumptions are met. While conducting the Shapiro-Wilk test, it was found that similar variables across all weight classes had samples which came from normal distributed population. For Flyweight and Light-Heavyweight, only one variable was found to have a normal distribution, namely, Strike Accuracy. Then for all other weight classes it was found that they all had the same two variables that were normally distributed (Strike Accuracy and Takedown Accuracy). Observing this we now know that Strike Accuracy is normal for all weight classes.

We also check to see if the assumption of homogeneity of variances was met for ANOVA. Levene's test will determine whether these variables have equal variances. Observing the output for the Levene's test, there are three variables which have variances that are equal. Strike Accuracy (p-value=.094), Strikes (p-value=.073), and Takedown Accuracy (p-value=.059) (SEE APPENDIX). For the five other variables it was found that there is a difference between the variances in the population.

After checking the assumptions we conducted the parametric test ANOVA for each variable. When organizing the data for the ANOVA test, SPSS only allows numerical data in each entry. So weight division 1 corresponds to Flyweight, weight division 2 corresponds to Bantamweight etc. For **Knockdowns** there is a statistically significant difference between groups as determined by one-way ANOVA (F (7,232) =3.455), p=.002(See APPENDIX). So we rejected our null hypothesis, then at least one difference occurs between all the mean **Knockdowns** across the weight classes. For **Passes** again we have a statistically significant difference between groups (F (7,232) =2.485), p=.018 (See APPENDIX). Thus we are rejecting our null hypothesis, so there exist at least one difference between the means. We continue to see that there is a statistically significant difference between groups for **Strike Accuracy, Strikes, Takedowns, Reversals,** and **Submissions** (See APPENDIX). As **for Takedown Accuracy** we do not have a statistically significant difference since our one-way ANOVA test determined (F (7,232) =1.336) p=.234 (See APPENDIX). The p-value resulted that we do not have enough evidence to reject our null hypothesis. Hence the means for Takedown Accuracy are equal across all weight classes. This is quite fascinating knowing that there is some similarity for the average **Takedown Accuracy** for all classes whether a fighter is 125 pounds or 265 pounds. An intuited assumption is that there must exist a difference for Takedown Accuracy between larger and smaller fighters.   Does this mean that there is some similarity for Takedown defense? At the moment Fightmetric does not provide that particular information. This is something that definitely that should be looked at. Given that for 7 out of 8 variables across each weight class were determined that at least one of the means differs from the other. Observing this we need to further investigate and find where exactly these differences occur.

To find where these differences occur we examined the Fisher LSD and Tukey HSD Post Hoc test. For **Knockdowns** we see that there are nine differences for the Fisher LSD test. Flyweight has differences between Lightweight, Welterweight, Middleweight, and Heavyweight (See APPENDIX). Bantamweight differs from Lightweight, Welterweight, Middleweight, and Heavyweight (See APPENDIX). We see that Flyweight and Bantamweight differ from the same weight divisions but not from each other. Last we see that Middleweight and Light-Heavyweight differ (See APPENDIX). Since we do know that Fisher's test has the tendency of claiming differences occur when there is no difference we look to Tukey's post hoc test to verify. According to Tukey the only pairs we do retain are Flyweight vs Middleweight and Flyweight vs Heavyweight (See APPENDIX).

For **Passes** we get a total of seven pairs that are claimed to be different by the Fisher test. Light-Heavyweight is different from Featherweight, Lightweight, Welterweight, and Middleweight (See APPENDIX). Then Heavyweight differs from Featherweight, Lightweight, and Welterweight (See APPENDIX). It was observed that Tukey, which has a less per-comparison error rate, recorded no differences between any pairs. Even thou that the ANOVA test had resulted in rejecting the null hypothesis. Tukey is quite conservative with multiple comparisons and this outcome was only seen for the variable **Passes**.

When comparing the means for **Strikes**, the most differences occurred for this variable. A total of eighteen differences were recorded by the Fisher LSD test (SEE APPENDIX). After investigating the Tukey Test, twelve of the eighteen pairs remained significant (SEE APPENDIX). Viewing the SPSS output for the Post Hoc Test, we see that Flyweight vs weight classes 3-6, that the mean differences are extremely negative. This implies that the mean Strikes for Flyweight are significantly less than Featherweight, Lightweight, Welterweight, and Middleweight. The same occurs for Bantamweight vs the same exact classes. Looking at the Tukey Test for **Strike Accuracy**, just two pairs, Flyweight vs Middleweight and Lightweight vs Heavyweight were claimed to have different means out of seven from the Fisher test (SEE APPENDIX). From ANOVA, we know the only variable that sustained the null hypothesis was **Takedown Accuracy**. Thus the post hoc test should have displayed no differences which Tukey did show, but the Fisher test said otherwise (SEE APPENDIX). According to the LSD test, Light-Heavyweight had differences between Flyweight and Bantamweight (SEE APPENDIX).

As for **Takedowns**, Fisher stated differences in almost half of the number of pair wise comparisons. There were twelve pairs that were listed distinct but Tukey on the contrary only reported two (SEE APPENDIX). When inspecting **Reversals**, Tukey kept six from the eleven pairs that Fisher presented (SEE APPENDIX).Then for our last variable, **Submissions**, the LSD test resulted that Lightweight had differences with Flyweight, Bantamweight, Featherweight, Light-Heavyweight, and Heavyweight. As well that Flyweight and Featherweight were different. Ultimately Tukey stated the actual differences are between Lightweight vs Flyweight and Lightweight vs Light-Heavyweight (SEE APPENDIX).

In the Non parametric test, known as Kruskal Wallis, we studied which pairs have significantly different distributions and which pairs have identical distributions. Just as the null hypothesis was retained in ANOVA for **Takedown Accuracy**, the same occurred when testing if the distributions were identical across all weight divisions. With a p value of .320 we did not have enough evidence to reject the null hypothesis. Thus we did not need to proceed with the Kruskal Wallis procedure for the variable Takedown Accuracy.

For the other seven variables, we did get to compare various pairs. **Strike Accuracy** (p-value=.006) and **Submissions** (p-value=.034) were the two variables under study that had the least number of differences. Note that the Shaprio-Wilk Test did indicate that the Strike Accuracy was normally distributed across all weight divisions but according to Kruskal-Wallis a fourth of the comparisons resulted that we will accept the alternative hypothesis. Then for Submissions twenty-three pairs have identical distributions. This is rather interesting to know this.

For **Knockdowns** (p-value = .000), Flyweight resulted in five paired differences, Bantamweight differed from four and Light-Heavyweight resulted in three paired differences (SEE APPENDIX). **Passes** (p-value =.006) showed that Light-Heavyweight did not have identical distributions to five such pairs and Welterweight had two such pairs. Once again **Strikes** did have the most differences with more than half of the pairwise comparisons rejecting the null hypothesis. A total of eighteen pairs resulted not having distributions that are equal to each other. Then for the last two variables, **Reversals** (p-value=.000) presented that half of the pairs were similar and half were different. Then for **Takedowns** (p-value=.000) sixteen pairs had distributions that are identical to each other.

CHAPTER V

CONCLUSION

For this study the data provided was strictly based on each fighter's resume in the promotion of UFC. This does not include data from other rival promotions that they may have fought for. Four pairs of variables we see positive correlation based on their significant slopes for their equation. Using the effect sizes of the correlation between two variables could be great a research study that could have many striking insights. Out of eight variables, we only retained the null hypothesis for **Takedown Accuracy** in both the parametric and non-parametric test. It would be interesting to find out exactly why this impact is happing. Beside each fighter's background, what other factors are determining this? It was found that for **Strikes**, **Knockdowns**, **Takedowns,** and **Reversals** they contain the largest amount of differences. Now after studying the data we know where exactly where the differences/similarities exists. For the distributions for each variable we see which are identically distributed to each other and if they are normal. As well as which groups have variances that are equal to each other.

What has become quite popular in recent years is Women MMA. It would be an interesting study to see if women portray similar statistics in mixed martial arts, since this research was strictly based for males. Currently there are two weight divisions for females in the UFC. It would be fascinating to see how the statistics differ from both men and women.

From the website provided in Chapter 2 the data gathered for each variable was considered to be basic. Under the advanced option there is more in depth report for the variables

Strikes and Strike Accuracy. Since Strikes was reported to have the most differences in means we can observe if this same trend follows for strikes landed to their opponents head, body, and legs. Strike Accuracy is also reported for each body part respectively. Expanding these statistical methods to these extra variables could be a contributing factor into further research. It would also be great for a comparative study and how the sport has evolved over the years.

In this study only the analysis of variances (ANOVA) was performed for the equality of means and we could extend this to the analysis of covariance (ANCOVA). In the future maybe this information along with additional investigating we could use Logistic Regression or Markov Chain Monte Carlo methods to find probabilities of particular fighters winning/losing a given fight.

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APPENDIX A

APPENDIX A

Table A.1: Data for Flyweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
D. Johnson	13	1244	0.619	55	0.534	2	32	2	3
C. Cariaso	12	783	0.510	10	0.400	0	16	1	0
J. Benavidez	11	600	0.415	14	0.298	4	25	1	1
I. McCall	7	576	0.536	11	0.262	0	14	0	0
J.Lineker	9	543	0.440	4	0.667	7	0	1	0
S. Jorgensen	11	523	0.467	19	0.413	1	13	3	1
B.Pickett	10	520	0.400	15	0.357	3	10	1	1
D.Ortiz	6	429	0.598	12	0.324	0	17	3	0
C.Camus	7	418	0.563	6	0.500	0	17	5	0
J.Moraga	8	366	0.536	4	0.222	1	4	1	3
S.Pettis	5	349	0.429	4	0.400	0	6	1	0
K.Horiguchi	5	325	0.561	5	0.417	2	4	0	0
H.Cejudo	3	320	0.604	7	0.292	1	7	0	0
N.Seery	5	315	0.527	3	0.500	2	2	2	0
J.Dodson	8	300	0.383	6	0.400	7	1	0	0
L.Smolka	4	282	0.479	8	0.348	1	14	4	0
J.Scoggins	5	255	0.638	17	0.654	0	25	0	0
Z.Makovsky	5	253	0.556	18	0.321	0	15	3	0
P.Holohan	4	249	0.643	7	0.500	1	17	1	1
A.Bagautinov	4	241	0.464	12	0.364	2	5	0	0
W.Reis	4	202	0.529	8	0.333	0	6	2	1
R.Vaculik	3	158	0.610	6	0.353	0	9	2	0
J.Formiga	6	148	0.527	11	0.423	1	14	0	1
C.Beal	4	146	0.412	5	0.625	1	8	2	0
D.Martinez	3	143	0.324	5	0.313	1	0	0	0
C.Kelades	3	116	0.707	2	0.333	0	6	1	0
R.Borg	4	72	0.673	11	0.733	0	9	1	2
R.Sangcha-an	2	72	0.493	3	0.600	0	4	1	0
J.Sanchez	1	67	0.302	2	1.000	1	4	0	0
J.Delos Reyes	3	64	0.496	2	1.000	2	3	1	1

Table A.2: Data for Bantamweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
T.Dillashaw	11	885	0.497	14	0.389	5	19	0	1
T.Mizugaki	11	788	0.483	16	0.516	3	11	0	0
G.Roop	11	781	0.553	8	0.571	1	3	1	0
R.Barao	10	654	0.386	12	0.429	4	8	0	3
A.Caceres	12	635	0.570	2	1.000	1	14	9	2
V. Lee	8	546	0.652	4	0.333	1	2	0	1
M.Gamburyar	14	497	0.525	30	0.337	1	8	1	3
I.Alcantara	11	483	0.604	14	0.700	2	32	1	0
R.Assuncao	8	467	0.507	11	0.324	1	7	0	1
R.Yahya	10	457	0.653	20	0.351	0	25	3	2
B.Caraway	7	443	0.477	15	0.273	0	23	1	4
Y.Jabouin	10	389	0.468	11	0.500	1	9	4	0
F.Rivera	9	363	0.487	5	0.625	5	1	0	0
M.Brimage	8	351	0.376	3	1.000	2	0	0	0
K. Ho Kang	5	336	0.664	10	0.714	0	30	5	1
E.Wineland	8	335	0.311	2	0.222	3	3	0	0
E.Perez	6	307	0.586	13	0.619	3	7	2	1
A.Sterling	3	286	0.728	10	0.417	0	9	0	1
D.Cruz	3	269	0.531	16	0.471	0	9	1	0
R.Doane	4	252	0.621	10	0.435	1	12	4	1
M.Gagnon	6	243	0.552	5	0.263	1	3	1	3
H.Viana	6	218	0.416	0	0.000	4	0	0	0
M.McDonald	7	217	0.446	6	0.667	5	4	0	1
R.Wee	3	201	0.794	9	0.818	0	13	0	0
C.Holdsworth	2	181	0.597	5	0.625	0	15	0	1
M.Hobar	4	181	0.531	8	0.444	1	8	0	0
T.Almeida	3	178	0.509	0	0.000	1	0	0	0
L.Issa	4	146	0.485	6	0.286	0	12	2	2
C.Gibson	4	129	0.370	5	0.385	2	3	0	0
F.Saenz	2	122	0.663	3	0.750	0	1	1	0

Table A.3: Data for Featherweight

Figher Name	Fights(UFC	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
F. Edgar	18	1777	0.490	61	0.381	2	42	2	2
D. Siver	20	1474	0.457	13	0.333	7	32	5	2
N. Lentz	15	1308	0.656	51	0.347	1	39	0	1
C. Guida	21	1100	0.443	57	0.388	3	46	1	4
T Tavares	16	999	0.637	40	0.417	0	32	5	4
J.Stephens	21	981	0.526	21	0.420	10	5	7	0
D.Elkins	12	829	0.492	15	0.242	1	24	0	0
C.Miller	18	742	0.414	5	0.263	4	24	8	7
U.Faber	12	678	0.515	18	0.321	3	10	2	6
D.Bermudez	10	658	0.565	25	0.417	5	23	2	2
M.Holloway	12	639	0.410	1	1.000	6	2	0	2
S.Siler	9	561	0.552	3	0.214	1	8	1	1
J.Aldo	8	538	0.448	12	0.706	3	11	0	0
C.Oliveira	14	514	0.601	15	0.349	2	14	2	7
C.Swanson	9	480	0.478	6	0.600	4	5	0	0
J.Hettes	6	449	0.688	22	0.449	0	24	2	2
M.Blanco	7	442	0.524	10	0.345	2	4	2	0
C.Mendes	11	391	0.536	24	0.462	6	6	0	0
F.Arantes	8	367	0.570	9	0.600	1	6	5	0
A.Phillips	2	339	0.815	0	0.000	0	1	1	0
S.Sicilia	9	331	0.466	10	0.476	1	10	1	0
H.Dias	5	316	0.646	16	0.471	0	13	0	0
R.Lamas	8	296	0.503	8	0.242	2	5	3	2
D.Brandao	8	287	0.573	15	0.682	2	12	0	2
C.McGregor	6	278	0.509	5	0.833	5	8	0	0
Y.Meza	6	248	0.609	6	0.273	0	15	3	1
M.Eddiva	3	234	0.576	4	0.250	0	0	0	0
M.Bektic	2	232	0.732	5	0.625	1	15	0	0
G.Pepey	7	225	0.603	1	0.091	1	4	3	2
D.Hooker	3	201	0.510	0	0.000	1	0	1	0

Table A.4: Data for Lightweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
N. Diaz	20	1428	0.533	15	0.263	3	14	6	8
S Stout	20	1205	0.328	10	0.385	3	9	1	0
G.Tibau	26	1165	0.49	82	0.543	2	61	1	4
E.Dunham	15	1157	0.437	22	0.349	2	13	1	1
R.Dos Anjos	18	1062	0.515	39	0.448	5	34	1	2
D.Sanchez	21	993	0.404	25	0.187	6	33	3	2
J.Miller	20	828	0.473	26	0.441	3	31	4	6
R. Pearson	16	822	0.468	10	0.323	6	3	1	0
D.Cerrone	18	818	0.507	9	0.36	8	16	2	4
M.Wiman	16	812	0.585	24	0.381	1	23	5	3
G.Maynard	16	665	0.415	36	0.414	6	30	3	0
D.Poirier	13	657	0.537	12	0.324	8	10	3	3
E.Escudero	11	654	0.575	10	0.556	5	7	1	1
D.Castillo	14	639	0.525	29	0.349	2	21	3	0
J.Masvidal	9	573	0.572	12	0.632	2	12	1	1
J.Makdessi	10	566	0.5	0	0	5	0	0	0
E.Barboza	13	513	0.407	4	0.444	8	2	0	1
J.Lauzon	19	507	0.461	24	0.436	2	52	8	7
A.Laquinta	9	505	0.424	8	0.296	5	6	0	0
M.Johnson	14	505	0.376	6	0.5	8	0	2	0
R.Nijem	10	500	0.585	29	0.617	1	21	1	0
F.Trinaldo	11	480	0.525	8	0.421	2	8	1	2
T.Gomi	10	470	0.452	1	0.25	2	3	1	0
T.Ferguson	10	441	0.423	6	0.6	3	4	2	3
P.Hallmann	5	434	0.576	11	0.44	0	6	0	2
D.Cruickskank	12	419	0.407	15	0.429	5	6	2	0
N.Parke	7	415	0.415	15	0.273	0	14	1	0
E.Silverio	5	388	0.581	6	0.857	1	9	0	1
K.Lee	5	344	0.479	14	0.389	0	11	1	1
J.Krause	6	333	0.464	2	0.111	0	2	2	2

Table A.5: Data for Welterweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
C. Condit	11	1172	0.556	6	0.462	5	25	6	0
R. Story	18	1168	0.507	36	0.554	5	28	5	2
B. Henderson	14	1153	0.545	29	0.547	3	22	1	2
J.Hendricks	15	1096	0.572	54	0.519	6	17	0	0
M.Brown	20	1090	0.625	23	0.489	7	15	3	2
J.Hathaway	10	1062	0.597	21	0.438	2	16	1	0
D.Maia	21	1036	0.589	48	0.308	1	64	3	6
T.Alves	20	1034	0.487	11	0.647	11	19	2	1
D.Kim	15	939	0.711	33	0.440	4	44	2	1
M.Pierce	13	918	0.619	31	0.431	3	12	0	1
R.Lawler	15	905	0.508	16	0.800	8	11	3	0
N.Magny	11	848	0.601	23	0.523	1	25	2	1
P.Cote	18	811	0.594	10	0.227	4	15	3	0
A.Sadollah	12	759	0.510	5	0.278	0	7	0	2
C.McGee	8	757	0.403	16	0.327	0	13	0	2
R.MacDonald	13	748	0.476	21	0.500	1	14	1	1
J.Howard	13	729	0.678	27	0.466	1	18	3	0
T.Means	10	631	0.525	7	0.467	5	5	2	1
M.Pyle	15	610	0.637	15	0.385	4	16	2	2
B.Saunders	11	575	0.722	1	0.250	2	4	0	3
M.Swick	15	550	0.502	8	0.471	4	14	1	2
P.Krauss	4	496	0.615	5	0.500	0	7	0	0
K.Robertson	9	496	0.613	8	0.267	2	12	1	2
J.Ellenberger	15	491	0.470	22	0.564	9	6	3	1
D.Hardy	10	491	0.463	6	0.353	3	0	0	0
S.Pierson	6	464	0.497	2	0.182	1	4	2	0
S.Baczynski	11	450	0.387	6	0.167	2	4	0	2
K.Gastelum	7	449	0.498	7	0.500	1	12	3	2
J.Burkman	13	446	0.491	26	0.377	2	7	1	1
S.Spencer	7	442	0.380	1	0.333	2	5	1	0

Table A.6: Data for Middleweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
M. Bisping	24	1616	0.436	26	0.441	5	15	2	0
Ni.Diaz	14	1616	0.596	14	0.350	3	9	4	2
E.Herman	17	956	0.679	30	0.508	2	32	4	4
R.Natal	13	849	0.576	32	0.348	4	34	1	1
L.Machida	21	847	0.582	14	0.636	13	40	2	1
A.Silva	19	771	0.672	3	0.750	17	3	1	3
T. Boetsch	17	759	0.607	19	0.333	6	12	2	0
C.Camozzi	15	730	0.472	0	0.000	0	1	1	1
D.Henderson	15	666	0.575	14	0.452	6	10	3	0
N.Marquardt	19	652	0.583	29	0.604	9	22	3	3
B.Tavares	12	621	0.478	14	0.326	1	6	1	0
D.Miller	14	616	0.516	15	0.517	2	3	2	4
C.Collaway	16	605	0.562	31	0.508	3	32	5	2
T.Leites	14	575	0.498	25	0.313	3	52	0	4
J.Te Huna	9	484	0.663	11	0.379	2	9	0	0
A.Craig	8	450	0.573	3	0.375	2	7	2	0
C.Weidman	9	447	0.525	21	0.568	3	22	0	2
T.Smith	7	413	0.741	5	0.238	0	12	2	0
G.Mousasi	7	396	0.609	4	0.571	1	9	1	1
C.Philippou	11	379	0.442	3	0.429	5	2	1	0
T.Watson	7	353	0.441	0	0.000	1	0	0	0
R.Whittaker	7	314	0.394	2	0.667	4	3	0	0
Y.Romero	7	309	0.634	11	0.458	4	6	0	0
V.Belfort	20	305	0.564	6	0.750	10	10	1	3
U.Hall	7	284	0.580	6	0.400	2	1	3	0
M.Cedenblad	4	280	0.846	6	0.545	0	10	2	2
I.Alcantara	7	279	0.468	13	0.684	0	11	0	1
K.Jotko	4	279	0.784	2	0.250	0	4	2	0
C.Hester	6	275	0.472	4	0.444	3	5	2	0
M.Guimaraes	3	268	0.590	5	0.132	0	1	0	0

Table A.7: Data for Light-Heavyweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
F. Maldonado	10	1042	0.669	4	0.571	1	5	1	0
R.Bader	17	819	0.552	40	0.440	6	34	0	1
M. Rua	15	800	0.626	17	0.395	9	18	0	0
R.Evans	19	796	0.484	50	0.459	4	36	1	0
R. Jackson	13	790	0.536	6	0.300	8	9	0	0
A.Johnson	16	597	0.588	16	0.571	11	7	1	0
A.Gustafsson	12	508	0.441	12	0.400	6	13	0	2
D.Cormier	7	484	0.612	10	0.400	1	15	0	2
T.Lawlor	10	403	0.590	15	0.306	3	6	0	2
G.Villante	6	359	0.522	5	0.263	1	4	0	0
G.Teixeira	8	346	0.478	9	0.529	3	11	1	2
S.O'Connell	5	323	0.580	0	0.000	2	0	0	0
P.Cummins	6	309	0.672	18	0.500	0	14	0	0
C.Anderson	3	236	0.501	9	0.474	0	3	0	0
A.Nogueira	8	232	0.387	1	1.000	2	2	3	0
J.Manuwa	6	220	0.636	3	0.333	1	1	1	0
F.Barroso	3	212	0.635	5	0.185	0	1	0	0
A.Perosh	12	210	0.536	9	0.225	2	15	0	3
N.Krylov	6	204	0.745	0	0.000	2	2	2	1
H.Stringer	3	178	0.757	4	0.364	0	2	0	0
O.Saint Preux	8	143	0.475	5	0.500	2	5	0	1
M.Van Buren	2	117	0.494	0	0.000	0	0	0	0
J.Blachowicz	3	72	0.511	0	0.000	0	0	0	0
C.Dempsey	3	66	0.395	3	0.250	0	2	0	0
R.Cavalcante	4	62	0.473	0	0.000	1	0	0	1
D.Spohn	1	52	0.650	0	0.000	0	2	0	0
I.Latifi	5	47	0.283	3	0.600	1	1	0	1
M.de Lima	3	40	0.851	0	0.000	2	0	0	0
R.Drysdale	1	2	0.286	1	1.000	0	1	0	1
K.Berish	1	1	1.000	0	0.000	0	0	0	0

Table A.8: Data for Heavyweight

Figher Name	Fights(UFC)	Strikes	Strike Accuracy	Take downs	Take down accuracy	Knock downs	Pass	Reversals	Submissions
C. Velasquez	14	1356	0.693	33	0.440	8	29	0	0
S Miocic	9	899	0.600	16	0.340	2	16	0	0
J Dos Santos	13	724	0.483	4	0.571	10	1	0	1
F Werdum	10	605	0.611	6	0.261	2	13	0	2
F Mir	25	537	0.595	20	0.455	8	23	1	8
M Hunt	10	495	0.576	7	0.538	6	8	1	0
A Arlovski	17	491	0.438	2	0.400	10	3	0	2
M.Cro Cop	11	455	0.592	2	0.333	3	7	0	1
S.Struve	15	432	0.558	3	0.750	2	11	5	4
G.Gonzaga	20	429	0.556	21	0.420	7	28	0	4
M.Nogueira	11	420	0.551	7	0.304	4	16	4	2
B.Schub	11	403	0.494	12	0.462	4	10	1	1
A.Overeem	7	384	0.792	2	0.286	4	2	0	0
R.Nelson	15	352	0.406	4	0.167	6	5	0	0
S.Jordan	9	339	0.603	8	0.471	3	14	0	0
M.Mitrione	13	332	0.538	0	0.000	8	2	0	0
T.Browne	12	308	0.491	8	0.727	5	15	0	1
J.Rosholt	6	294	0.667	4	0.333	0	4	0	0
J.Barnett	8	281	0.680	4	0.800	1	10	0	2
S.Palelei	7	273	0.750	8	0.471	0	12	0	0
B.Rothwell	8	257	0.574	7	0.333	3	16	0	1
An.Silva	8	212	0.594	0	0.000	3	3	0	0
A.Hamilton	4	203	0.853	8	0.727	0	5	0	0
V.Pesta	2	170	0.605	5	0.227	0	5	0	0
D.omielanczuk	5	153	0.793	3	0.375	2	1	0	0
R.Magomedov	2	116	0.433	1	1.000	1	0	0	0
D.Lewis	5	102	0.618	2	0.400	0	4	1	0
T.Duffee	5	95	0.364	0	0.000	3	0	0	0
A.Oliynyk	2	51	0.699	1	0.250	1	1	0	1
W.Harris	3	44	0.291	0	0.000	2	0	0	0

APPENDIX B

APPENDIX B

Table B.1: Strikes vs Strike Accuracy

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.507	0	y	2.264*10^-5	0.766	n
Bantamweight		0.553	0	y	-0.00004894	0.628	n
Featherweight		0.591	0	y	-0.0000658	0.133	n
Lightweight		0.496	0	y	-0.00001786	0.694	n
Welterweight		0.469	0	y	0	0.111	n
Middleweight		0.59	0	y	-0.0000307	0.594	n
Lightheavy weight		0.561	0	y	1.248*10^-5	0.902	n
Heavyweight		0.566	0	y	4.657*10^-5	0.605	n

Table B.2: Strikes vs Takedowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		-0.089	0.966	n	0.029	0	y
Bantamweight		4.444	0.067	n	0.012	0.031	y
Featherweight		-2.416	0.511	n	0.031	0	y
Lightweight		-0.575	0.932	n	0.026	0.008	y
Welterweight		-7.03	0.281	n	0.032	0	y
Middleweight		3.711	0.254	n	0.015	0.004	y
Lightheavy weight		-0.103	0.968	n	0.026	0	y
Heavyweight		-0.973	0.548	n	0.02	0	y

Table B.3: Strikes vs Takedown Accuracy

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.532	0	y	0	0.157	n
Bantamweight		0.438	0	y	0	0.596	n
Featherweight		0.414	0	y	-0.00001287	0.903	n
Lightweight		0.453	0	y	-0.00007804	0.469	n
Welterweight		0.246	0.003	y	0	0.016	y
Middleweight		0.438	0	y	-0.000009788	0.925	n
Lightheavy weight		0.253	0.002	y	0	0.151	n
Heavyweight		0.355	0	y	0	0.532	n

Table B.4: Strikes vs Knockdowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.767	0.186	n	0.002	0.226	n
Bantamweight		0.675	0.282	n	0.002	0.099	n
Featherweight		1.275	0.115	n	0.002	0.079	n
Lightweight		2.4	0.059	n	0.002	0.35	n
Welterweight		0.401	0.793	n	0.004	0.053	n
Middleweight		1.948	0.18	n	0.003	0.162	n
Lightheavy weight		0.109	0.866	n	0.007	0	y
Heavyweight		1.329	0.114	n	0.006	0.002	y

Table B.5: Strikes vs Passes

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		3.874	0.064	n	0.019	0.001	y
Bantamweight		5.728	0.094	n	0.011	0.183	n
Featherweight		-0.493	0.855	n	0.025	0	y
Lightweight		1.05	0.873	n	0.021	0.023	y
Welterweight		-7.83	0.201	n	0.031	0	y
Middleweight		6.246	0.182	n	0.011	0.108	n
Lightheavy weight		-0.157	0.936	n	0.022	0	y
Heavyweight		1.867	0.369	n	0.019	0	y

Table B.6: Strike Accuracy vs Takedowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		-1.917	0.842	n	22.635	0.223	n
Bantamweight		3.541	0.559	n	10.397	0.352	n
Featherweight		0.765	0.004	y	-0.649	0.143	n
Lightweight		0.045	0.83	n	0.739	0.094	n
Welterweight		-5.954	0.706	n	42.9	0.141	n
Middleweight		14.647	0.176	n	-4.162	0.82	n
Lightheavy weight		12.008	0.162	n	-6.793	0.639	n
Heavyweight		-0.389	0.952	n	11.983	0.273	n

Table B.7: Strike Accuracy vs Takedown Accuracy

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.602	0.004	y	-0.27	0.466	n
Bantamweight		0.141	0.521	n	0.637	0.121	n
Featherweight		0.765	0.004	y	-0.649	0.143	n
Lightweight		0.045	0.83	n	0.739	0.094	n
Welterweight		0.403	0.022	y	0.041	0.893	n
Middleweight		0.383	0.064	n	0.087	0.8	n
Lightheavy weight		0.871	0	y	-0.946	0.003	y
Heavyweight		0.156	0.466	n	0.41	0.255	n

Table B.8: Strike Accuracy vs Knockdowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		5.504	0.002	y	-8.103	0.015	y
Bantamweight		6.145	0	y	-8.499	0.001	y
Featherweight		10.093	0	y	-13.829	0.003	y
Lightweight		9.191	0.009	y	-11.893	0.086	n
Welterweight		3.966	0.236	n	-1.221	0.838	n
Middleweight		4.058	0.341	n	-0.625	0.931	n
Lightheavy weight		2.795	0.2	n	-0.934	0.779	n
Heavyweight		8.394	0.002	y	-8.22	0.06	n

Table B.9: Strike Accuracy vs Passes

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		-5.495	0.456	n	30.559	0.036	y
Bantamweight		-6.379	0.406	n	30.07	0.039	y
Featherweight		20.033	0.177	n	-9.731	0.71	n
Lightweight		7.422	0.709	n	16.507	0.686	n
Welterweight		-13.847	0.339	n	53.512	0.047	y
Middleweight		9.603	0.487	n	5.531	0.815	n
Lightheavy weight		10.03	0.15	n	-5.416	0.643	n
Heavyweight		3.205	0.654	n	9.593	0.425	n

Table B.10: Takedowns vs Takedown Accuracy

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.481	0	y	-0.002	0.619	n
Bantamweight		0.495	0	y	-0.001	0.843	n
Featherweight		0.401	0	y	0	0.884	n
Lightweight		0.364	0	y	0.002	0.272	n
Welterweight		0.369	0	y	0.003	0.085	n
Middleweight		0.386	0	y	0.004	0.29	n
Lightheavy weight		0.286	0	y	0.006	0.17	n
Heavyweight		0.352	0	y	0.006	0.297	n

Table B.11: Takedowns vs Knockdowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		1.321	0.011	y	0.001	0.971	n
Bantamweight		1.881	0.001	y	-0.031	0.523	n
Featherweight		2.387	0.001	y	0.005	0.861	n
Lightweight		3.806	0	y	-0.02	0.517	n
Welterweight		2.773	0.002	y	0.03	0.43	n
Middleweight		3.085	0.014	y	0.05	0.506	n
Lightheavy weight		1.29	0.037	y	0.12	0.009	y
Heavyweight		2.68	0.001	y	0.139	0.065	n

Table B.12: Takedowns vs Passes

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		4.43	0.004	y	0.596	0	y
Bantamweight		3.747	0.14	n	0.654	0.006	y
Featherweight		4.207	0.033	y	0.656	0	y
Lightweight		1.508	0.456	n	0.815	0	y
Welterweight		4.662	0.128	n	0.613	0	y
Middleweight		0.666	0.792	n	0.986	0	y
Lightheavy weight		0.761	0.308	n	0.76	0	y
Heavyweight		2.402	0.017	y	0.969	0	y

Table B.13: Takedown Accuracy vs Knockdowns

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.918	0.313	n	0.896	0.619	n
Bantamweight		1.762	0.017	y	-0.337	0.796	n
Featherweight		0.847	0.353	n	3.984	0.05	n
Lightweight		4.26	0.002	y	-1.981	0.507	n
Welterweight		-1.645	0.23	n	11.616	0.001	y
Middleweight		-1.517	0.332	n	12.061	0.001	y
Lightheavy weight		1.548	0.083	n	2.044	0.316	n
Heavyweight		4.018	0.001	y	-1.06	0.653	n

Table B.14: Takedown Accuracy vs Passes

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		12.637	0.003	y	-5.194	0.502	n
Bantamweight		6.272	0.091	n	7.111	0.295	n
Featherweight		15.178	0.006	y	-1.258	0.909	n
Lightweight		9.684	0.195	n	14.185	0.408	n
Welterweight		9.934	0.206	n	12.76	0.463	n
Middleweight		6.98	0.254	n	13.378	0.302	n
Lightheavy weight		4.241	0.126	n	8.124	0.205	n
Heavyweight		6.067	0.041	y	6.924	0.268	n

Table B.15: Knockdowns vs Passes

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		11.576	0	y	-1.007	0.213	n
Bantamweight		12.015	0	y	-1.447	0.143	n
Featherweight		15.107	0	y	-0.179	0.859	n
Lightweight		17.958	0.001	y	-0.748	0.494	n
Welterweight		15.102	0	y	0.08	0.928	n
Middleweight		10.228	0.004	y	0.686	0.265	n
Lightheavy weight		3.464	0.079	y	1.568	0.005	y
Heavyweight		6.145	0.012	y	0.738	0.141	n

Table B.16: Passes vs Reversals

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.79	0.045	y	0.05	0.1	n
Bantamweight		0.308	0.559	n	0.092	0.03	y
Featherweight		1.483	0.023	y	0.026	0.416	n
Lightweight		0.956	0.037	y	0.061	0.006	y
Welterweight		0.914	0.032	y	0.051	0.018	y
Middleweight		1.299	0.001	y	0.021	0.284	n
Lightheavy weight		0.332	0.055	n	0	0.993	n
Heavyweight		0.204	0.526	n	0.026	0.338	n

Table B.17: Passes vs Submissions

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.16	0.528	n	0.033	0.101	n
Bantamweight		0.562	0.077	n	0.038	0.117	n
Featherweight		0.662	0.238	n	0.062	0.038	y
Lightweight		0.68	0.189	n	0.073	0.005	y
Welterweight		0.447	0.174	n	0.051	0.004	y
Middleweight		0.464	0.16	n	0.052	0.006	y
Lightheavy weight		0.402	0.047	y	0.024	0.171	n
Heavyweight		0.029	0.945	n	0.11	0.004	y

Table B.18: Reversals vs Submissions

		Intercept	Significance level	Significant	Slope	Significance level	Significant
Flyweight		0.487	0.043	y	0.01	0.935	n
Bantamweight		0.778	0.003	y	0.13	0.222	n
Featherweight		0.814	0.092	n	0.403	0.02	y
Lightweight		0.189	0.64	n	0.848	0	y
Welterweight		1.231	0.002	y	0.001	0.993	n
Middleweight		0.76	0.063	n	0.239	0.222	n
Lightheavy weight		0.605	0.002	y	-0.114	0.621	n
Heavyweight		0.736	0.027	y	0.61	0.025	y

APPENDIX C

APPENIDIX C

Table C.1: Flyweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.152	30	.074	.846	30	.001
Strike.Accuracy	.082	30	.200	.988	30	.975
Takedowns	.216	30	.001	.632	30	.000
Takedown.Accuracy	.215	30	.001	.843	30	.000
Knockdowns	.272	30	.000	.703	30	.000
Passes	.137	30	.160	.918	30	.025
Reversals	.259	30	.000	.850	30	.001
Submissions	.386	30	.000	.629	30	.000

Table C.2: Bantamweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.129	30	.200	.913	30	.018
Strike.Accuracy	.080	30	.200	.988	30	.979
Takedowns	.117	30	.200	.925	30	.036
Takedown.Accuracy	.096	30	.200	.971	30	.555
Knockdowns	.275	30	.000	.831	30	.000
Passes	.165	30	.036	.883	30	.003
Reversals	.306	30	.000	.652	30	.000
Submissions	.260	30	.000	.787	30	.000

Table C.3: Featherweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.169	30	.028	.843	30	.000
Strike.Accuracy	.107	30	.200	.954	30	.215
Takedowns	.198	30	.004	.801	30	.000
Takedown.Accuracy	.145	30	.111	.962	30	.346
Knockdowns	.209	30	.002	.858	30	.001
Passes	.190	30	.007	.880	30	.003
Reversals	.209	30	.002	.812	30	.000
Submissions	.251	30	.000	.744	30	.000

Table C.4: Lightweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.183	30	.012	.882	30	.003
Strike.Accuracy	.104	30	.200	.958	30	.270
Takedowns	.216	30	.001	.770	30	.000
Takedown.Accuracy	.154	30	.068	.968	30	.487
Knockdowns	.181	30	.014	.909	30	.014
Passes	.203	30	.003	.836	30	.000
Reversals	.252	30	.000	.811	30	.000
Submissions	.210	30	.002	.801	30	.000

Table C.5: Welterweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.148	30	.094	.898	30	.008
Strike.Accuracy	.125	30	.200	.971	30	.580
Takedowns	.155	30	.062	.908	30	.013
Takedown.Accuracy	.115	30	.200	.968	30	.491
Knockdowns	.181	30	.013	.897	30	.007
Passes	.189	30	.008	.789	30	.000
Reversals	.176	30	.019	.879	30	.003
Submissions	.208	30	.002	.780	30	.000

Table C.6: Middleweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.185	30	.010	.789	30	.000
Strike.Accuracy	.129	30	.200	.954	30	.221
Takedowns	.199	30	.004	.891	30	.005
Takedown.Accuracy	.099	30	.200	.964	30	.399
Knockdowns	.204	30	.003	.804	30	.000
Passes	.257	30	.000	.813	30	.000
Reversals	.175	30	.020	.895	30	.006
Submissions	.290	30	.000	.778	30	.000

Table C.7: Light-Heavyweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.185	30	.010	.879	30	.003
Strike.Accuracy	.108	30	.200	.960	30	.313
Takedowns	.239	30	.000	.694	30	.000
Takedown.Accuracy	.157	30	.057	.901	30	.009
Knockdowns	.270	30	.000	.762	30	.000
Passes	.227	30	.000	.734	30	.000
Reversals	.447	30	.000	.540	30	.000
Submissions	.379	30	.000	.695	30	.000

Table C.8: Heavyweight Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Strikes	.160	30	.049	.850	30	.001
Strike.Accuracy	.126	30	.200	.981	30	.852
Takedowns	.258	30	.000	.772	30	.000
Takedown.Accuracy	.144	30	.114	.953	30	.207
Knockdowns	.179	30	.016	.907	30	.012
Passes	.181	30	.014	.886	30	.004
Reversals	.445	30	.000	.428	30	.000
Submissions	.284	30	.000	.629	30	.000

APPENDIX D

APPENDIX D

Table D.1: Test of Homogeneity of Variances for Knockdowns

Levene Statistic	df1	df2	Sig.
2.749	7	232	.009

Table D.2: Test of Homogeneity of Variances for Passes

Levene Statistic	df1	df2	Sig.
2.120	7	232	.042

Table D.3: Test of Homogeneity of Variances for Reversals

Levene Statistic	df1	df2	Sig.
3.856	7	232	.001

Table D.4: Test of Homogeneity of Variances for Strike Accuracy

Levene Statistic	df1	df2	Sig.
1.770	7	232	.094

Table D.5: Test of Homogeneity of

Variances for

Strikes

Levene Statistic	df1	df2	Sig.
1.885	7	232	.073

Table D.6: Test of Homogeneity of

Variances for

Submissions

Levene Statistic	df1	df2	Sig.
4.146	7	232	.000

Table D.7: Test of Homogeneity of Variances for Takedown Accuracy

Levene Statistic	df1	df2	Sig.
1.981	7	232	.059

Table D.8: Test of Homogeneity of Variances for Takedowns

Levene Statistic	df1	df2	Sig.
3.620	7	232	.001

APPENDIX E

APPENDIX E

Table E.1: ANOVA Table for Knockdowns

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	182.267	7	26.038	3.455	.002
Within Groups	1748.467	232	7.536		
Total	1930.733	239			

Table E.2: Fisher Knockdowns

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	Y	Y	Y	N	Y
BW(2)			N	Y	Y	Y	N	Y
FTW(3)				N	N	N	N	N
LW(4)					N	N	N	N
WW(5)						N	N	N
MW(6)							Y	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.3: Tukey Knockdowns

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	Y	N	Y
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	N	N
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.4: ANOVA Table for Passes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2213.533	7	316.219	2.485	.018
Within Groups	29519.400	232	127.239		
Total	31732.933	239			

Table E.5: Fisher Passes

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							Y	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.6: Tukey Passes

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)	N		N	N	N	N	N	N
FTW(3)	N	N		N	N	N	N	N
LW(4)	N	N	N		N	N	N	N
WW(5)	N	N	N	N		N	N	N
MW(6)	N	N	N	N	N		N	N
LHW(7)	N	N	N	N	N	N		N
HW(8)	N	N	N	N	N	N	N	
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.7: ANOVA Table for Strike Accuracy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.232	7	.033	2.820	.008
Within Groups	2.721	232	.012		
Total	2.953	239			

Table E.8: Fisher Strike Accuracy

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	Y	N	Y
BW(2)			N	N	N	N	N	N
FTW(3)				Y	N	N	N	N
LW(4)					Y	Y	Y	Y
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.9: Tukey Strike Accuracy

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	Y	N	Y
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table C.10 ANOVA Table for Strikes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6122854.529	7	874693.504	10.098	.000
Within Groups	20095456.433	232	86618.347		
Total	26218310.963	239			

Table E.11: Fisher Strikes

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	Y	N	N
BW(2)			Y	Y	Y	Y	N	N
FTW(3)				N	Y	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						Y	Y	Y
MW(6)							Y	Y
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.12: Tukey Strikes

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	Y	N	N
BW(2)			N	Y	Y	N	N	N
FTW(3)				N	N	N	Y	N
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							Y	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.13: ANOVA Table for Takedown Accuracy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.425	7	.061	1.336	.234
Within Groups	10.551	232	.045		
Total	10.977	239			

Table E.14: Fisher Takedown Accuracy

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	Y	N
BW(2)			N	N	N	N	Y	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	N	N
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.15: Tukey Takedown Accuracy

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	N	N
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.16: ANOVA Table for Takedowns

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3834.600	7	547.800	3.846	.001
Within Groups	33045.133	232	142.436		
Total	36879.733	239			

Table E.17: Fisher Takedowns

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	N	N	N
BW(2)			Y	Y	Y	N	N	N
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.18: Tukey Takedowns

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	N	Y
WW(5)						N	N	Y
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.19: ANOVA Table for Reversals

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	78.196	7	11.171	4.446	.000
Within Groups	582.967	232	2.513		
Total	661.163	239			

Table E.20: Fisher Reversals

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	Y	Y
BW(2)			N	N	N	N	Y	N
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							Y	Y
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.21: Tukey Reversals

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.22: ANOVA Table for Submissions

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42.250	7	6.036	2.604	.013
Within Groups	537.733	232	2.318		
Total	579.983	239			

Table E.23: Fisher Submissions

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	N	N	N	N
BW(2)			N	Y	N	N	N	N
FTW(3)				N	N	N	Y	N
LW(4)					N	N	Y	Y
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table E.24: Tukey Submissions

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	Y	N	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	Y	N
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

APPENDIX F

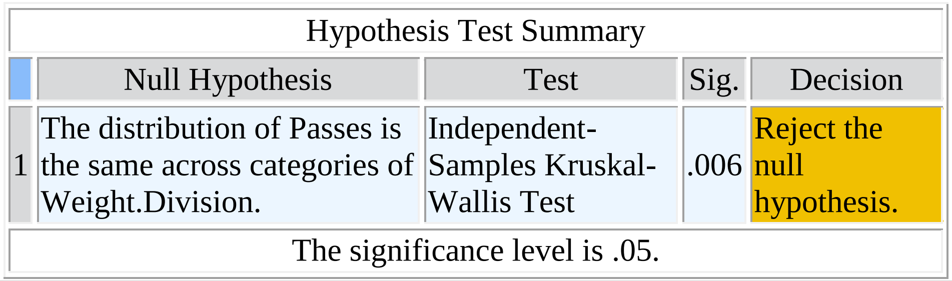
APPENDIX F

Table F.1: Kruskal-Wallis Output for Knockdowns

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Knockdowns is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	Y	N	Y
BW(2)			N	Y	Y	Y	N	Y
FTW(3)				N	N	N	N	N
LW(4)					N	N	Y	N
WW(5)						N	Y	N
MW(6)							N	N
LHW(7)								Y
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

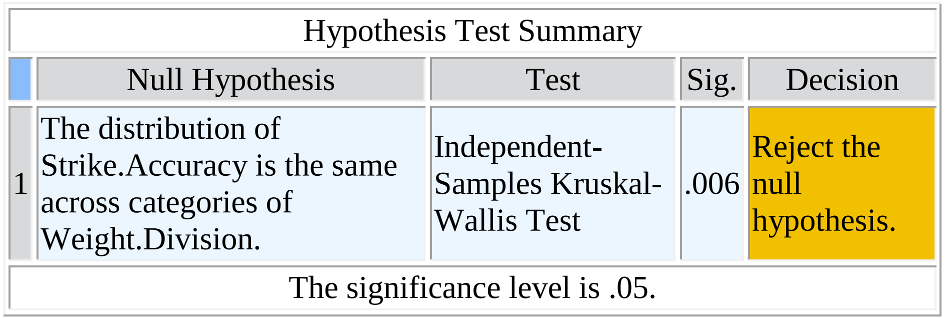
Table F.2: Kruskal-Wallis Output for Passes



Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Passes is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	Y	N
BW(2)			N	N	Y	N	N	N
FTW(3)				N	N	N	Y	N
LW(4)					N	N	Y	N
WW(5)						N	Y	Y
MW(6)							Y	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table F.3: Kruskal-Wallis Output for Strike Accuracy



Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Strike.Accuracy is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	N	Y
BW(2)			N	Y	N	N	N	N
FTW(3)				Y	N	N	N	N
LW(4)					Y	Y	Y	Y
WW(5)						N	N	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table F.4: Kruskal-Wallis Output for Strikes

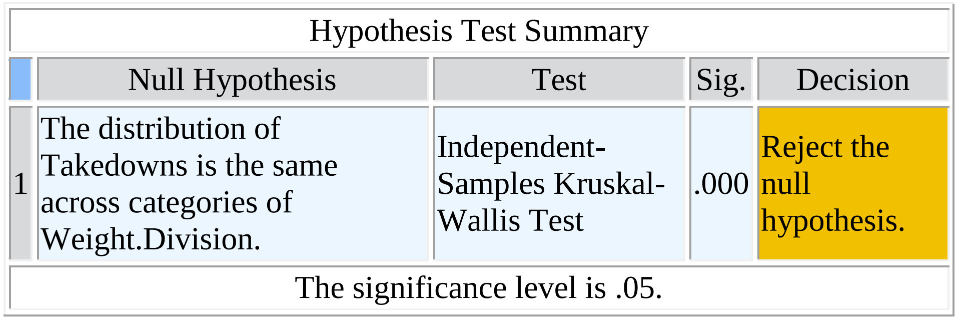
Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Strikes is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	Y	N	N
BW(2)			Y	Y	Y	Y	N	N
FTW(3)				N	Y	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						Y	Y	Y
MW(6)							Y	Y
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table F.5: Kruskal-Wallis Output for Takedown Accuracy

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Takedown.Accuracy is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.320	Retain the null hypothesis.
The significance level is .05.				

Table F.6: Kruskal-Wallis Output for Takedowns



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Takedowns is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

The significance level is .05.

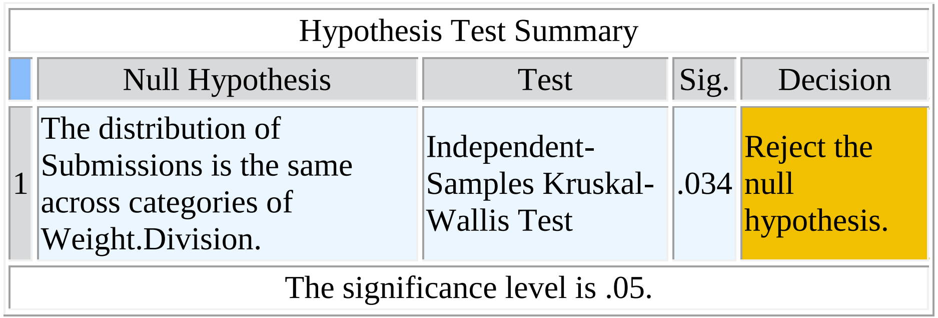
	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	Y	Y	N	N	N
BW(2)			N	Y	Y	N	N	N
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							Y	Y
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table F.7: Kruskal-Wallis Output for Reversals

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Reversals is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	N	N	N	N	Y	Y
BW(2)			N	Y	Y	Y	N	Y
FTW(3)				N	N	N	Y	Y
LW(4)					N	N	Y	Y
WW(5)						N	Y	Y
MW(6)							Y	Y
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

Table F.8: Kruskal-Wallis Output for Submissions



Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Submissions is the same across categories of Weight.Division.	Independent-Samples Kruskal-Wallis Test	.034	Reject the null hypothesis.
The significance level is .05.				

	FLW(1)	BW(2)	FTW(3)	LW(4)	WW(5)	MW(6)	LHW(7)	HW(8)
FLW(1)		N	Y	Y	Y	N	N	N
BW(2)			N	N	N	N	N	N
FTW(3)				N	N	N	N	N
LW(4)					N	N	Y	N
WW(5)						N	Y	N
MW(6)							N	N
LHW(7)								N
HW(8)								
FLW=FlyWeight								
BW=BantamWeight								
FTW=FeatherWeight								
LW=LightWeight								
WW=WelterWeight								
MW=MiddleWeight								
LHW=LightHeavyWeight								
HW=HeavyWeight								
Y-Significant								
N-Not Significant								

BIOGRAPHICAL SKETCH

Victor Villalpando was born 1990 in Weslaco, Texas. He completed his Associates in Education from South Texas College in the year 2012. He then went on to complete his Bachelor of Science in Mathematics in 2014 at UTPA. Immediately finishing his BA he began the Master's program and received his MS in August 2016 at UTRGV. He can be contacted at vvillalpando@outlook.com.